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System Approach to Direct the System Development Capability

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Abstract

In the paper our original approach for taking decisions in capability development process is presented. The developed model is a tool that formally includes real options logic and thus directs the decision-making process regarding development of capabilities. Basic method applied to the numeric part of the model is fuzzy analytic hierarchy process. The following phase uses interval results of this method to calculate the integral uncertainty evaluation, which compared with boundary assessment, defines the risk of this process. How the use of such model will affect the quality of decision-making in real environment will be known the future, when the model will actually be subjected to the learning curve logic.

Keywords: dynamic capabilities; system approach; decision-making; uncertainty; risk

1. Introduction

Addressing strategic capacities opens many different problems when we encounter the issue of how to manage capacity [1]. The problem management capacities issue is associated with uncertainty, because uncertainty a primordial characteristic of the capacity development, due to structural and procedural features [2].

Structural features represent the fact that capacity is a system as well. Capacity is composed of dispersed knowledge [3]. It consists therefore of a combination of different knowledge and resources. The capacity represents integrated knowledge, and such knowledge can be integrated at different levels [4]. An overview of the system features shows that the capacity is a very complex system. The complexity of this system affects the uncertainty, since, due to limited rationality, the managers never know exactly what forms the capacity of the organizational

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system [5]. We can never know with certainty what combination of knowledge will be required in specific circumstances.

The capacity is to a great extent determined by the process characteristics as well [6]. Just as the individual's knowledge is formed in very long cycles and lifelong learning is discussed more and more, the knowledge of the organizational system develops though a long-lasting process. This of course means that the capacity of the organizational system is of strategic importance because competitors cannot easily imitate capacity which has resulted from a long and unique learning process determined by the historical dependence [7]. Uncertainty of the capacity development is determined by the inability of individuals to predict the future [8].

The fact that the process of capacity development is uncertain due to the complex structure of knowledge in the organizational system and its long-lasting development, urged the researchers to examine the applicability of real options theory to interpret the process of capacity development [9]. Strategic options arise as an interface between the knowledge of the organization system and the opportunities offered by the environment. Existing capacities, therefore allow access to potential opportunities in the future [10]. When a business opportunity becomes sufficiently clear and certain, it is possible to identify a set of real options that are executed when the uncertainties are reduced. Capacities represent a fund of knowledge that allows the organizational system to take advantage of potential opportunities or eliminate the potential dangers. By developing their capacities the companies are buying options enabling them to take advantage of a business opportunity in the future [11]. The more uncertain business opportunity, the more organizational system gains i.e. it loses less, if there are options at disposal [12].

Investing in capacity development means creating opportunities to use business opportunities in the future. When such opportunities arise, i.e. the uncertainty of the existence of opportunities is reduced, the organizational system will know more than at the time when the capacity development was started [13].

2. System approach

The system approach to direct skills development has been developed to facilitate the transfer of the model and its logic in various system environments and the rules governing its use value. In the following text, the system approach is described in order to emphasize the application of the developed heuristics.

System approach as our original contribution consists of three substantial parts:

- Analytical part,
- Process part,
- Decision-making part.

As the results of the research show, the developed heuristic model is used to support and develop capabilities using real options theory in economic organization [14, 15].

Transferability-usability of the model: it is recommendable to transfer it to another business environment, such as for instance, transfer of technical and technological activities in all parallel system business functions. Meanwhile, it would be interesting to follow all the uncertainties both in terms of techniques and technologies, as well as the economic indicators of the business system.

2.1. Analytical part

The analytical part is similar to project start. Before you can begin implementing the processing and decision-making part, the basic problems shall be evaluated and all necessary information shall be obtained, as to define the development of the capability in question. It is important to form an expert group to carry out the assessment of the importance and uncertainty of factors. The expert group must be divergent in regard to experience, education, formal status and age. Divergence depends on the complexity of the problem. The more complex the problem, the more divergent the group shall be.

In the analytical part, it is necessary to analyze in detail the resources and capabilities. It is necessary to determine which resources and capabilities are already available and in which contexts they can be used. The deficit of resources and capabilities shall be established as well. The professional literature offers some systemic approaches that support the analysis of resources and capabilities. Before the expert group undertakes capability development breakdown into categories and factors, it is necessary to define the types of uncertainties.

The breakdown of the reviewed process into categories and factors of uncertainty represents a part which is substantially different in the various system environments. The expert group, which deals with uncertainty of moving the production in a geographically remote location, will identify the different factors and categories than the expert group for business system, which deals with the implementation of the business operations of the system. The breakdown into categories and factors of uncertainty represents decomposition of the complex problem and enables launching of the process part.

2.2. Process part

The process part is dedicated to valorisation of the analyzed factors. The basic method used is the fuzzy analytic hierarchy process (primarily used to support multi-attribute decision making), which is based on mutual determining of the relationships between the individual categories and factors of uncertainty (first according to their importance, and in the next phase according to the degree of uncertainty of factors) and the mathematical calculation of weights reflecting the previously mentioned importance and the degree of uncertainty. The advantage of the method is exactly in the mutual determination of the relations, as it is significantly easier to assess by comparing in pairs and use of fuzzy numbers, when in the calculation, the possibility of error by the evaluator is taken into consideration for one class (to the left or to the right, while a bigger error is practically excluded) and this is taken in account in the calculation, since the results are shown at certain intervals. The disadvantage of the applied method is the relatively large number of required assessments, which can be avoided by grouping the factors into categories, as early as in the analytical part, as well as the risk of non-compliant over-evaluation, requiring a repeat of the comparison procedure, i.e. correction of the selected assessments.

Herein below, we use the interval results of the fuzzy AHP method to construct the vector of significance of factors and vector of uncertainty of factors, the scalar product of which gives an integrated assessment of uncertainty, which compared with the limit assessment, defines the risk of the process in question.

<u>Integral evaluation of uncertainty</u>

The problem of uncertainty, discussed through categories and factors, shall also be quantified in numbers. Applying the method of fuzzy AHP [16] the areas (intervals) and significance level of uncertainty for each factor is established, which enables appropriate selection of more or less critical factors (Fig. 1). The specified value areas are used as follows:

- creation of vector of factors importance $\vec{P}$, whose members are the values of factors importance obtained as arithmetic mean between the minimum and maximum value of the importance factor (given in percentage),
- creation of vector of factors uncertainty $\vec{N}$, whose members are the values of the uncertainty degree, calculated as the arithmetic mean of the extreme values of uncertainty degree (given in percentage).

The integral (total) uncertainty assessment *(ION)* is the scalar product of the vectors $\vec{P}$ and $\vec{N}$:

$$ION = \vec{P} \cdot \vec{N} \tag{1}$$

The limit assessment of uncertainty is obtained by using the same average values for all components of vectors, i.e. with n factors:

$$ION_m = \sum_{i=1}^{n} \left[\left(\frac{100}{n} \right) \cdot \left(\frac{100}{n} \right) \right] = n \cdot \frac{100}{n} \cdot \frac{100}{n} = \frac{10000}{n} \tag{2}$$

The realistic limits of *ION* in practical use are related to the number of factors (in range of 4 to about 100), which gives: ION_m = 100 ... 2500.

The integral assessment of uncertainty, exceeding the limit, shows that there is activity (operation) of high risk and vice versa [17, 18, 19].

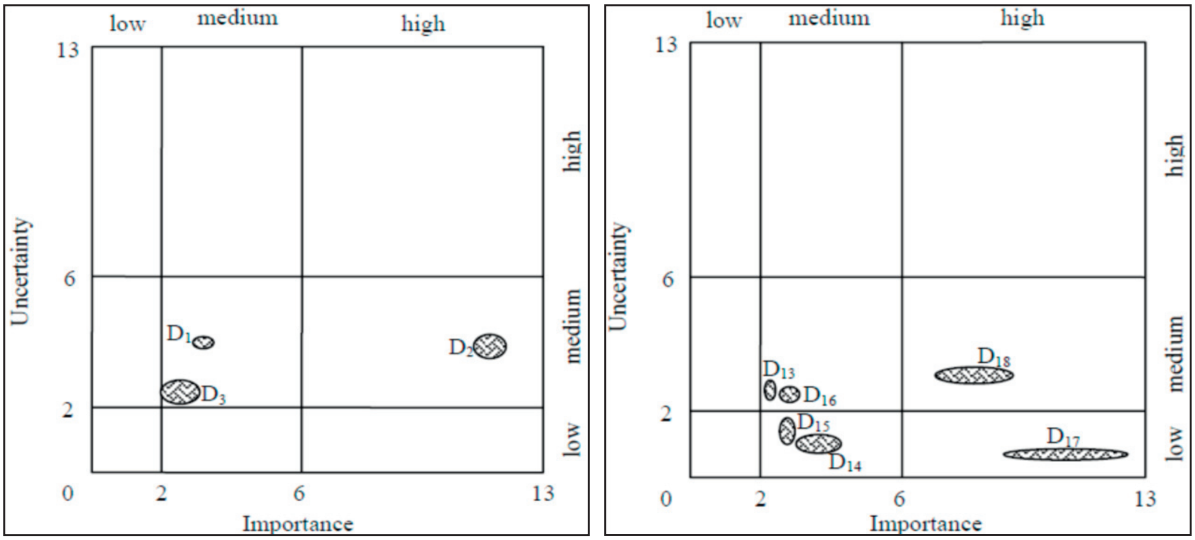

Fig. 1. Positions of factors of category K_1 (left) and K_4 (right).

Based on the original diagrams 'Uncertainty/ Importance' ABC attention diagram is formed (Fig. 2) which serves for selection i.e. ranking of uncertainty factors on which the decision making regarding the system approach is based.

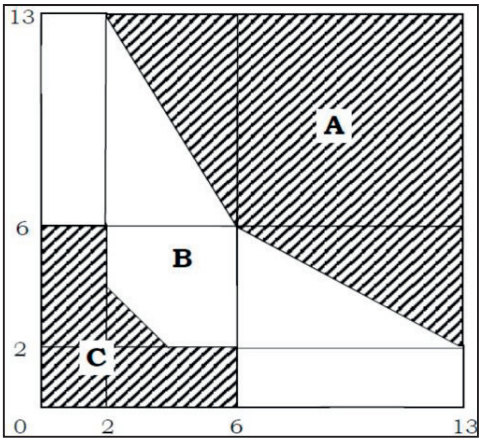

Fig. 2. Attention area (A – higher, C – lower).

2.3. Decision making part

Decision-making is the most important part of the approach, from aspect of model applicability criteria. In this part, the logic of the model is transferred into real decisions. The decision making model starts with ranking of factors. Factors C are those who do not need special attention having in mind the level of importance and uncertainty. When such factors required certain decisions or actions, they can be implemented quickly and effectively, without any special worries on how it will impact the consequences of the decision (Fig. 3).

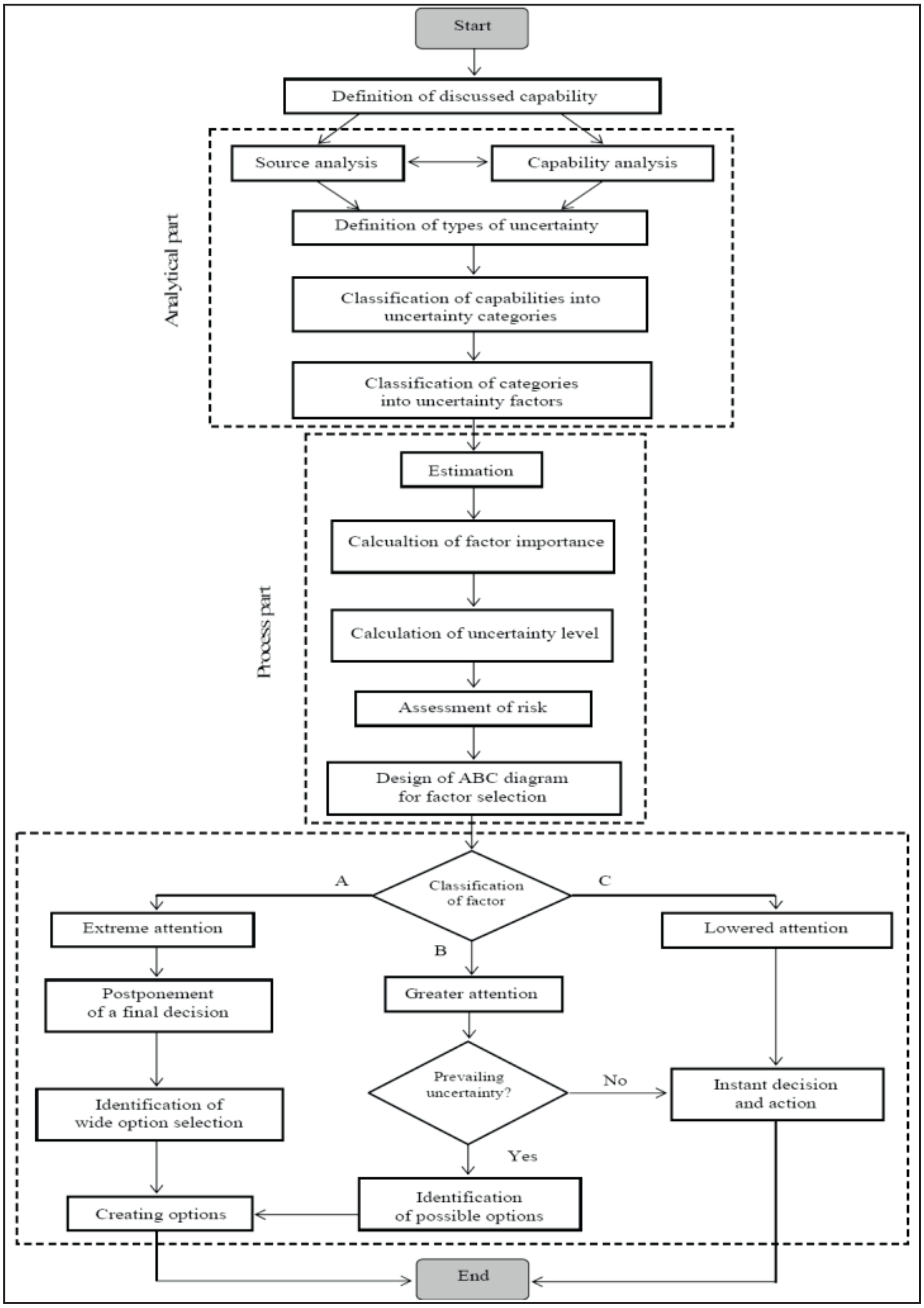

Fig. 3. System approach to direct capability development.

Factors A represent the opposite pole of factors in order of importance and uncertainty. These factors should be given utmost attention. The instructions shall be reviewed in detail as to propose final decisions. These instructions shall not be construed as a proposal for not making a decision. The instructions say that in this case no decisions shall be adopted that would be final and would not allow for flexible action. These decisions should be aimed at creating a wide range of options that enable reaction under different scenarios of development. Prior to making of decision that creates options in the future, it is necessary to identify a wide range of possible options. B factors, according to their importance and the degree of uncertainty, are among factors A and C. These are factors that should be paid great attention to. The share of attention, of course, also depends on many factors which have been identified as factors with A degree. If a large number of factors with A degree are obtained, then the attention to factors with B degree will be slightly lower than in the case where there are only a few A factors. In case when the factors are in category B since they are important, but they are not subject to uncertainty, it is possible, for them to adopt the same measures as for the factors C. In case of significant uncertainty, decisions that enable flexible action in the future must also be adopted for factors B (Fig. 3).

3. Conclusion

The presented model incorporates an original synthesis of real options theory, risk management, uncertainty modelling, Analytic Hierarchy Process method and fuzzy logic and represents a contribution to developing tools for support in decision making in directing development of production capabilities in an organization system. The procedure is designed with moderate and manageable number of factors and provides a comprehensive management of problems that arise in search for acceptable solutions.

The system approach to direct capability development has been developed to facilitate the transfer of the model and its logic in various system environments and the rules governing its use value.

The model is extremely application-oriented, while the link of real options theory and fuzzy logic is highly original. The key advantage of the model is its contextual robustness. The model was developed on a production system case, but it can easily be transferred into the environment of business systems.

Using the logic of real options, despite the restrictions of the individual decision making case study in relation to the development of capability, has proven to be adequate.

Heuristic system approach based on real options theory as a support for decision-making in the production system has proven to be adequate. The most important part and original contribution of our work is the uncertainty quantification and the three-step system approach for decision-making under uncertainty. All listed and applied tools were found suitable and optimal for directing the development of capability.

Future work will be focused in development of software tools for higher degree of decision-making process automation tested in many real business conditions and in improvement of classification procedure of uncertainty factors.

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