

**SPECIFICS OF MANAGEMENT OF ENTERPRISE INNOVATION ACTIVITIES
IN THE CZECH REPUBLIC – THE DECISION-MAKING MECHANISM***Jindra PETERKOVÁ, Jiří FRANEK*
*VŠB – Technical University of Ostrava***Abstract:**

The majority of Czech managers are aware that the long-term competitiveness of the company depends primarily on the use of innovative technical solutions and investments in new technologies. Despite awareness of the importance of innovation, many companies do not know how to manage, implement, and evaluate them. Empirical research showed that most innovation firms implement, but do not systematically manage the implementation of innovative projects and the allocation of funds. There is a contradiction between companies' ability to orientate themselves in the approaches available in the area of innovation management and the existence of a large number of approaches that can be used to address a particular type of innovation problem. A set of innovation concepts has been created to solve those challenges. Practical steps of the decision-making mechanism for selecting innovation concepts have been proposed. The decision-making mechanism is based on the analytic hierarchy process (AHP) and serves primarily for managers of medium and large enterprises.

Key words: *AHP method, innovation activities, innovation concept, innovation management*

INTRODUCTION

The results of the statistical survey of innovation for the period 2012-2014 show that 42% of enterprises realize innovation activities [16]. However, from an international perspective, enterprises in the Czech Republic innovate less than the EU27 average (49% for 2010-2012) [16]. Innovations are most intensively implemented by large enterprises and, regardless of the size of the enterprise, more technical innovations than non-technical innovations. In terms of enterprise ownership, large and small enterprises with foreign control (54%) innovate more than domestic enterprises (39%) [16]. What is the success of innovative businesses? Successful innovative companies know why to innovate and not only reduce costs, what types of innovation can be realized, and what benefits from implemented innovations arise. At the same time, they are able to manage innovation activities and evaluate the effects of them [21, 24]. On the one hand, many companies are aware of the importance of innovation for their further development, but they do not know how to manage, implement and evaluate innovations [11, 28, 30]. It leads to the following questions for managers: Can innovation be managed at all? In the case innovations can be managed, how to you approach to it? It is pointed out that innovation can be managed, but it is not easy [15, 23]. Innovations are a key business process that is linked to the change of what an enterprise offers how it is created and delivered to the customer. On the other hand, literature and business re-

sources provide a great number of principles on how to create an innovative business, the best practices of successful companies, and a range of approaches to innovation management, innovation implementation and evaluation. There is a contradiction between companies' ability to orient themselves in the approaches available in the area of innovation management and the existence of a large number of approaches that can be used to address a particular type of innovation problem. Suggestions for solutions that respond to the enterprise's ability to innovate are called concepts in the paper.

The primary goal of the paper is to present results of performed empirical research on the management of innovation activities of enterprises in the Czech Republic on a selected sample of enterprises, and to create a set of innovation concepts that can be used to solve innovative problems. Secondary goal is to create a set of decision-making criteria with the help of expert team for practical use based on the AHP method. This decision-making mechanism will make it easier for business managers to decide on the choice of concepts of innovation.

RESEARCH METHODOLOGY*Empirical research*

The empirical research lasted 2 months. During this time personal interviews in companies on the basis of pre-prepared questions were done. Data obtained from empirical research on a selected sample of 130 companies was pro-

cessed by SPSS. Determination of the type of implemented innovation management model in selected companies is based on a theoretical model of innovation management which is modified for the purpose of the research [30]. A selective analysis is performed to assess differences in types of innovation management models with respect to enterprise size. The Pearson's chi-squared test was used for the assessment.

Innovations concepts

Selection of the concepts presented in this paper reflects the level of reached research findings in the time of the paper submitting. Set of 10 innovation concepts was worked out based on searches, see Table 1.

Table 1
Set of 10 Innovation Concepts

Concept title	Concept Abbreviation	Determination according to following authors
Concept based on measurement of innovation performance	I ₁	[27], [6], [32], [19]
Concept Balanced Scorecard	I ₂	[9], [20]
Concept based on the evaluation of innovations through investment efficiency indicators	I ₃	[1], [25], [7]
Concept of value analysis	I ₄	[17], [29]
Concept based on organizational readiness for innovation	I ₅	[6]
Concept based on determination of innovative potential	I ₆	[14], [18], [10]
Concept based on the creation of innovative radar	I ₇	[27], [6]
Concept based on the innovation index	I ₈	[6]
Concept based on an innovative interactive panel	I ₉	[3], [5]
Concept based on experience from corporate practice	I ₁₀	[12], [13]

Source: [22].

Criteria creation for innovation concept selection

On the basis of an experts' discussion (3 + 3 persons) a list of 8 criteria was elaborated in order to evaluate innovation concepts. Criteria were mainly assessed according to their use (operability), the tightness of the links among the individual criteria (independence) and whether they are not overdeveloped (non-redundancy). In case of 5 criteria (from 8) selected by the expert group it is possible to determine order of importance. Selected criteria C₁ to C₅, see Table 2, have the nature of the maximization criteria, that is, the best variants according to this criterion have the highest values. Criteria C₁, C₂, C₃, C₄, C₅ evaluate an object by expressing a certain intensity of the rating on a given scale from 1 to 5.

Table 2

Chosen criteria for applications in decision models

Criteria for evaluation of innovation concepts	Determined rating scale	New order and criterion designation
C ₃ - applicability of the concept of innovation in practice	(1 - very low, 2 - low, 3 - average, 4 - high, 5 - very high).	C ₁
C ₅ - usability of the concept of innovation in an enterprise	(1 - very low, 2 - low, 3 - average, 4 - high, 5 - very high).	C ₂
C ₆ - level of elaboration of the concept of innovation into management levels	(1 - very low, 2 - low, 3 - average, 4 - high, 5 - very high).	C ₃
C ₇ - determination of innovation metrics and their form	(1 - very low, 2 - low, 3 - average, 4 - high, 5 - very high).	C ₄
C ₈ - savings resulting from training of existing employees when implementing the concept of innovation	(1 - very low, 2 - low, 3 - average, 4 - high, 5 - very high).	C ₅

Procedural steps of the AHP method

The AHP method is based on pair-wise comparisons to determine priorities. The partial goal of AHP is to reduce the number of scale dimensions to one. The process of the analytic hierarchical process is determined by the following steps [4, 22, 31]:

- Determining the weights of the criteria using the Saaty method (quantitative pair-wise comparison) and determining the order of the individual criteria based on the calculated weights w_i according to the formula (1), checking the consistency of the matrix pair comparison (2).
- Assessing each variant based on the Saaty scale preferences (1-9) in each criterion and calculating the weights by means of the geometric mean of the lines (2) and then verifying the consistency of the pair-wise comparison matrix (3).
- Creating an AHP matrix, the weights of the criteria and weights of each variant in the relevant criteria.
- Calculation the final score (the weighted sum of each criterion weights and the weights of the respective variants) and determining the order of the variants.
- For determination of weights, we can use Saaty's method of quantitative pair-wise comparison based on the matrix = s_{ij} , where $i, j = 1, 2, \dots, k$. The s_{ij} elements of the pair-wise matrix represent estimated relative weights of the i -th and j -th criterion [8]:

$$s_{ij} \approx \frac{w_i}{w_j} \tag{1}$$

where:

$i, j = 1, 2, \dots, k$

Pair-wise comparison of the criteria determines the dimension of the preference, which is expressed by a certain number of points from the Saaty's scale: "1", i and j are equal, "3", i is slightly preferred to j , "5", i is strongly preferred to i and strongly preferred before j , "7", i is very strongly preferred to j , "9", i is absolutely preferred to is given to j , values 2, 4, 6 and 8 are left to evaluate the intermediate stages.

The decision-making is performed by using pair-wise comparisons of a set of items (criteria) f_1, f_2, \dots, f_k [8]. By comparing these items with each other the matrix $S = (s_{ij})$ is created, where $i, j = 1, 2, \dots, k$. It is now necessary to derive the weight of these items (criteria) from the pair-wise comparison matrix. The vector of their values is denoted by $v = (w_1, w_2, \dots, w_k)$. Pair-wise comparison matrix S contains quantified information about the relationship of the individual pairs of items illustrated in Figure 1. The element s_{ij} of this matrix can be interpreted as the ratio of the importance of the elements f_i and f_j . The elements on the diagonal have assigned value $s_{ii} = 1$ (the criterion is equivalent to itself). The matrix S is reciprocal, ie. must apply that $s_{ij} = 1/s_{ji}$ for all i .

	f_1	f_2	...	f_k
f_1	1	s_{12}	...	s_{1k}
f_2	$1/s_{12}$	1		s_{2k}
\vdots	\vdots			
f_k	$1/s_{1k}$	$1/s_{2k}$...	1

Fig. 1 General Outlook of the Saaty Matrix

Source: [8].

In practice, the most commonly used method of weights determination is to use the row geometric mean method (RGMM) [8]. This solution is based on calculation of geometric mean of individual rows from the decision matrix (multiplying the elements of the individual rows of this matrix and determining the k root of these sums). By normalizing these row geometric means (by dividing them by the sum of these geometric means) we obtain the criterion weights w_i [8]:

$$w_i = \frac{[\prod_{j=1}^k s_{ij}]^{\frac{1}{k}}}{\sum_{i=1}^k [\prod_{j=1}^k s_{ij}]^{\frac{1}{k}}} \tag{2}$$

pro $i = 1, \dots, k$.

The consistency of pair-wise matrices is checked as a part of the process of determination of weight by Saaty method. Consistency should be checked before the weights determination with the aim to figure out whether the matrix is sufficiently consistent. The geometric consistency index (GCI) was specifically created for the use of RGMM method of weights determination. The GCI is calculated as follows [2, 26]:

$$GCI = \frac{2}{(n-1)(n-2)} \sum_{j \geq i} \left(\log(s_{ij}) - \log \frac{w_i}{w_j} \right)^2 \tag{3}$$

Where n represents number of criteria, w_i/w_j is Ratio of approximate weights. Approximate threshold values for consistency assessment were set by Escobar et al. (2004) as follows: GCI_{max} for $n = 1.2$ is 0.31; for $n = 3$ then 0.3147; for $n = 4$ is 0.3526 and for criteria number $n > 4$ is 0.37.

FINDINGS

Results of empirical research

The research sample consists of a random selection of 130 companies. Among the three largest groups of companies according to CZ-NACE belong: companies active in the wholesale and retail trade 21%, followed by 18% of companies operating in manufacturing and 17% of companies in other activities. It was found that 92% of companies performed innovative activities from the research sample and the remaining 8% did not carry out any innovation. Research on a research sample did not confirm the results presented by the Czech Static Office that they are more innovating in large companies (32%), as shown by the survey from the Czech Statistical Office. On the other hand, in the sample of surveyed companies surveyed small companies innovate more (37%). In a larger scale, enterprises perform more technological innovations, i.e. product and process innovations (88%), than non-technical, i.e. marketing and organizational innovations (57%). Implementation of innovation is linked to innovation spending. These innovation-related expenditures are average for 51% of companies, high for 31% of surveyed firms and only for 5 companies (4%) are very high.

It was found that 52% of businesses find incentives for innovations in customers, 34% of enterprises find incentives for innovations in competitors and 25% of companies draw innovations from own research. Companies use multiple sources to find incentives for innovation. It was found that the largest number of companies did not have any model to manage innovation activities (38.5%). And, when the management model is applied, 31.5% of companies have a management model of an occasional character and 13.8% has enabling character. This means that there is no deliberate focus on innovation activity in the Occasional Management Model, and financial resources are not systematic but are only allocated after an assessment of the suitability of an innovative project. And in case of the Enabling Management Model, the implementation of innovative projects is scattered, only selected projects are supported and they are systematically supported financially. In only 16.1% of companies, innovations are targeted, either through the Producer Management Model (9.2%) or through the Enforcing Management Model (6.9%). In case of Producer Management Model, there exists support for the entire enterprise team and its systematic financial support. Also, for the Enforcing Management Model, there is support for the focused implementation of innovation activities, but only within the separate business units to which funds are allocated. The results are shown in Table 3.

Table 3
Type of management model of innovations

Type of management model of innovations	Frequency	Valid Percent
No management model	50	38.5
Occasional management model	41	31.5
Enabling management model	18	13.8
Producer management model	12	9.2
Enforcing management model	9	6.9
Total	130	100.0

At the same time, a selective analysis was conducted to find out the difference between the choice of the innovation management model and the size of the enterprise. For enterprises up to 49 employees, the innovation management model is not used by 22%, whereas for enterprises ranging from 50 employees it is 17%. For enterprises of 50 employees, innovation is more systematically managed and financially supported. The difference in choice of the innovation management model with respect to enterprise size was statistically verified. A Pearson Chi-Square test was performed which had a value of 47.75 with 12 degrees of freedom, meaning that 55% had expected count less than 5. The minimum expected count is 1.94.

Selection of the innovation concept based on decision making mechanism

The application of the AHP method is used to organize 10 concepts of innovation based on a preference assessment of individual concepts within a given criterion. Before application of the AHP method author determined the weights of the individual criteria using the Saaty method and author also determined the order of each criterion based on the calculated weights w_i according to the formula (1). The created Saaty matrix, see Table 4, is the result of the consensus of the expert group of (3 + 3) who have agreed on the evaluation of the pair comparison in the table with the assistant of the investigator (author).

Table 4
Determination of the Weights of the Criteria Using the Saaty Matrix

Criterion	C ₁	C ₂	C ₃	C ₄	C ₅	Row Geometric Mean	Weight (w _i)	Order
C ₁	1	2	8	8	8	4.000	0.504	1
C ₂	1/2	1	6	6	6	2.551	0.321	2
C ₃	1/8	1/6	1	1/2	3	0.500	0.063	3
C ₄	1/8	1/6	2	1	1/2	0.461	0.058	4
C ₅	1/8	1/6	1/3	2	1	0.425	0.054	5

Check of the consistence of Saaty pair-wise comparison matrix was provided; see Table 4 with the help of consistency index GCI. Geometrical consistency index GCI was calculated (3) and its value is 0.37 which refers to the limit value for the 5 criteria. The calculations made when applying AHP method are performed in MS Excel.

The decision-making mechanism based on AHP method was used to organize 10 concepts of innovation based on the preference assessment of individual concepts within a given criterion. Then each innovation concept variant was assessed on the basis of Saaty scale (1 to 9) in criterion C₁, C₂, C₃, C₄, C₅. The preferences of the concepts were calculated using the geometric mean of rows (2). The consistency of the pair-wise comparison matrices was checked using the GCI consistency geometric index (3). GCI (2,3) score was 0.369 < 0.37, thus the pair-wise comparison matrix is consistent. AHP matrix was created using criteria weights and preferences or particular innovation concepts (variants) in the relevant criteria, see Table 5.

Table 5
Matrix AHP

Criteria	C ₁	C ₂	C ₃	C ₄	C ₅	
Criteria weights	0.504	0.321	0.063	0.058	0.054	
Concepts	I ₁	0.025	0.053	0.121	0.148	0.213
	I ₂	0.217	0.180	0.121	0.148	0.078
	I ₃	0.025	0.053	0.121	0.148	0.298
	I ₄	0.174	0.345	0.121	0.148	0.056
	I ₅	0.156	0.053	0.017	0.034	0.156
	I ₆	0.156	0.180	0.121	0.034	0.056
	I ₇	0.025	0.016	0.121	0.034	0.018
	I ₈	0.025	0.053	0.121	0.148	0.053
	I ₉	0.025	0.016	0.017	0.011	0.017
	I ₁₀	0.174	0.053	0.121	0.148	0.055

Finally, the resulting score (the weighted sum of criteria weights and the preferences of respective variants) has been calculated and the order of the variants is shown in Table 6.

Table 6
Final order of innovation concept

Innovation concepts	I ₁	I ₂	I ₃	I ₄	I ₅	I ₆	I ₇	I ₈	I ₉	I ₁₀
Resulting score	0.057	0.187	0.062	0.218	0.107	0.149	0.028	0.048	0.020	0.124
Order	7	2	6	1	5	3	9	8	10	4

CONCLUSION

The empirical research was performed on a sample of 130 selected companies and it was found that the vast majority of companies are implementing innovative activities, with more innovating small firms than large. To a greater extent, companies are implementing technological innovations, which are realized with average expenses. Companies are looking for incentives to innovate, especially at the side of customers, competitors, and own research. At the same time, it was found that the largest number of companies did not have any model of innovative activity

management. And when the management model is applied, the most often is Enabling Management Model and Occasional Management Model. On the basis of the selected analytical survey, the difference between the choice of innovation management model with respect to the micro, small, medium and large enterprise was determined.

A set of 10 innovation concepts (I_1 - I_{10}) was created. This file cannot be considered as the definitive list of existing innovation concepts. The created file responds to the researcher's research findings and to the availability of resources from which the paper was processed.

The concepts of innovation were chosen through a pairwise comparison method and analytical hierarchical process (AHP). Prior to the selection of concepts of innovation with respect to their applicability in the company, a list of five criteria for their evaluation was created. An expert team of three business experts and three academics was created to ensure objectivity in defining criteria and choosing concepts of innovation.

The result of the AHP implementation is the successive decision-making steps that can be applied in the decision-making mechanism for selecting innovation concepts. The decision-making mechanism is particularly suitable for managers of medium to large enterprises. It will enable managers to simplify the choice of a specific concept of innovation for business application. At the same time, the presented decision-making steps can be a guide for managers to create their own decision-making mechanism when changing criteria or a set of innovation concepts.

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