THE RISK CUBE APPLIED TO STRATEGY FORMULATION IN ELECTRODISCHARGE MACHINING FIELD

Daniela, Ghiculescu[1], Niculae Ion, Marinescu[2], Liviu Daniel, Ghiculescu[3] and Claudiu Pîrnău[4]
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
4 - Total School Bucharest, claude_pyr@yahoo.com

ABSTRACT: The paper deals with use of risk cube method for strategy formulation in case of an organization from nonconventional technology field. The cube risk is based on risk minimization on three axes: product, market, and development strategy. The method has several stages, which integrates elements from Customer Matrix and Producer Matrix. The strategy is formulated after solving two decisional nodes addressing two items: the coverage of the gap between the organization and the market leader, and the choice of a solution from three variants: inner development, alliance, and acquisition. A case study is approached concerning a medium organization from electrodischarge machining field, formulating a strategy based on alliance.
KEY WORDS: risk cube, strategy, customer matrix, producer matrix.

1. INTRODUCTION

The risk cube is a complex method of decision making at microeconomic level, which considers three variables: product, market and development strategies [1]. Using this method in decision making process, an organisation aims at risk minimisation. It is well known the Ansoff Matrix, which takes into account the first two variables, the product and the market, developing an extension strategy in four steps [2]. The risk cube has an additional variable against Ansoff matrix, namely the development strategy, this component transforming the method in a decision tool.

2. DECISION PROCESS IN RISK CUBE METHOD

The decision process at the risk cube method application covers several stages, having the goal of establishing the most adequate strategy. The logical scheme of the method is presented in fig. 1 (after [1], [3]).

In the first three stages, the option is established regarding the products and the market segment / segments to which the products are addressed. In connection, the quality characteristics of the products, required by client target are determined, meaning the Perceived Use Value (PUV). These items are the result of Customer Matrix application [1].

In the next two stages, firstly, the needed essence competencies (for a favourable competitive position) are established in order to satisfy the client's requirements that belong to the market segment addressed by the products characteristics. Secondly, the actual level of organization competencies is determined. These two stages are specific to Producer Matrix [1].

The logical scheme is finalized by two successive decisional nodes. At the first node, the required essence competencies are compared to those had by the organization at the moment of analysis, respectively by the time of decision making. If the competencies of organization are not enough, the second node is approached. Here, the development solutions are established by covering the gap between the needed and actual level of competencies.

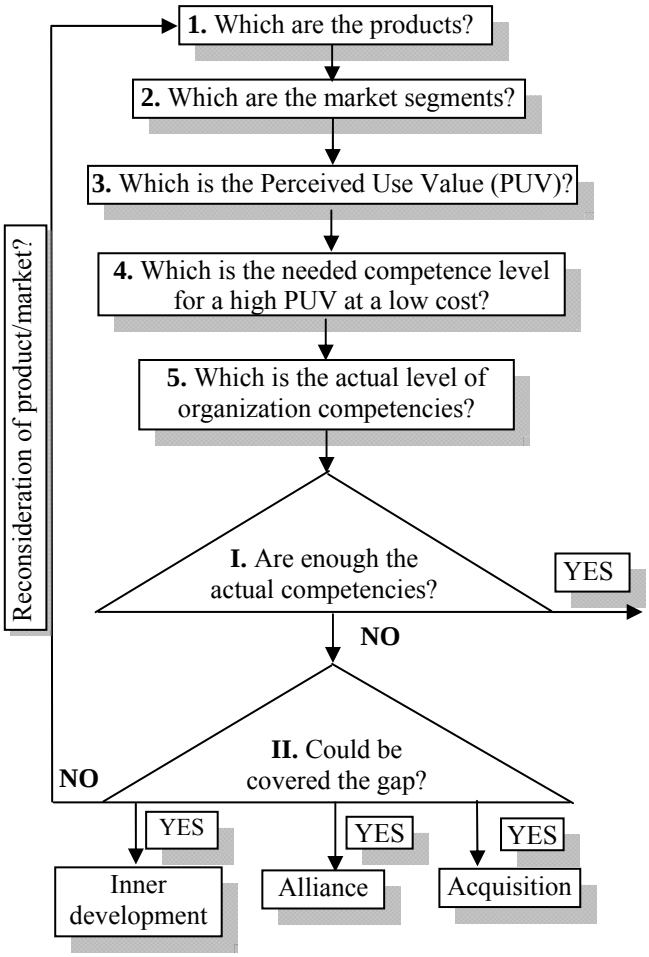


Figure 1. The logical scheme of decisional process at use of risk cube method

From the logical scheme, three generic solutions emerge: inner development of studied organization, alliance between organization and other partners, acquisition of other organizations. The choice of a solution of development from the three available supposes different risk levels. Application of the method contributes to minimization of risk.

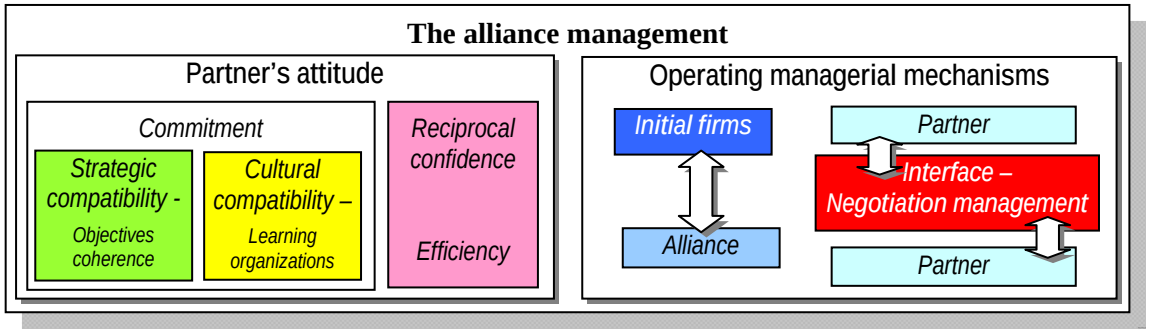


Figure. 3. The components of alliance management

In logical scheme of decisional process, a major feed-back reaction is provided, which appears when the final response is negative, concerning the gap covering by the three strategic options. In this case, the initial option of products/market couple must be reconsidered. The following approaches could be taken into account:

(1) *Launching the same product on the same market*, which supposes the remaking of Customer Matrix, and possible, Producer Matrix if the new clients requirements need other essence competencies;

(2) *A new product achievement on the same market*, which determines the remaking of Producer Matrix; the new product needs other essence competencies for the accomplishing of Perceived Use Value and unitary costs, and consequently, the adjustment of Customer Matrix;

(3) *Launching a new product on a new market*, which imposes the changing both the Customer and Producer Matrix.

All the three strategic options previously presented will be evaluated by application of risk cube method, establishing the risk degree corresponding to each option.

3. CUBE RISK VARIABLES AND MAJOR STRATEGIC OPTIONS

The three variables of risk cube – product, market, developing strategies presented in fig. 2 (after [1]). The senses of coordinates system axes point out the increase of risk degree.

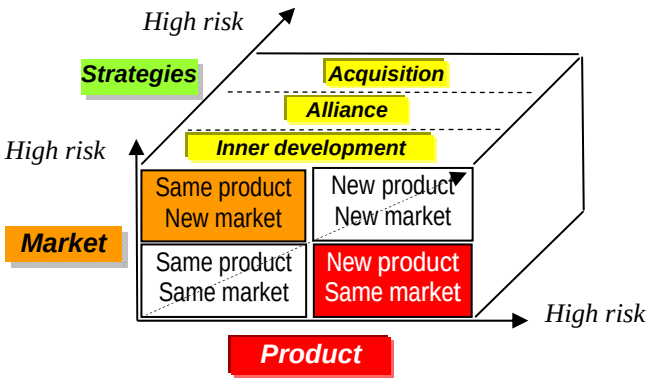


Figure 2. The risk cube variables and strategic options

Comparatively analyzing the risks taken by the organization, practice shows that risks rise progressively as the organization goes farther from the markets where it activates at the moment of analysis and the products that are achieved in the present, in other words, the origin of the coordinates system. The risk is higher at the achievement of a new product when the innovation level is greater than in case of penetrating new markets with the same product.

This principle was emphasized by Igor Ansoff in his Products /Markets Matrix [4].

The axis dedicated to development strategies offers three options – *inner development, alliance, and acquisition – arranged* in the order of risk growing. In the presented frame, the option with the lowest risk is the achievement of same product for same market, obtained by inner development of organization.

This option can not be taken by the organization, when the product is in decline phase within its life cycle, or the market is saturated. Subsequently, the organization can consider the other options with growing risk: *launching the same product on a new market; achievement a new product for the same market; launching a new product on a new market.* All these options mentioned above are located on the frontal face of the risk cube (fig. 2).

Concerning the three options of organization strategy, inner development, alliance, and acquisition, their locations on the third axis is in the succession of risk increase. The alliance supposes the operation next to an unfamiliar partner. The organization has a limited control on it, and consequently, a high level of incertitude. However, there are some mechanisms specific to negotiation and crisis management, which could contribute at risk minimization. There are some specific managerial methods, based on compatibility of partnership regarding the objective coherence, cultural compatibility, and mutual confidence (fig. 3). From the operational point of view, an interface is created between partners where negotiation and crisis management methods are undertaken.

The acquisition is more risky because the harmonization of competencies of implied organizations is necessary, which is a difficult process that could lead to an organizational unbalance. The high resource consume needed to achieve the acquisition has also to be considered. For these reasons, it is recommendable that this strategy is preceded by a long period of collaboration between the purchaser and purchased firm.

A basic criterion for the choice of the acquisition is the balance portfolio of business, which can be expressed by the location of the products within the profitable and of perspective quadrants from the Boston Consulting Group – *cash cows, stars, question marks* [5].

The advantages of acquisition are comparable with the strategies of inner development and alliance, proving a supplement, as it is justified below:

♦ The possibility to enter new sectors of activities and markets; For example, a company has technological competencies but it wants to extend them by the acquisition of a Small and Medium Enterprise (SME), focused on nonconventional technologies.

Table 1. The results obtained at determination of Perceived Use Value of four electrodischarge machines

No.	Characteristics	*D*		*C*		*B*		*A*		p_{imed}
		X_i	X_{ir}	X_i	X_{ir}	X_i	X_{ir}	X_i	X_{ir}	[%]
1	L [mm]	3000	1	3500	0	3200	0.6	3400	0.2	1.5
2	l [mm]	2000	1	2500	0	2400	0.2	2300	0.4	1.5
3	h [mm]	2000	1	2100	0.5	2100	0.5	2200	0	1.5
4	M [kg]	2500	0	3100	1	2700	0.33	2900	0.67	1.5
5	L_m [mm]	600	0	800	1	700	0.5	750	0.75	1.5
6	l_m [mm]	350	0	650	1	550	0.67	450	0.33	1.5
7	L_c [mm]	700	0	850	1	750	0.33	810	0.73	1.5
8	l_c [mm]	400	0	700	1	600	0.67	480	0.27	1.5
9	h_c [mm]	400	0	600	1	400	0	500	0.5	1.5
10	m_p [kg]	300	0	450	1	380	0.53	420	0.8	3
11	X [mm]	300	0	450	1	400	0.67	420	0.8	1.5
12	Y [mm]	250	0	400	1	350	0.67	380	0.87	1.5
13	Z [mm]	250	0	400	1	380	0.87	380	0.87	1.5
14	$T_{pX,Y}$ [μm]	5	1	10	0	10	0	8	0.4	4
15	T_{pZ} [μm]	4	1	8	0	6	0.5	6	0.5	4
16	$6\sigma_{X,Y}$ [μm]	2	1	4	0	3	0,5	3	0.5	4
17	$6\sigma_Z$ [μm]	2	1	4	0	3	0.5	3	0.5	4
18	$T^{-1}_{pX,Y}$ [μm]	3	1	5	0	4	0.5	4	0.5	4
19	T^{-1}_{pZ} [μm]	3	1	5	0	4	0.5	4	0.5	4
20	$v_{sX,Y}$ [mm/min]	1500	1	1800	1	1600	0.67	1200	0	1.5
21	v_{sZ} [mm/min]	700	0	900	1	800	0.5	800	0.5	1.5
22	$V_{W,Cu/st}$ [mm^3/min]	450	0.67	500	1	400	0.33	350	0	2
23	$V_{W,qr/st}$ [mm^3/min]	550	1	550	1	450	0.33	400	0	2
24	$R_{a,Cu/st}$ [μm]	0.05	1	0,1	0.86	0,1	0.86	0.4	0	8
25	$R_{a,Cu/MC}$ [μm]	0.1	1	0,2	0,86	0,2	0.86	0.8	0	8
26	f [μm]	5	1	10	0	6	0.8	6	0.8	4
27	p_{inj} [MPa]	0.1	1	0.1	1	0,05	0	0.06	0.01	3
28	p_{asp} [MPa]	0.05	1	0.03	0.33	0,02	0	0.02	0	3
29	t_r [°C]	4	1	6	0	6	0	4	1	1
30	I_{max} [A]	50	0.5	60	1	50	0.5	40	0	3
31	I_{min} [A]	0.5	0	0.5	0	0,4	0,25	0.1	1	5
32	t_{imax} [μs]	1000	0.67	1200	1	800	0.33	600	0	2
33	t_{imin} [μs]	0.5	0.56	1	0	0,8	0.22	0.1	1	5
34	U_{0max} [V]	200	0.55	250	1	180	0.36	140	0	3
35	U_{0min} [V]	100	0.33	120	0	100	0.33	60	1	3
TOTAL		$PUV_D = 68.58$		$PUV_C = 49.46$		$PUV_B = 47.24$		$PUV_A = 41.56$		100%

Thus, it could benefit from purchased firm know-how and cumulating its other available complementary resources, it could rapidly penetrate the nonconventional technology field;

♦ The possibility to achieve synergy if the two organizations have complementary essence competencies, and the purchased managerial team wants to remain loyal to purchaser;

♦ The possibility to reduce the costs:
- creating scale economy through exceeding the critical threshold of economic profitability;
- acquiring some competencies focused on costs decrease.

The high risks resulted from an organisation acquisition are motivated through the following situations:

• the organisational cultures implied in transaction are incompatible, representing a barrier for synergy creation;

• the possibility that performing employees leave the company in the moment of acquisition or their performances decrease if before the acquisition, they were motivated, having shares at the sold company;

• if the acquisition price is decreased, the purchased firm could have low performances, which could lead to an additional consume of resources of purchaser firm;

• if the price is increased, justified by high performance of purchased firm, the financial resources consumed at acquisition can exceed the possibilities of purchaser; in this case, only the inconvenient of passing the critical moment of transition could exist, specific to change management [6], achievable through harmonization of essence competencies and synergy creation; similar to alliances, the specific methods of negotiation management play an important role.

4. CASE STUDY

The cube risk method was applied at decisional process regarding the strategy formulation in case of a Romanian Research Institute (named *A* in the case study) that has also production activity, which is a medium enterprise from the field of nonconventional technologies. The studied organization intends to enter again on electrodischarge machines market, respectively on market segment, comprising SMEs that use electrodischarge machining, mainly to achieve moulds in thermally hardened electric conductive materials.

Based on logical scheme of decisional process from the fig. 1, the following stages were accomplished:

Stage 1: Product defining. The studied organization intends to produce a CNC medium size electrodischarge machine with massive electrode. The evaluation of the mentioned product was made comparatively with the products of main competitors from other countries: A-Romania (the organization, subject of method application), B-Spain, C-Germany, D-Switzerland.

Stage 2: Market segment. The electrodischarge machine addresses a market segment composed by SMEs, EDM users interested in precision and quality of machined surfaces.

Stage 3: Perceived Use Value establishing. The dimensions of PUV are described through 35 quality characteristics, specified in table 1 and explicitly presented below:

Overall machine dimensions:
(1) length (L); (2) width (l); (3) height (h); (4) weight (M);
Dimensions of working table:
(5) length (L_m); (6) width (l_m);
Dimensions of working tank:
(7) length (L_c); (8) width (l_c); (9) Height (h_c);
(10) Maximum workpiece weight (m_p);
Axes travels:
(11) X axis (X); (12) Y axis (Y); (13) Z axis (Z);
Positioning precision:
(14) Positioning clearance on X and Y axes ($T_{p\ X,\ Y}$); (15) Positioning clearance on Z axis (T_{pZ});
(16) Mean positioning dispersion on X and Y axes ($6\sigma_{X,\ Y}$);
(17) Mean positioning dispersion on Z axis ($6\sigma_{Z}$);
(18) Repositioning clearance in inverse sense on X and Y axes ($T^{-1}_{p\ X,\ Y}$);
(19) Repositioning clearance in inverse sense on Z axis ($T^{-1}_{p\ Z}$);
Fast feed speeds:
(20) on X and Y axes ($v_{s\ X,\ Y}$); (21) on Z axis ($v_{s\ Z}$);
Machining rate:
(22) For cooper/steel couple ($V_{W,\ Cu/st}$);
(23) For graphite/steel couple ($V_{W,\ gr/st}$);
Minimum roughness R_a of machined surface:
(24) For cooper/steel couple ($R_{a\ -\ Cu/steel}$);
(25) For cooper/carbide couple ($R_{a\text{-}Cu/MC}$);
Dielectric unit:
(26) Filtration finesse (f); (27) Injection pressure (p_{inj}); (28) Aspiration pressure (p_{asp}); (29) Temperature of cooling agent (t_c);
EDM generator:
(30) Maximum current step (I_{max});
(31) Minimum current step (I_{min});
(32) Maximum pulse time (t_{imax});
(33) Minimum pulse time (t_{imin});
(34) Maximum ignition voltage (U_{0max});
(35) Minimum ignition voltage (U_{0min}).

The perceived use value is determined with the relation:

$$PUV = \sum_{i=1}^{n} p_i \cdot X_{ir} \tag{1}$$

where: X_{ir} is the relative value of quality characteristic i on an unitary scale 0-1; p_i – the weight allocated by user (customer) to quality characteristic i.

The relative value of quality characteristic is calculated with the relation:

$$X_{ir} = \frac{X_i - X_{i\min}}{X_{i\max} - X_{i\min}} \tag{2}$$

where: $X_{i\ min}$ is the worst value from the competitors products; $X_{i\ max}$ - the best value; X_i - the current absolute value of quality characteristic i.

The weight sum allocated to all quality characteristics (1,..., n) for a product fulfils the condition:

$$\sum_{i=1}^{n} p_i = 100\% \tag{3}$$

In order to reduce the subjectivism at weights allocation, in table 1, medium weights (p_{imed}) were used. They were established as arithmetic mean of values assigned by an experts working group.

The organization has produced Romanian electrodischarge machines in the past from ELER series. But this product, the subject of the applied method has to be a new one, up-dated and aligned to actual market requirements, which are dramatically changed. In fact, the nonconventional technologies field, including electrodischarge machining, is characterized by a high development rate. Under those circumstances, the situation is considered as new product/ new market, the diagonal arrow from the frontal face of risk cube (see fig. 2).

The available strategies for new product achievement, which have different levels of risk, could be:

► Achievement of complementary products (extension of products range), which supposes a lower risk degree, because the innovation level is lower; the organization *A* could use its large experience accumulated in the EDM field and adapt some technical solutions to actual requirements of the market;

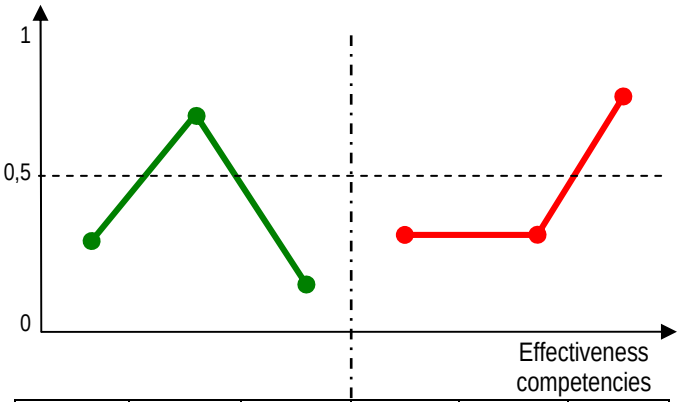
► Taking a new product on license basis or franchising in order to minimize the risk degree; the problem is to find such a license/ franchising provider under the conditions of keen competition in EDM field and low financial resources of organization *A*; but *A* has proved in the past that has innovation capacity needed to create a product, which could respond to market demands;

► Achievement of a new product through own research-development; this strategy has the highest risk level – statistically it is known that less than 10% from new products have real commercial success – taking into account the complexity of the new product; an analysis will focus on this variant if it is feasible through inner forces or it necessary an alliance.

The strategy new product / new market (movement on diagonal on the frontal face of risk cube, fig. 2) has the highest risk from movements located in this plane. The use of this variant based on own resources it is recommended only under circumstances with high chances of success. The organization *A* could use its image, the known name on Romanian profiled market. The strategy could be assimilated with a new product on a *quasi* new market.

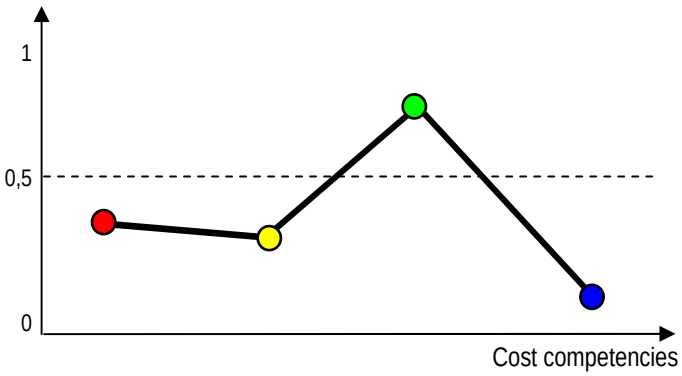
For diminishing the risk, the cube risk method could be associated with *Failure Mode and Effects Analysis* method (FMEA) [7]. The two methods are complementary, both aiming at risk minimization. FMEA encourages the solutions validated by previous experience.

Stage 4: **Evaluation of needed competencies level.** The required level of competencies on the target segment results from the relative position against the leaders of the field. Two competitive profiles are presented: effectiveness competencies (fig. 4) and competencies focused on unit cost decrease (fig. 5).



Technology	Supply	Marketing	Innovation	Quality Assurance	Value Increase
30%	10%	10%	25%	20%	5%
Operating competencies			System competencies		

Figure 4. Operating and system competencies of Romanian organization *A*



Coordination and Control	Continuous Cost Decrease	Production Factor Costs	Economy of Scale
50%	30%	15%	5%

Figure 5. Competencies focused on costs decrease of Romanian organization *A*

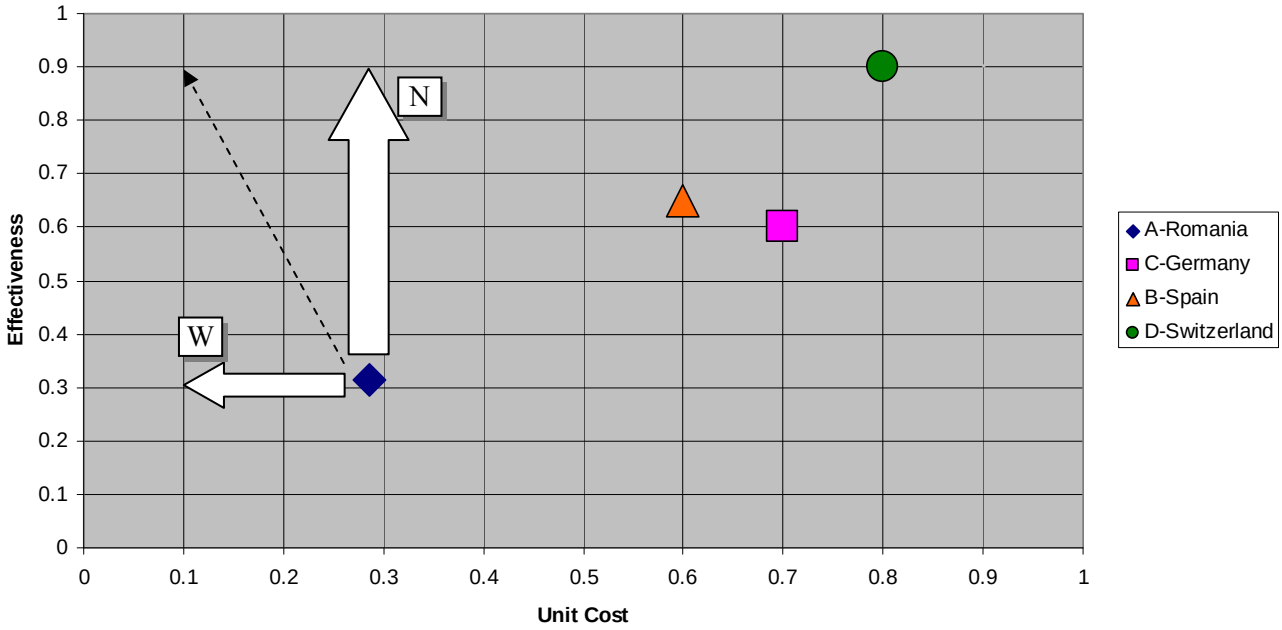


Figure 6. Position of competitors in Producer Matrix

Decisive competencies that have higher weights in competitive profile should be positioned in the upper part on the relative scale 0-1. Thus, the operating competencies, more specific Technology competencies with 30% weight should be over 0.5, and Marketing competencies (weight10%) should be at higher level, closer to relative level of 0.5. Concerning, system competencies, those regarding Innovation whose weight is 25% and respectively, Quality Assurance with weight of 20% should be situated over relative level of 0.5. Regarding the competencies focused on costs decrease, Coordination and Control as well as Continuous Cost Decrease with highest weights, of 50% and respectively 30% should be greater than 0.5 relative level.

Stage 5: **Evaluation of actual level of organization competencies**. An aggregate mark of operating and system competencies (N_{os}), which determines the position on effectiveness axis in the Producer Matrix (fig. 6), is established through the following relation:

$$N_{os} = \sum p_i \, C_{osi} \qquad (4)$$

where: C_{osi} represents the mark allocated to an operating or system competence i on the unitary relative scale 0-1 (fig. 4); p_i - the weight assigned to competence i; the sum of weights values of operating and system competencies must satisfy the relation (3).

Another aggregate mark is used to determine the level of competencies focused on costs through the following relation:

$$N_{fc} = \sum p_i \, C_{fci} \qquad (5)$$

where: C_{fci} is the relative mark granted to a competence i related to unit costs on the relative unitary scale 0-1 (fig. 5). p_i - has similar significance like above and must fulfil the same condition about the sum of weights.

The position accuracy on costs axis could be obtained through reliable information regarding costs repartition in Porter's Value Chain analysis [8], but those are very difficult to find out in case of competitors.

Under these circumstances, the profile of competencies focused on costs is used. This evaluation has an inherent subjective

character but has the important advantage that information can be acquired easier, on the basis on different forms of benchmarking [9].

The calculation of aggregate marks, of operational and system competencies (N_{os}) and cost focused competence (N_{fc}), using the relations (4) and (5) led to the following:

$N_{os} = 0{,}315$ and $N_{fc} = 0{,}35$

After the five stages of cube risk method, it can be assumed that organization *A* is in the following situation regarding combination of Customer and Producer Matrix (fig. 7):

Figure 7. Correlation between Customer and Producer matrix

This means that organization achieves a product with a low Perceived Use Value at a low price. Internally, the efficiency is relative good, because the costs are low, but effectiveness is also low.

In this case, the firm is in danger to act only on price decrease, based on maximum using of competencies focused on costs decrease - the movement on W direction in Producer Matrix, fig. 6). Consequently, the profit margin could decrease if the complementary competencies of effectiveness, operational and system ones could be not increase. Presently, organization *A* can use only the competencies based on production factors competencies, which are still low in Romania, comparing to the other competitors. On long term, the increase of the competencies strongly related to sustainable competitive advantage [8] is a major objective. Taking into account the high dynamics of electrodischarge machining field, the movement to N direction in Producer Matrix (fig. 6), based on improvement of operational and system competencies is the main strategy to be considered in case of organization *A*. Composing the two movements results a NW oriented vector.

Basically, the recommendations for this combination of Customer and Producer matrix are:

- The growing of effectiveness of organization *A*, the movement to N in producer matrix (fig. 6), can be the result of some alliances with organizations which have the needed operational and system. In fact, organization *A* has appealed to such alliances (partnerships) in the past when it has participated to the research-development-innovation projects;

- The improvement of effectiveness competencies is strongly supported by an efficient knowledge management, through specific methods, the *sine qua non* condition in the actual age of knowledge based economy [10].

Decisional Node I: Are enough actual competencies of organization A? From Producer Matrix (fig. 6), it results a big gap on effectiveness axis, reported to the market leader *D*:

$\Delta = N_{os\text{-}Market\ leader} - N_{os\text{-}Organization\ A} = 0{,}9 - 0{,}315 = 0{,}685$

On costs competencies axis, organization *A* has still an advantage against competitors, which can be maintained. It needs the compulsory growing of competencies regarding *Coordination and Control* as well as *Continuous Decrease of Costs.*

Decisional Node II: Which is the needed strategy to cover the gap between the organization *A* and the main competitors? Taking into account the product – electrodischarge machine – based on multidisciplinarity and complex activities, at the moment of analysis, organization *A* can not provide the required competencies through inner development. It is not possible to acquire such competencies through acquisition of other organizations due to *A* low financial resources available. In this case, the only valid strategy is the alliance, which is also provided by Greiner model, stage 6 [11]. The partnership will provide necessary additional competencies regarding electrodischarge machining technology, marketing, innovation, quality assurance, coordination - control and continuous costs decrease.

5. CONCLUSIONS

The cube risk is a complex method with holistic character that has the advantage of leading to an appropriate decision of organization development, based on both component of analysis: external (elements from Customer Matrix) and internal (items from Producer Matrix). During the actual eve of globalization and knowledge based economy, taking also into account the complexity of the product - electrodischarge machine - and required polyvalence, the solution presented in the case study is based on alliance with other organizations that provide complementary competencies in order to create synergy with essential conditions to have partners' coherent objectives. The alliance could embrace actual adequate shapes such as firm networking, clusters or virtual organizations.

6. ACKNOWLEDGEMENTS

Researches achieved in the project POSDRU/CPP107/DMI1.5/S/76851/ cofinanced from European Social Fund through Sectorial Operational Program, Human Resources Development 2007-2013.

7. REFERENCES

1. David Faulkner, Cliff Bowman, *Essence of Competitive Strategy*, Teora, Bucharest, (2000).
2. Igor Ansoff, *Corporate Strategy,* Revised edition, Penguin Books, (1989).
3. Daniel Ghiculescu, *Strategic Management*, Printech, Bucharest, (2007).
4. Igor Ansoff, Strategies for Diversification, *Harvard Business Review*, Vol. 35, Issue 5, pp. 113-124, (1957).
5. Bruce Henderson, *The Product Portfolio*, BCG Perspectives, p.135, 1973.
6. Dai Williams, Human responses to change, *Report from the strategic planning journal Futures*, Vol.31 (6), pp. 609-616, (1999).
7. Constantin Oprean, Mihail Țîțu, *Quality Management in the Economy and Organization Based on Knowledge*, AGIR, Bucharest, (2008).
8. Michael, E. Porter., *Competitive Advantage. Guide of Surviving and Growing of Firms under Market Economy Conditions*, Teora, Bucharest, (2001).
9. Viorel Scurtu, Corneliu Russu, Ioan Popescu, Benkmarking. *Theory and Applications*, Economic Publishing House, Bucharest, (2006).
10. Ovidiu Nicolescu, Ciprian Nicolescu, *Organization and Management Based on Knowledge*, Pro Universitaria, Bucharest, (2011).
11. Larry Greiner., *Evolution and revolution as organizations grow*, Harvard Business Review Classic, p. 4-11, 1998.