PROFILES OF EFFECTIVENESS OF TECHNOLOGY ENTREPRENEURSHIP: OUTCOMES OF PAIR COMPARATIVE METHOD OF MEMBERS OF AVIATION VALLEY IN POLAND

PIOTR KORDEL

Institute of Management, Administration and Logistics, Department of Organization and Management, Silesia University of Technology
E-mail: piotr.kordel@polsl.pl

Abstract — Author presents the issue of effectiveness of technology entrepreneurship as development mechanism of high – technology companies. The technology entrepreneurship model and multidimensional construct of effectiveness are presented in theoretical part of the article. Author presents outcomes of empirical research of members of Aviation Valley in Poland in the second part of the paper. Investigated firm are divided in two groups, i.e. start – up and growth companies. The investigation research are qualitative, the data analysis is based on pair comparative method.

Index Terms — Technology Entrepreneurship, Profiles of Effectiveness, Pair Comparative Method, Aviation Valley in Poland

I. INTRODUCTION

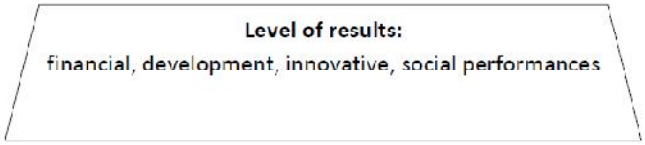
A common feature of the high-tech enterprises environment is the increasing complexity and dynamics and consequently, the necessity to consider the changes occurring in the organisation as development opportunities. In such a light, it becomes impossible for the manager to understand strategic management only as a fulfillment of the long-term development visions. The manager of a high technology enterprise must complete his workshop in the field of classical methods of the implementation of strategic plans with the entrepreneurial approach, which assumes the co-creation of ongoing changes with a skillful use of technology development processes.

The use of entrepreneurial approach in the management of high-tech enterprises requires a change in the perspective of looking at the fundamental, from the managerial point of view, issue of measuring the effectiveness. The aim of the article is to present the multi-dimensional efficiency profiles of the high technology enterprises which have been placed at two successive stages of development, i.e., the start-up phase and the phase of consolidated growth.

II. TECHNOLOGICAL ENTREPRENEURSHIP AS THE MECHANISM OF HIGH-TECH ENTERPRISES DEVELOPMENT

Technological entrepreneurship is a type of entrepreneurial strategy, which considers the development of technology to be the key element of the organisation development. In other words, the organisation as an entity of technological entrepreneurship strategy is a catalyst for technological projects, ranging from the technological idea, and ending with the market product. The entrepreneurial model of the organisation development is a dialectical process of the development of an organisation and its environment, of which the main logic is the continuous recognition and exploitation of the development opportunities. The model of technological entrepreneurship recognizes the development of technology and its consequent technological opportunities to be the core of the process.

Analysing the technological entrepreneurship in the perspective of strategic development of an organisation it is necessary to consider it as a motor mechanism and understand it in three ways: (a) at an activity level, as a process of technological entrepreneurship, (b) at the level related to the attribute, as specific features of internal and external environment of technological entrepreneurship, (c) at the level of results, as different perspectives of technological entrepreneurship performance (see the Fig. 1.).



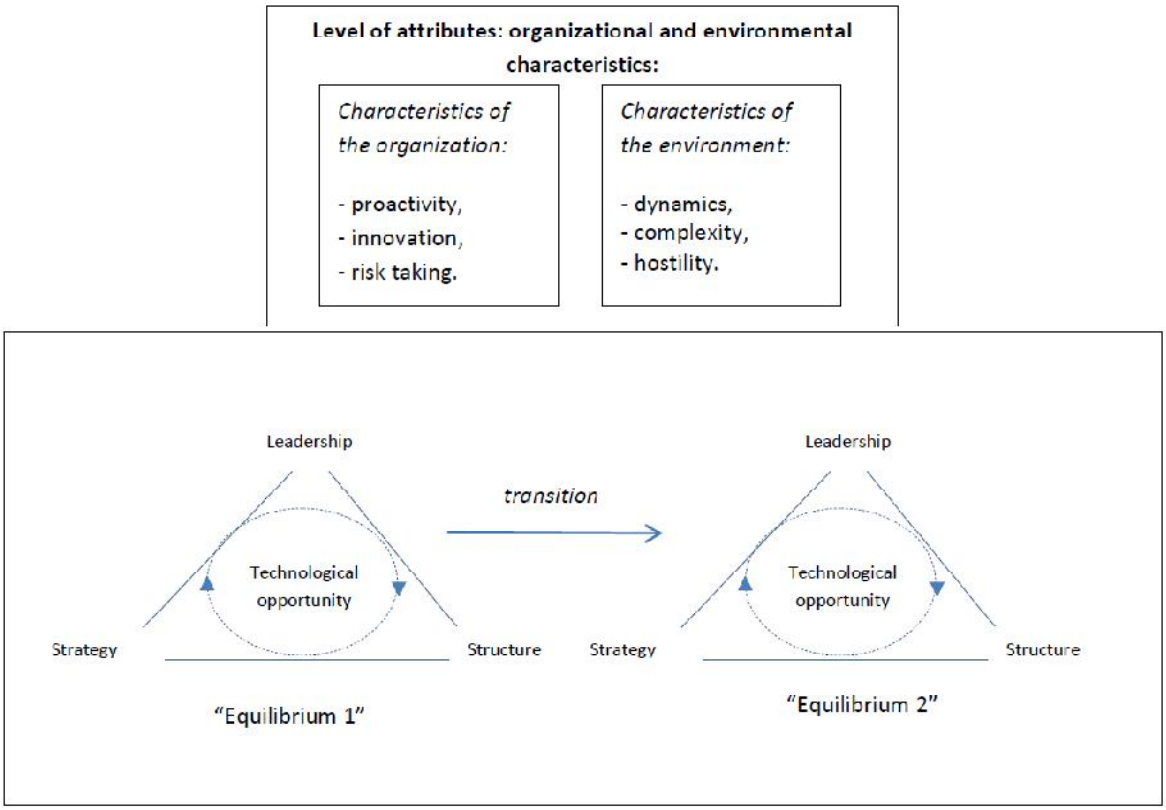


Figure 1. Technology entrepreneurship model
Source: own study.

At the level associated with the process, in accordance with the configuration approach [5], technological entrepreneurship is understood as a short-term configuration of elements of the managerial leadership, the organisational structure and the development strategy. At the level associated with the attributes, in the light of the concept of the organisation entrepreneurial orientation [7], three characteristics of the entrepreneurial organisation may be distinguished: pro-activity, risk-taking and innovativeness. On the other hand, the characteristics of the features of an organisation environment may be performed on the basis of the following attributes [4]: hostility, complexity and variability. At the level associated with the results, in accordance with the concept of a high-performance organisation [3], the entrepreneurial mechanism of an organisation development must translate, in a given time perspective, into its above-average growth.

The development of technological enterprises, as the indications of technological entrepreneurship, is subject to the regularities, which results from the life cycle theory. From the point of view of research on entrepreneurship, two early stages of the development of technological ventures are crucial ones, which are characterised by different configurations or development patterns, including [8]: (a) the stage of early development, where organisations strive to produce an innovative product (b) the phase of consolidated growth, at which organisations strive to increase sales and build the product portfolio. Stages of high-tech organisations development are understood as the configurations of an organisational design, which represent the adjustment of an enterprise to a relevant context of business activity at a given time.

II. Measuring The Effectiveness of Technological Entrepreneurship

An integrated approach to various perspectives of measuring the organisational effectiveness corresponds well with the theoretical construct of a high-efficiency organisation[3]. According to this concept, the high-efficiency organisations are defined as organisations that achieve higher financial and non-financial results in comparison to their direct competitors (with the measurement being most frequently conducted over the periods of time of 3 to 10 years). According to this concept, the measurement of the organization performance must be made using a multi-dimensional tool, taking into account the financial perspectives, but also the perspectives of growth, innovation and social performance elements [1]. According to this logic of the multidimensional and sustainable measurement of the organisational effectiveness, the sample measuring parameters may include the following components:

- the perspective of financial performance, including the parameters of profitability and return of the generated revenues from sales of products and services over the period of the last three years;

- the perspective of an organisation development, which consists of measuring the parameters of employment growth and an increase in revenues from the sale of products or services over the period of the last three years,
- the perspective associated with the innovativeness an organisation, which includes the measurement of the share of revenues from the sale of new or upgraded products or services in a total sale of an organisation over the period of the last three years,
- the social perspective, consisting of the measuring parameters indicating the social condition of an organisation (see the Integrated Social Performance Scale, as part of a well-known in the literature tool referred to as Michigan Organisational Assessment Questionnaire) , including: the level of job satisfaction, involvement in the performance of the duties, willingness to change a job, a sense of pride in the work done as well as the level of optimism regarding the organisation, where the work is performed.

Connection of the above presented, four perspectives of measuring the organisation effectiveness forms a balanced approach to the measurement of the performance of technological entrepreneurship as a development mechanism of high-tech enterprises. It complements the existing research on the effectiveness of entrepreneurship which focuses primarily on financial and development perspectives as well as innovativeness-related and social ones.

III. Methodology and the results of empirical research

The aim of the empirical research was to develop the profiles of the effectiveness of high-tech enterprises, which have been placed at two successive stages of development, i.e., the start-up phase and the phase of consolidated growth.

Empirical studies were carried out at the turn of 2015 and 2016 and they involved the group of enterprises included in the Aviation Valley in Poland. The Aviation Valley provides an excellent laboratory to study the effectiveness of the processes of technological entrepreneurship. It is made up of the enterprises, characterised by high intensification of research and development work [9], which mostly belong to the so-called group of high-tech enterprises, according to the OECD classification.

The research was of a qualitative in nature, based on a comparative case study methodology [14]. The selection of companies for research was intentional, the main criterion for the selection of cases were the presence of processes of technological entrepreneurship. The size of a research sample, following the verification of the obtained research results, eventually amounted to the number of twenty enterprises, equally divided into two groups, i.e., ten cases of companies in the phase of the market entry and ten cases of companies at the stage of consolidated development. The respondents in both groups of the surveyed companies were the senior managers, whilst in the group of the market entering companies, they were the owners of most of the studied organisations.

The process of the empirical research implementation was the multi-stage one, composed of the phase of direct interviews with the senior management of the pro-innovation structures, i.e.: the Aviation Valley Association in Rzeszów, the Pre-incubator of the PodkarpackiScientific-Technological Park and the Podkarpacki Science and Technology Park as well as with the staff managing the enterprises associated in the Aviation Valley.

The research tool was composed of the introductory part, regarding a short characteristics of the surveyed company and the appropriate part, describing the multidimensional construct of effectiveness. The introductory part contained open questions concerning the name of the company, its website, the classification of economic activities as well as the ownership structure of the company. The appropriate part of the questionnaire consisted of five questions selected on the basis of a theoretical construct of four perspectives of the organisation efficiency measurement[1] and direct interviews with the top management being in charge of strategic management of the surveyed enterprises. All the questions were evaluated with respect to the last three years of the enterprise's activity, on the basis of the 7-point Likert scale.

The following shows the structure of the surveyed group of enterprises in accordance with the criterion of ownership, developed on the basis of information obtained from the introductory part of the research questionnaire (see the Tab. 1.).

Group of companies	owner – inventor	owner – trader	owner – venture capital
In the phase of introduction	10 (100%)	10 (100%)	0 (0%)
In the phase of consolidated growth	6 (60%)	10 (100%)	0 (0%)

Table 1.The ownership structure of the surveyed enterprises
Source: own study

Analysis of the ownership structure indicates that enterprises in the phase of market entry are managed by the authors of technological ideas, while the enterprises in the phase of consolidated growth are managed jointly by the authors of technological ideas and marketers. Effectiveness of the companies

surveyed in the phase of market entry is established by technological competences of the owners, while the efficiency of companies surveyed in the phase of consolidated development is established by technological and marketing competences. There were no high-risk funds among the owners of the two groups of surveyed enterprises.

The pair comparative method was used to analyse the statistical data obtained from the appropriate part of the questionnaire. In order to estimate the differences between the research cases according to individual criteria of effectiveness, the function of outranking was applied, that has been defined in the following logical formula:

F(x)= - 1, when -6 <= x <=- g
F(x)=(x+D)/(G-D), when –G<x<=-D
F(x)=0, when -D<=x<=D
F(x) = (x-D)/ (G-D), when D<=x<=G
F(x) =1, when G<x<=6
$R(i,k) = \sum_{j \neq i} f(P(i,k) - P(j,k))$; P(j,k) - assessment of the i-th company according to the k-th criterion.
$O(i)=\sum R(i,k)$ - synthetic evaluation of effectiveness of i – th company.
where: x is a difference in assessment of two compared companies, D is the threshold of indiscernibility and G is the full outranking threshold. In the conducted analyses, the indiscernibility threshold was one, while the full outranking threshold was six.

The results of multi-criteria analysis of the efficiency of surveyed companies in the group of market entering enterprises have been shown in the table below (see the Tab. 2.).

Case no.	E1. Profit margin on sales	E2. Growth in sales	E3. Increase in employment	E4. Sales of new products	E5. Involvement of employees	Total
1	-0.8	-0.2	0	0	-2	-3
2	-0.8	-0.2	0	-0.4	-0.8	-2.2
3	-0.8	0	0	0	1.4	0.6
4	-0.2	0	0	0	0.6	0.4
5	0.8	0	0	0.2	1.4	2.4
6	-0.2	0	0	0	0.6	0.4
7	2.2	0.6	0	0	1.4	4.2
8	-0.2	0	0	0	-2	-2.2
9	0.8	0	0	0.2	1.4	2.4
10	-0.8	-0.2	0	0	-2	-3
mean	5	4.8	4.4	5.1	5.7	
s.d.	1.05	0.63	0.52	0.57	1.34	

Commentary: all measurements of effectiveness cover the period of 2012-2014. The increase in sales is understood as an increase in total revenues from sales of products/services; Profit margin on sales is understood as the ratio of profit to revenue from sales of products/services; The increase in employment is calculated jointly with the increase in the employment of people under the employment and civil law contracts; The employee involvement is understood as a measure of social efficiency.
Mean stands for average mean, s.d. stands for standard deviation, shaded row stands for the case with the highest outranking function (the highest performance individual start – up profile).

Table 2. The analysis of the outranking function of individual parameters of the effectiveness in the group of the start-up companies Source: own study.

Analysis of the obtained distributions of the outranking function for the surveyed companies being in the phase of market entry indicates the biggest differences in the financial perspective when measured by the profit margin on sales and in the social perspective measured by the involvement of employees in the activity of an enterprise. The two remaining perspectives of effectiveness, i.e.: the perspective of development measured by growth in sales and employment as well as the perspective associated with the innovativeness measured by the sales of new products do not show significant differences. Growth in employment as a measure of the development perspective does not indicate any differences, which is understandable in the case of companies entering the market.
The results of empirical research show, that the high-tech enterprises in the phase of market entry shape their efficiency mainly on the basis of the social perspective, which is measured by the involvement of employees in the activity of their company and the financial perspective measured by the profit share in sales revenues**.** The resulting profile of the effectiveness of high technology enterprises in the phase of market entry may be referred

to as the creation of high value for the customer on the basis of high employee involvement in the process of creating that value.

Results of the multi-criteria analysis regarding the efficiency of the surveyed companies in the group of enterprises with the stable market position have been shown in the table below (see the Tab. 3.).

Case no.	E1. Profit margin on sales	E2. Growth in sales	E3. Increase in employment	E4. Sales of new products	E5. Involvement of employees	Total
1	-0.4	-0.8	-1	-0.6	-0.6	**-3.4**
2	1.6	1.2	1	1	0.4	**5.2**
3	-0.4	-0.8	1	-0.6	0	**-0.8**
4	-0.4	-0.8	-1	-0.6	0	**-2.8**
5	0.2	1.2	-0.2	-0.2	0	**1**
6	-1	-0.2	-1	-0.2	0.4	**-2**
7	1.6	2.6	2.2	2.6	0.4	**9.4**
8	-0.4	-0.8	-1	-0.2	0	**-2.4**
9	-0.4	-0.8	-1	-0.6	-0.6	**-3.4**
10	-0.4	-0.8	1	-0.6	0	**-0.8**
mean	4.4	4.8	5	4.8	5.1	
s.d.	0.96	1.13	1.15	1.03	0.74	

Commentary: all measurements of effectiveness cover the period of 2012-2014. The increase in sales is understood as an increase in total revenues from sales of products/services; Profit margin on sales is understood as the ratio of profit to revenue from sales of products/services; The increase in employment is calculated jointly with the increase in the employment of people under the employment and civil law contracts; The employee involvement is understood as a measure of social efficiency.

Mean stands for average mean, s.d. stands for standard deviation, shaded row stands for the case with the highest outranking function (the highest performance individual start – up profile).

Table 3. The analysis of the outranking function of the effectiveness parameters in the group of companies at mature growth stage of development
Source: own study

Analysis of the obtained distributions of the outranking function for the surveyed companies, being in the phase of consolidated growth, indicates the biggest differences in the perspective of development when measured by the growth of sales and employment, as well as in the financial perspective measured by the profit margin on sales and the perspective associated with innovativeness measured by the sales of new products. It is possible to notice slightest differences in the social perspective, measured by the involvement of employees.

The obtained results of empirical research indicate, that the high-tech enterprises in the phase of consolidated growth shape their efficiency mainly on the basis of development perspective measured both by the growth in sales and employment, the financial perspective measured by the profit margin on sales and the perspective associated with innovativeness measured by sales of new products. The social perspective measured by the involvement of employees definitely plays the smallest in the case of enterprises in the phase of consolidated growth. The resulting profile of the effectiveness of high-tech enterprises in the phase of consolidated growth may be referred to as the market expansion of a company by the increasing innovativeness.

Additionally, on the basis of analysis of individual outranking functions, the two profiles of effectiveness, i.e. the highest performance start-up company profile and the highest performance growth company profile, have been compared (see the Tab. 4.).

	E1.	E2.	E3.	E4.	E5.
Start –up, case no. 7	2.2	0.6	0	0	1.4
Growth, case no. 7.	1.6	2.6	2.2	2.6	0.4

E1 - profit margin on sales; E2 - growth in sales; E3 - increase in employment; E4 - sales of new products; E5 - involvement of employees (the same in the tables. no 2 and 3).

Table 4. Comparison of the highest performance profiles in two groups of companies
Source: own study.

Comparison of the effectiveness profiles of the market entering companies and the companies with consolidated growth clearly indicates, that along with the transition of an enterprise to the phase of consolidated growth, the significance of the social perspective measured by the involvement of employees decreases dramatically and the importance of the financial perspective measured by the profit margin on sales is reduced. At the same, the transition of an enterprise to the phase of consolidated growth means a dramatic increase in the importance of the development perspective measured both by the growth in sales and employment as well as the increase in the innovation-related perspective measured by sales of new products.

CONCLUSION

The conducted analysis of effectiveness related to the high-tech enterprises which are at two subsequent stages of development indicates significant differences. Top management of high-tech enterprises in the phase of market entry includes their owner as well as the authors of business ideas, which are the base of an enterprise. They represent high technical competence, supported by practical industry know-how. Business ideas, which become the basis of a subsequently operating technological enterprises are a practical result of the process of recognition and exploitation of technological opportunities, in other words, of the whole process of technological entrepreneurship. The effectiveness profile of high-tech enterprises in the phase of market entry is based on a strong involvement of employees as well as on profit margin on sales of an innovative product. In other words, a high value for the customer, confirmed by the high margin on sales, is achieved by building a strong social capital around the technological knowledge.

Top management of high-tech enterprises in the phase of consolidated growth includes the teams of authors and specialists on the customer markets of enterprises. Technological and industry know-how is in the case of companies in the growth phase completed with the marketing knowledge. Such enterprises focus more on the exploitation of a technological opportunity than on its recognition. The efficiency profile of high-tech enterprises in the phase of growth consolidation is based on the development performance perspective, namely on the increase in sales and employment and on the innovativeness-associated perspective, which means the introduction of new products to the market. The result of the development orientation of an enterprise in the phase of growth is smaller social efficiency when compared to the enterprises in the phase of market entry.

The transition in the models of technological entrepreneurship efficiency from the market entry phase to the phase of consolidated growth consists in the reduction of the social performance perspective of an organisation and the increase in the perspective of growth performance. In other words, the strong involvement of employees of technological enterprises in the market entry phase is replaced by an increase in the number of employees and the intensification of company relations with clients in the case of enterprises in the consolidated growth phase.

REFERENCES

[1] D. Audretsch,“Entrepreneurship research”, Management Decision, no. 5, pp. 755-764, 2012.

[2] H. J.Bernardin, M. Wiatrowski,“Performance Appraisal”, Psychology and Policing, no. 3, pp. 257 – 267, 2013.

[3] A.A. De Waal, “Characteristics of High Performance Organisations”, Business Management and Strategy, no. 3, pp. 28-45, 2012.

[4] G. G. Dees, D. W. Beard,“Dimensions of Organisational Tasks Environments”, Administrative Science Quarterly, pp. 52-73, 1984.

[5] G.G.Dess, S.Newport, A. M. A. Rasheed, “Configuration Research in Strategic Management: Key Issues and Suggestions”, Journal of Management, no. 4, pp. 775-795, 1993.

[6] E.Hull, S.Rothenberg,“Firm Performance: The Interactions of Corporate Social Performance with Innovation and Industry Differentiation”, Strategic Management Journal, no. 7, pp. 781–789, 2008.

[7] C.Jeffrey, G. T.Lumpkin, “Entrepreneurial Orientation Theory and Research: Reflections on a Needed Construct”, Entrepreneurship: Theory & Practice, no. 35, pp. 855–872, 2011.

[8] R. K. Kazanjian, “Relation of Dominant Problems to Stages of Growth in Technology-Based New Ventures”, Academy of Management Journal, no. 2, pp. 257-279, 1998.

[9] S.K.Khilji, T.Mroczkowski, B.Bernstein,“From Invention to Innovation: Toward Developing an Integrated Innovation Model for Biotech Firms”, Journal of Product Innovation Management,no. 23, pp. 528–540,2006.

[10] L. M. Luca, G. Verona, S. Vicari,“Market Orientation and R&D Effectiveness in High-Technology Firms: An Empirical Investigation in the Biotechnology Industry”, Journal of Product Innovation Management, no. 27, pp. 299–320, 2010.

[11] G.B.Murphy, J.W.Trailer, R.C.Hill,“Measuring Performance in Entrepreneurship Research”, Journal of Business Research, no. 36, pp. 15-23,1996.

[12] M. Orlitzky, F. L. Schmidt,S. L. Rynes,“Corporate Social and Financial Performance: A Meta-Analysis”, Organisation Studies, no. 3, pp. 403–441, 2003.

[13] C.C.Ragin, “The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies”, University of California Press, 2014.

[14] J.Rialp, D.Urbano, Y.Vaillant,“The Born-Global Phenomenon: A Comparative Case Study Research”, Business Research, no 2 , pp. 133–171, 2005.

[15] J.Shields, “Managing Employee Performance & Reward: Concepts, Practices, Strategies”, Cambridge University Press, 2015.

★★★