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Procedia Engineering 182 (2017) 701 – 708

Procedia Engineering

www.elsevier.com/locate/procedia

7th International Conference on Engineering, Project, and Production Management

Importance of Technological Factors in the Creation of Cooperation

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Abstract

The purpose of this article is to specify the values of technological factors in the formation of cooperation. The article uses the method of critical analysis of literature and statistical analysis of data obtained from a survey conducted in 381 Polish companies of leading industries in Podlaskie Province. The importance of factors related to the management of technology in relation to the rest of the factors influencing the development of cooperation was analysed. Companies are interested in cooperation to a small degree. In addition, factors associated with the possibility of taking joint technology action are not essential for establishing such cooperation.

Peer-review under responsibility of the organizing committee of EPPM2016

Keywords: cooperation; inter-company cooperation; areas of cooperation; Podlaskie; technological factors

1. Introduction

Changes in the enterprises' approach to cooperation can be observed over the last few years – the scope and types of cooperation forms are becoming more numerous, and one of the key success factors is economic effects resulting from integration of companies [1–4]. Although cooperation between organizations was in the past regarded as a facilitator of innovation [5–9], currently it is one of the ways of business operations or even a necessity [10].

Technology, however, for several years has been one of the most valuable assets of an organization, contributing to its growth and productivity increase [11]. Therefore, the question whether the selected factors related to technology affect the level of cooperation between companies in the industry, the business environment institutions and the sphere of scientific research becomes important, as well as the other question whether positive changes in these factors may improve the level of cooperation.

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Peer-review under responsibility of the organizing committee of EPPM2016
doi:10.1016/j.proeng.2017.03.183

The article uses the method of critical analysis of the literature and statistical analysis of data obtained from a survey conducted among 381 Polish companies in industries leading in Podlaskie Province.

2. Literature review

The concept of co-operation, commonly functioning in society, can be used in different contexts and in different areas of the economy [12]. The concept of coopetition appeared in the stream of management more than 100 years ago, but development of the research associated with it was started much later [13].

Wide interest in this issue resulted in multiplicity of definitions and synonyms of the concept – collaboration is identified with cooperation, interaction (which are used interchangeably in journals, scientific and specialist texts), alliance and outsourcing [14–17] – in the modern global economy a dynamic development of various forms of cooperation between economic operators can also be observed [18].

It should be noted that the sources of companies' advantages are dependent on the balance between competition and cooperation. There is no contradiction between cooperation and competition [17]. Cooperation means the search for synergies with inter-organizational relationships and exists in the process of creating additional value in the network, and the competition concerns division of this value [13]. Composed competition and cooperation can be identified with coopetition [19].

Cooperation is a relationship bounding at least two entities and involving collaboration, the aim of which is to achieve common goals by these entities [20, 21], or – in case of forced cooperation – achieving advantages by some of the entities [4]. The prerequisite to work together is a common interest resulting in the need to strengthen the potential in different arenas [22–24]. We should emphasize here that common objective of cooperation, often stressed in the literature, in fact, is not always present – partners can work together, but for entirely different reasons [25].

Cooperation may involve whole enterprises, organizations, their departments, individuals or groups of people. It can also refer to the mutual relationships not only between organizations, but also between regions or countries where it is defined as a voluntary coordinated action of two or more countries, taking place within legal conditions and serving a specific purpose [26].

Due to multitude of the concept definitions there are many criteria for dividing cooperation. Those considered by the author as the most important are presented in the table below.

Table 1. Selected criteria of classification of cooperation.

Criteria	Kind of cooperation
Duration	Short-term – for no longer than one year or time of project completion
	Long-term – for longer than a year, but not permanent
	permanent
Kind of relationship	formal – cooperation confirmed in writing, reflected in documents, agreements
	informal – no formal confirmation of cooperation
Direction	vertical – cooperation in frames of production chain – e.g. supplier – producer; producer – distributor
	horizontal – between entities of similar business activities
Cooperating entity	sphere of industry
	sphere of science
	business environment institutions
	public administration
Financing sources	own funds – cooperation is financed exclusively with the partners' own capital
	external funds – cooperation is financed with the external capital
	mixed funds – cooperation is financed with both own funds and external funds
Number of engaged sectors	intra-sector – cooperation within one sector
	inter-sector – engaging entities from two sectors

Criteria	Kind of cooperation
	multi-sector – engaging public organizations, non-governmental and commercial
Number of engaged actors	bilateral – between two areas
	multi-lateral – between at least three partners (also activities in organizations, associations)
Size of engaged actors	cooperation between small companies (of network nature)
	cooperation between a small company/companies and big one/ones (e.g. licensing, franchising)
	cooperation between big companies (e.g. Strategic alliance)
Kind of engaged actors	actors of one kind – cooperate entities of the same legal form
	actors of different kinds – cooperate entities of different legal form
Efficiency	effective cooperation
	ineffective cooperation

Source: [27–32].

Ability to shape cooperation between enterprises may lead to future joint problem solving, joint control over processes or mutual learning.

There are many studies on identification of factors affecting the level and success of cooperation [33–37]. In this article the author has tried to investigate whether technological factors influence the level of cooperation.

3. Research methodology

Taking the above into consideration the rest of this paper presents the results of partial research carried out in the framework of an international research project "Readiness of enterprises to create cross-border networking". The project resulted from an agreement between the Polish Academy of Sciences and the National Academy of Sciences of Belarus in 2014-2016. Quantitative studies, carried out in late 2014 and early 2015 on the basis of deliberate choice, covered 381 Polish enterprises of industries leading in Podlaskie province (research was conducted on a sample of 381managers).

The research approach based on Desk Research analysis was applied for realization of the set objectives. As a result of the literature analysis and ongoing discussions the factors shaping cooperation between enterprises have been determined in the context of strengthening the development of entrepreneurship. An analysis was carried out of factors affecting the level of cooperation on the basis of the available statistical data and source materials.

Three areas of cooperation were indentified:

- Between companies in the industry
- Companies with business environment institutions
- Companies with science-research sphere.

The respondents indicated their assessment of the level of cooperation in relation to each of the areas (on a scale 1 – 7, where 1 means lack of any cooperation, 7 – very good cooperation). Then, for each kind of cooperation from a few to several factors were distinguished and the respondents assessed how the various factors affect the level of cooperation (on the scale 1 – 7).

The respondents also indicated the degree of interest in establishing closer cooperation and the extent to which positive changes in various factors may affect the improvement of the level of cooperation

4. Analysis and discussion on the research results

Analyzing the level of cooperation between companies in the industry, companies and business institutions and companies with the sphere of science-research (Table 2) one will find that the respondents by far the worst assessed the current level of cooperation with the sphere of science-research. This was indicated by both the ratio of the

arithmetic mean, median, and dominant. Cooperation of companies with business institutions was assessed slightly higher (but well below the average). Top respondents' assessments received cooperation between companies in the industry.

Table 2. Assessment of the current level of cooperation in the chosen areas.

Areas of cooperation	$\bar{x}$	M	D	V
Cooperation between companies in the industry	3.94	4	4	1.59
Cooperation of companies with business institutions	3.07	3	3	1.53
Cooperation of companies with science-research sphere	2.51	2	1	1.56

It was also analyzed whether the respondents are interested in strengthening the cooperation in the next 2-3 years. Comparing the test results one can notice only negative trends in the assessments of the degree of interest in strengthening cooperation between companies in the industry (arithmetic mean at the level of 3.62 and 3.94 for the current level of cooperation). Other indicators remained at the same level (median and dominant related to strengthening cooperation between companies) or increased.

Table 3. Assessment of the degree of interest in strengthening cooperation in the next 2 – 3 years.

Areas of cooperation	$\bar{x}$	M	D	V
Cooperation between companies in the industry	3.62	4	4	1.52
Cooperation of companies with business institutions	3.69	4	4	1.60
Cooperation of companies with science-research sphere	3.19	3	3	1.66

Analyzing Spearman's rank correlation coefficient (Table 4) one can state that in each case there is a positive correlation (increase in the average value of one feature is accompanied by an increase in the average value of the other features) – for current and future cooperation between companies in the industry the correlation is low, in the case of the current and future cooperation of companies with business institutions and the sphere of science-research it is moderate.

Table 4. Evaluation of the current level of cooperation and possibilities of its strengthening in the future.

Areas of cooperation	Spearman's rank correlations
Cooperation between companies in the industry	0.39
Cooperation of companies with business institutions	0.66
Cooperation of companies with science – research sphere	0.60

For each type of cooperation the factors potentially affecting the level of cooperation were distinguished. The respondents assessed how these factors affect the level of cooperation in the sector and to what extent the positive changes in various factors may affect strengthening of cooperation in the field. The results are shown in Tables 5 – 7, wherein it should be noted that in this article only technological factors (and technology related) are analyzed.

The arithmetic mean of the respondents' assessments of the extent to which all the individual factors influence the level of cooperation between companies in the industry is in the range <2.82; 4.11>. Therefore it can be assumed that factors related to technology (the average at the level of 2.86; 3.16; 3.46) are not essential for development of cooperation in the industry.

The arithmetic mean of the degree of impact of positive changes in the factors on the level of cooperation between companies in the industry is in the range <3.44; 4.50> – in this case the factors of technical nature (for which the average was respectively 3.63, 3.64 and 3.88) do not play a key role in strengthening cooperation between companies in the industry. In addition, the Spearman coefficient shows low (0.33) or moderate (0.56; 0.58) correlation (Table 5).

Table 5. Factors influencing the level of cooperation in the industry and the impact of positive changes in the factors on improvement of cooperation level.

Factor	$\bar{x}$	M	D	V
Increase of innovative potential	3.46	3	3	1.80
Positive changes in increase the innovative potential	3.88	4	4	1.70
Spearman's rank correlations	0.56			
Access to competitor's resources (e.g. technological)	3.16	3	1	1.77
Positive changes in access to competitor's resources	3.64	4	5	1.74
Spearman's rank correlations	0.58			
The possibility of joint investment projects implementation	2.86	3	1	1.83
Positive changes in the possibility of joint investment projects implementation	3.63	4	1	1.88
Spearman's rank correlations	0.33			

The arithmetic mean of the respondents' opinions on the extent to which all the individual factors influence the level of cooperation between companies and institutions of business environment is in the range <2.86; 3.73>, so one can assume that the possibility of joint research and development projects implementation (3.01) and access to research infrastructure (3.04) are less important for the development of cooperation than help in technology transfer (3.40). None of the factors affects significantly the level of cooperation between companies and business environment institutions.

The arithmetic mean of the degree of impact of positive changes in the factors on the level of cooperation between companies in the industry is in the range <3.39; 4.26>. Therefore, it can be assumed that factors of a technical nature, for which the average was respectively: 3.69, 3.70 and 3.99, are not either the critical factors for cooperation development. It should also be noted that in each analyzed case, the Spearman correlation coefficient indicated high correlation (Table 6).

Table 6. Factors influencing the level of cooperation between companies and business environment institutions and the impact of positive changes in the factors on improvement of cooperation level.

Factor	$\bar{x}$	M	D	V
The possibility of joint R&D projects implementation	3.01	3	1	1.73
Positive changes in the possibility of joint R&D projects implementation	3.70	4	4	1.84
Spearman's rank correlations	0.72			
Access to research infrastructure	3.04	3	1	1.75
Positive changes in access to research infrastructure	3.69	4	4	1.77
Spearman's rank correlations	0.69			
Help in technology transfer	3.40	3	1	1.81
Positive changes in help in technology transfer	3.99	4	4	1.76
Spearman's rank correlations	0.68			

The arithmetic mean of the respondents' assessments of the extent to which all the individual factors influence the level of cooperation between companies and R&D sphere is in the range <2.79; 3.38>. It can be assumed that the possibility of joint research and development projects (2.79) and access to research infrastructure (2.92) are less important for development of cooperation than help in solving technological problems (3.14).

The arithmetic mean of the degree of the impact of positive changes in the factors on the level of cooperation between companies and R&D sphere is in the range <3.39; 4.26>. Therefore, it can be assumed that the analyzed factors of technical nature, for which the average was respectively; 3.49, 3.59 and 3.77 have a medium impact on improving the level of cooperation in this area. It should be noted that in each analyzed case Spearman correlation coefficient indicated high correlation (Table 7).

Table 7. Factors influencing the level of cooperation between companies and science-research sphere and the impact of positive changes in the factors on improvement of cooperation level.

Factor	$\bar{x}$	M	D	V
The possibility of joint research and development projects	2.79	2	1	1.75
Positive changes in the possibilities of joint implementation of research and development projects	3.59	3	1	1.86
Spearman's rank correlations	0.68			
Access to research infrastructure	2.92	3	1	1.74
Positive changes in access to research infrastructure	3.49	4	1	1.83
Spearman's rank correlations	0.69			
Help in solving technological problems	3.14	3	1	1.79
Positive changes in solving technological problems	3.77	4	4	1.87
Spearman's rank correlations	0.64			

5. Conclusion

This article presents the importance of technological factors in creation of cooperation in the context of three areas – cooperation between companies in the industry, cooperation between companies and institutions of business environment and cooperation between companies and R&D sphere.

It should be noted that both current and potential levels of cooperation are at a relatively low or moderate level – managers and owners of companies in Podlaskie Province lack a positive attitude to the potential benefits from establishing various forms of cooperation. This is particularly disadvantageous because the majority of the studied companies belong to the SME sector which is characterized by relatively low growth potential, and companies belonging to it are not able to run development activities alone. Therefore, they should value benefiting from the synergy effect characteristic for cooperation.

The impact of the analyzed factors of technical nature on current and future cooperation does not also play a key role in the respondents' opinion – none of the defined technology factors has reached the average impact level of 4.

In conclusion, the analysis of the responses' assessments allows for the formulation of the conclusion that they are not significantly interested in closer cooperation and factors of technical nature and potential changes occurring in this area do not have a significant impact on establishing cooperation.

Acknowledgements

The research was conducted within S/WZ/3/2015 project and was financed from Ministry of Science and Higher Education funds.

Ministry of Science and Higher Education
Republic of Poland

7th International Conference on Engineering, Project, and Production Management (EPPM2016) was financed in the framework of the contract no. 712/P-DUN/2016 by the Ministry of Science and Higher Education from the funds earmarked for the public understanding of science initiatives.

7th International Conference on Engineering, Project, and Production Management (EPPM2016) finansowana w ramach umowy 712/P-DUN/2016 ze środków Ministra Nauki i Szkolnictwa Wyższego przeznaczonych na działalność upowszechniającą naukę.

7th International Conference on Engineering, Project, and Production Management (EPPM2016) was co-organised by the Agency for Restructuring and Modernisation of Agriculture (Poland).

References

[1] Powell WW. Neither market nor hierarchy: Network form of organization. *Research in Organizational Behaviour* 1990;12:295–336.
[2] Noteboom B. The dynamic efficiency of networks. In: Grandori A, editor. *Interfirm networks: Organization and industrial competitiveness*, London: Routhledge; 1999.
[3] Powell WW, Koput KW, Smith-Doerr L. Interorganizational collaboration and the locis of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly* 1996;41:116–145.

[4] Strzyżewska M. *Współpraca między przedsiębiorstwami – odniesienie do polskiej praktyki* [Cooperation between enterprises – a reference to the Polish practice]. Warszawa: Oficyna Wydawnicza SGH; 2011.
[5] Tu C, Hwang SH, Wong JY. How does cooperation affect innovation in micro-enterprises?. *Management Decision* 2014;52(8):1390–1409.
[6] Florida R. *The Flight of the Creative Class. The New Global Competition for Talent*. New York: Harper Collins; 2007.
[7] Tu C. A multilevel investigation of factors influencing creativity in NPD teams. *Industrial Marketing Management* 2009;37(1):119–126.
[8] Ejdys J. Future oriented strategy for SMEs. *Procedia – Social and Behavioral Sciences* 2014;156:8–12.
[9] Ejdys J, Ustinovicius L, Stankevičienė J. Innovative application of contemporary management methods in a knowledge-based economy – interdisciplinarity in science. *Journal of Business Economics and Management* 2015;16(1):261–274.
[10] Adamik A, Staniszewska K. Zarządzanie współpracą z partnerami biznesowymi z wykorzystaniem rozwiązań IT [Management of cooperation with business partners using IT solutions]. In: Lachiewicz S, Zakrzewska-Bielawska A, editors. *Zarządzanie przedsiębiorstwem w warunkach rozwoju wysokich technologii* [Business management in conditions of high technology development], Łódź: Politechnika Łódzka; 2008.
[11] Zahra SA, Kirchhoff BA. Technological resources and new firm growth: A comparison of start-up and adolescent ventures. In: Keister LA, editor. *Entrepreneurship. Research in the sociology of work*. Emerald Group Publishing Limited; 2005.
[12] Głąbicka-Auleytner K. Usługi socjalne jako nowy instrument współpracy wobec wykluczenia społecznego [Social Services as a new instrument for cooperation against social exclusion]. In: Zamkowska A, editor. *Wsparcie społeczne i współpraca jako instrument walki z wykluczeniem społecznym* [Social support and cooperation as an instrument to combat social exclusion], Radom: Wyd. Uniwersytetu Techniczno-Humanistycznego w Radomiu; 2013, p. 115–120.
[13] Nalebuff BJ, Brandenburger A. *Co-opetition*. London: Harper Collins Business; 1996.
[14] Deepen MJ, Goldsby TJ, Knemeyer AM, Wallenburg SM. Beyoond Expectation: An examination of Logistics Outsourcing Goal achievement and Goal Exceedance. *Journal of Business Logistic* 2008;29(2):75.
[15] Romanowska M, Trocki M. *Przedsiębiorstwo partnerskie – w poszukiwaniu równowagi pomiędzy rywalizacją i współdziałaniem* [Company affiliate – in the search for a balance between competition and interoperability]; MBA, 2002, p. 6–46.
[16] Mazur J. Współpraca przedsiębiorstw w teorii i praktyce polskiej [The cooperation of companies in the theory and polish practice]. In: Brdulak H, Duliniec E, Gołębiowski T, editors. *Współpraca w łańcuchach dostaw a konkurencyjność przedsiębiorstw i kooperujących sieci* [Cooperation in the supply chain and the competitiveness of enterprises and cooperative networks], Zeszyty Naukowe Kolegium Gospodarki Światowej; 2011, p. 32–90.
[17] Tomaszewski M. Teoretyczne aspekty kooperacji przedsiębiorstw [Theoretical aspects of cooperation of enterprises]. In: Świadek A, Wiśniewska J, editors. *Współpraca przedsiębiorstw a innowacje i transfer technologii – wybrane aspekty* [The cooperation of enterprises and innovation and technology transfer – selected aspects], Szczecin: Wyd. Nauk. IVG; 2015.
[18] Wybieralski P., *Alianse technologiczne a strategiczne zachowania korporacji międzynarodowych na rynkach niedoskonałych* [Technological alliances and strategic behavior of multinational corporations in markets imperfect]. Toruń: Adam Marszałek; 2015.
[19] Zakrzewska-Bielawska A, editor. *Koopetycja w rozwoju przedsiębiorstw high-tech. Determinanty i dynamika* [Coopetition in the development of high-tech enterprises. Determinants and dynamics]. Warszawa: Placet; 2014.
[20] Hillebrand B, Biemas D. The relationship between internal and external cooperation: Literature review and proposition. *Journal of Business Research* 2003;56:735–73.
[21] Lichtarski L. *Współdziałanie gospodarcze przedsiębiorstw* [Cooperation of economic enterprises]. Warszawa: PWE; 1992.
[22] Hamel G. Competition for competence and inter-partner learning within international strategic alliances. *Strategic Management Journal* 1991;12:83–104.
[23] Håkansson H. *Industrial technological development, A network approach*. London: Croon Helm; 1987.
[24] Inkpen AC, Crossan M. Believing is seeing: Joint ventures and organizational learning. *Journal of Management Studies* 1996;32(5):596–618.
[25] Santos FM, Eisenhardt KM. Organizational Boundaries and theories of Organization. *Organization Science* 2005;16(5):491–508.
[26] Solarz P. *Współpraca transgraniczna jako czynnik procesu integracji europejskiej* [Cross-border cooperation as a factor in the European integration process]. Warszawa: Vizja Press &IT; 2009.
[27] Powell WW. Neither market nor hierarchy: Network form of organization. *Research in Organizational Behaviour* 1990;12:295–336.
[28] Smith-Doerr L, Powell WW. *Networks and Economic Life*. New York: Rusell Sage Foundation-Princeton University Press; 2005.
[29] Chrisidu-Budnik A. Elementy sieci – aspekty prawne [Network elements – the legal aspects]. In: Niemczyk J, Stańczyk-Hugiet E, Jasiński B, editors. *Sieci międzyorganizacyjne: Współczesne wyzwania dla teorii i praktyki zarządzania* [Inter-organizational networks: Contemporary challenges for management theory and practice], Warszawa: C.H. Beck; 2012, p. 43.
[30] Wasiluk A. Zaufanie i współpraca pomiędzy przedsiębiorstwami w perspektywie budowy i rozwoju struktur klastrowych [Trust and cooperation between companies in the perspective of cluster structures' formation and development]. *Ekonomia i Zarządzanie* 2013;4:51–52.
[31] Świadek A, Wiśniewska J, editors. *Współpraca przedsiębiorstw a innowacje i transfer technologii – wybrane aspekty* [The cooperation of enterprises and innovation and technology transfer – selected aspects], Szczecin: Wyd. Nauk. IVG; 2015, p. 5.
[32] Dozbłasz S, Raczyk A. *Współpraca transgraniczna w Polsce po akcesji do UE* [Cross-border cooperation in Poland after accession to the EU], Warszawa: Oficyna Wolters Kluwer Business; 2010.
[33] Wasiluk A. Prerequisites for undertaking and developing cooperation by industrial and construction companies. *The 9th International Scientific Conference "Business and Management 2016": Conference Proceedings*; 2016.
[34] Daniluk A, Tomaszuk A. Conditions for development of companies' cooperation and entrepreneurship. *The 9th International Scientific Conference "Business and Management 2016": Conference Proceedings*; 2016.
[35] Cygler J. Kooperencja przedsiębiorstw. Czynniki sektorowe i korporacyjne [Cooperation of companies. Factors sectoral and corporate], Warszawa: Oficyna Wydawnicza SGH w Warszawie; 2009, p. 116–138.
[36] Patel H, Pettitt M, Wilson JM. Factors of collaborative working: A framework for a collaboration model. *Applied Ergonomice* 2012;43:1–26.

[37] Mattessich PW, Monsey BR. *Collaboration: What makes It Work, A review of Research Literature on Factors Influencing Successful Collaboration*. St. Paul Minessota: Amherst H. Wilder Fundation; 1992, p. 15–27.