

R&D ORGANIZATIONS IN AUTOMOTIVE SUPPLY CHAINS

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Abstract

Automotive concerns manage the innovation of their suppliers, facilitate regional and cross-border cooperation among suppliers, care for the protection of intellectual property, ensure the safe transfer of technologies, ideas, goods, services and people. They use the single market, digital infrastructure, transport infrastructure and the European network of knowledge. They develop research and development centers in host countries and assign them specific roles. One of them are devoted primarily to technical support (technology adaptation) for the local branch of their mother corporation. Other centers support an entire group of branches in a given geographic region (e.g. in Europe), and their role is to develop products for the local or regional market, and to acquire and cooperate with suppliers in R&D. The purpose of this article is to describe the organization and management of research and development activities in selected automotive concerns, and to identify the roles of R&D centers situated in Poland. The author attempts at assessing: the involvement of automotive suppliers in cooperation with R&D centers. The impact of this involvement on the functioning of international supply chains was analyzed. Companies which invested in research and development and which cooperate with R&D centers change their relations within the supply chain, shifting from integrated, transaction-oriented activities and adapting dynamic approach, whereby all activities start with shared research and development projects.

Keywords: R&D, supply chain, manage the innovation in supply chain, intellectual property

1. INTRODUCTION

Based on secondary data, the author defined the role of R&D centers as links that shape dynamic supply chains in the automotive industry. The locations and relations of R&D organizations situated in Poland were analyzed in the context of their impact on the shape of the supply chain. The study was carried out on companies from the automotive industry in the form of a survey. The purpose of the study was to assess the involvement of companies in R&D activities and the impact of this involvement on the relations within the supply chain. All references confirming the significance of R&D organizations in the development of dynamically changing supply chains are quoted in the text.

2. THE ROLE OF R&D CENTERS IN SHAPING SUPPLY CHAINS

Literature devoted to innovative activities implemented by international corporations discusses studies which classify R&D centers. This classification has been performed on the basis of the responsibilities of these centers. According to empirical studies, there are four primary roles of research and development centers controlled by corporations. Selected classifications of foreign R&D centers in international corporations are presented in **Table 1**.

Poznańska and Kraj [2] noted that (even as early as in the 1980's) international corporations conducted R&D works in their corporate centers only (centers, laboratories). This centralist approach to research and development was rooted in the managers' conviction that this specific functional area should be kept under strict control and protection from the competition. However, since the 1980's, there has been a gradual process of decentralizing R&D functions, which is also referred to as the internationalization of R&D. Companies have been creating foreign centers which started to cooperate with suppliers, clients, and even car users. There are



many advantages to opening up to outside ideas. However, this process also entails economic, legal [3], political and cultural problems. Supply chains which had been integrated and closed in the past, which was characteristic for the automotive industry, have slowly become dynamic and open for innovative suppliers. R&D activities have remained centralized in basic research, and suppliers are admitted to participate in developmental works. Decentralized units situated in host countries have developed cooperation with other entities (not only first tier suppliers, but also successive suppliers, regional clusters, schools, independent R&D centers). The scope of recommended works is determined by eight factors [4]: non-codified knowledge and the degree of necessary coordination, degree of production outsourcing, the importance of R&D functions, the demand for specialist skills and equipment, increasingly multidisciplinary and multitechnological nature of innovation, and the need to reduce costs. These factors cause the need to dynamically change the links in today's supply chains in the automotive industry.

Table 1 Selected classifications of R&D centers in international corporations [1]

Item	Main			
Classification author	Adaptation of technology, technical support for local corporation branch	Research (applied), development of products for the local or regional market	Research (applied) of products placed on local markets	Competence center in research and development
R. Ronstadt (1977)	Technology transfer centers	Local technology centers	Global product centers	Corporate technology centers
N. Hood, S. Young (1982)	Supporting laboratory	Local integrated laboratory	International, codependent laboratory	
W. Kuemmerle (1997)	Mother database operational centers (knowledge and technology)		Mother database expansion centers (knowledge and technology) from supply chains and networks	
J.W. Madcof (1997)	Local marketing support center; Local production support center	Local development centers, International development center	International development center	Local research center; International research center
H. Davis, G. Jones (2000)	Local oriented support/adaptation centers	Local oriented R&D centers	Global oriented R&D centers	

Analyzing the powers of development centers, we can conclude that they have been evolving in directions set by the researchers. According to Boutellier and associates [5], technical offices which were initially created to service clients on the local market, have gradually evolved towards the development of new technologies and products, driven by such forces as: developing autonomy from the central office, employing talented people, satisfying the growing needs of the market, gaining prestige. In turn, offices created to monitor the local research infrastructure and to maintain proficient ties with the scientific environment display a tendency to increase the scope of tasks and responsibilities assigned. They have been evolving towards research centers combining various organizations aiming at creating new solutions. In this case, the driving forces are: the need to manage the local talent, increasing the knowledge database, shaping new supply chains to develop subsequent, innovative solutions. R&D organizations thrive on local suppliers who display their developmental potential and complete subsequent R&D projects, thus internationalizing their activities and finding new, international recipients.

Analyzing the geographic locations of R&D functions of automotive concerns outside the borders of their mother states, we can conclude that the R&D function (as serving to develop products placed on global markets) appears as the last one in the host country. Its creation depends on the innovative maturity of local

suppliers. The following questions therefore arise: Has the time come for automotive concerns based in Poland to create a R&D function (serving to develop products placed on global markets)? What is the degree of involvement of Polish automotive suppliers in research and development cooperation? Do automotive companies perceive research and development as an opportunity to join international supply chains?

3. AUTOMOTIVE COMPANIES AS SUPPLY CHAIN LINKS AND RESEARCH AND DEVELOPMENT CENTERS PROVIDING SERVICES FOR THE AUTOMOTIVE INDUSTRY IN POLAND

In 2017, there were more than 900 production companies operating in the automotive industry in Poland, out of which 270 were foreign-owned. 500 of them received ISO/TS 16949 certification. According to data from the Main Statistical Office, the largest companies (more than 249 employees) were responsible for 84 % of the employment and for 92 % of the sales revenues recorded by the entire sector. Approximately 650 automotive companies operating in Poland are owned by Poles, and a great majority of them are small and medium enterprises. According to estimated data derived from own studies, 95 % of the companies have operated within integrated supply chains, focusing on the production of components developed by the concern. Few of them engage in own research and development of own products [7,8] (approx. 15 % of the companies). For this purpose, they have engaged in cooperation with R&D centers (independent ones and ones that belong to international concerns) and with other companies (usually the members of automotive clusters). **Figure 1** presents the geographic distribution of the automotive industry in Poland.

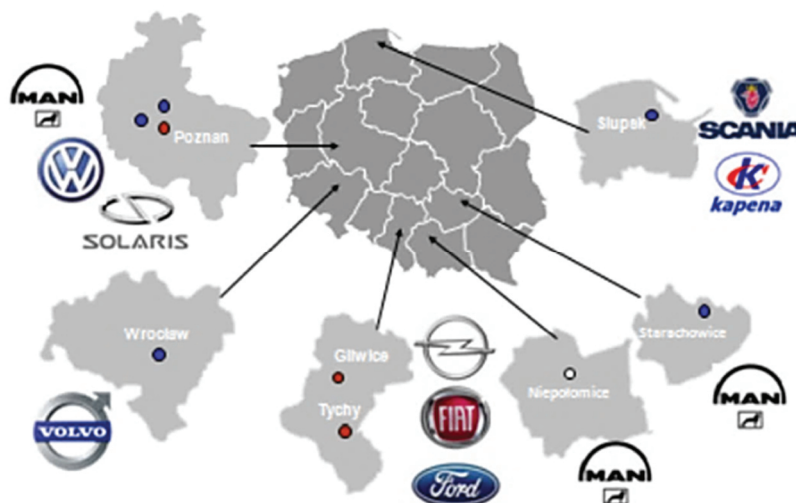


Figure 1 Location of the automotive industry in Poland [6]

Having adopted a strategy for building a competitive economy, Polish authorities have consistently pursued an economy based on knowledge and innovation. In January 2016, an Innovation Board was appointed in Poland, aiming to stimulate cooperation of R&D institutions with Polish companies. Financial and non-financial tools for supporting companies were established, including: creation of technological and industrial parks, invitation to create branches in the areas of international research & development centers (not only from Europe, but also from BRIC (Brazil, Russia, India and China)). There are currently about 77 research and development centers in Poland, which employ several thousand Polish scientists and specialists. The majority of them work for the ICT, automotive, chemical, aviation, food and IT sectors. Among research centers, there are domestic and international companies which have functioned as the branches of foreign concerns. These are, among others: Oracle, Samsung, Faurecia, GlaxoSmithKline, Microsoft, Volvo, Capgemini, IBM, ABB, Lurgi, Google, Bosch, Siemens [9].

Analyzing research and development activities as part of services provided to the automotive industry, we are bound to conclude that R&D institutes and laboratories have been established and have actively contributed to the global development of mobility. Some of the leading organizations of this type are: the Electrotechnical Institute, the Motor Transport Institute, the Institute of Electrical Drives and Machines KOMEL, the Automotive Industry Institute. Automotive research issues are also raised by such entities as: all Technology Universities, the Institute of Power Engineering, the Communication Institute, the Aviation Institute, the Fuel and Renewable Energy Institute, the Tele- and Radiotechnical Institute, the Industrial Institute of Construction Machinery, the Industrial Institute of Farming Machinery, the Military Institute of Armored and Motor Technology, the Research and Development Center for Compact Vehicles, Impact Design Europe, Amz-Kutno Sp. z o.o., Zakład Kompozytów Sp. z o.o., Solaris Bus & Coach S.A. Delphi (which has two research and development centers in Krakow and Ostrów Wielkopolski, aside from its 4 production plants), Tenneco, TRW, Valeo, Faurecia, Wabco, Eaton, Draexlmaier, Volkswagen have been working in Poland for some time now. **Figure 2** presents the distribution of international research and development centers working for the automotive industry.



Figure 2 Location of R&D centers providing services for the automotive industry in Poland [9]

In the automotive industry, technological development has become apparent thanks to the modern appeal of research and development centers which have created an entirely new environment for creative work in research campuses. They elevated Polish companies to positions among innovators which are recognized on the international market. Some of them joined the integrated supply chains of automotive concerns.

Finances spent on innovation and aid provided by companies offering research and development services will however not suffice if companies do not cooperate as partners in co-creating innovative solutions. Therefore, what is important are networking measures, those which form clusters. According to various studies, there are network structures including regional automotive companies. In Poland, there are six functional automotive clusters [10]. These clusters become most effective when technologies do not change drastically. They frequently create absolute possibilities, thanks to the dynamic configuration of networks from various organizations (owing to the cluster's manager).

4. EVALUATION OF SUPPLY CHAINS USING R&D CENTERS (ANALYSIS OF OWN STUDIES)

The research objective was to evaluate: the involvement of Polish automotive suppliers in cooperation with R&D centers. The impact of this involvement on the functioning within international, dynamic supply chains was also analyzed. Research hypothesis H1 is: The participation of Polish suppliers in R&D measures is low, as they have been focusing on the production of components recommended by the same recipients for years. Research hypothesis H2a is: Companies which opened to the research and development activities of automotive concerns and/or have cooperated with R&D centers have changed their relations within the supply chain, switching from integrated chains to dynamic ones. This relation is stronger in companies which have additionally functioned in automotive networks/clusters and which have conducted R&D works with other companies - hypothesis H2b. A research model, presented in **Figure 3**, was prepared for the purpose of this study.

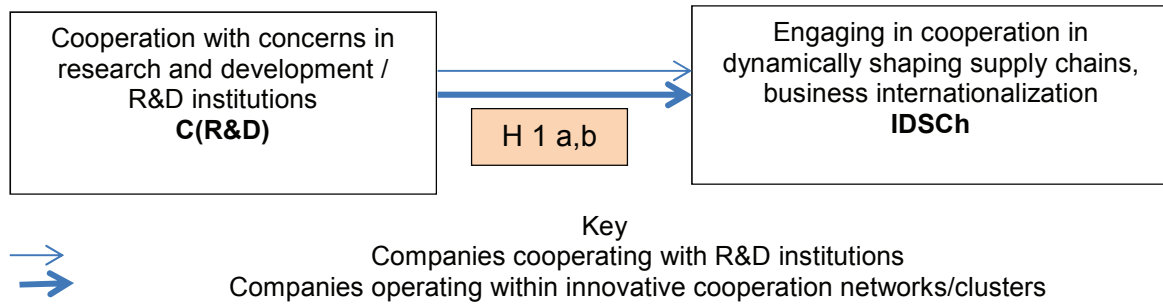


Figure 3 Research model [own study]

The study was carried out on 60 companies from the automotive industry, which have completed production works requested by an automotive concern / automotive concerns in the recent years. Only 40 of them were involved in research works devoted to product development (which stemmed from their internal, organizational motivation). The respondents from these 40 companies declared that the annual intensity of research works was 0.1 % - 2 % (measured by the ratio of R&D to net sales). This very analysis confirms hypothesis H1. Among the 40, there are 20 companies which cooperate with R&D centers. These companies were further analyzed. The purpose of this analysis was to verify whether this cooperation with R&D centers in product development changed the relations of the company to a supply chain link. Companies have opened up to innovative cooperation with new, international recipients - H2a.

Among the 20 companies 6 have been cooperating with R&D institutions and have also served as members of automotive clusters. An analysis of data obtained from these companies confirms hypothesis H2b. The results of survey results are presented in the table below. The table presents the questions asked in the questionnaire, and the number of replies from respondents serving as representatives of automotive companies. The dark color and the s index means that the companies cooperate with R&D centers and other companies functioning in the network/cluster. Respondents from companies from the automotive industry (20 people) responded to the questions below in numbers presented in columns 1 - 5 in **Table 2**.

Table 2 Table of research questions and answers (contingency table - cross-tabulation) [own study]

Enter "x" in the right column (1 = totally disagree; 5 = Totally agree)		1	2	3	4	5
No	Questions	Number of respondents				
1	R&D works are necessary for developing product innovations	0	0	0	2	18 6s
2	Companies from the automotive industry, involved in R&D works, have generated higher profits to those which have not invested in R&D	3	4	4	5 3s	4 3s
3	Conducting R&D works results in relations being established with new recipients	0	1	6	6 1s	7 5s
4	Conducting R&D works results in relations being established with international recipients	1	2	5	5 1s	7 5s
5	Cooperation with an automotive concern in R&D opens it to new possibilities in cooperation within the international supply chain	6 1s	4 1s	3	3 3s	4 1s
6	Cooperation with an independent R&D center opens new possibilities in cooperation within international supply chains	0	2	4	6 1s	8 5s
7	Cooperation in inter-organizational networks / cluster membership is a catalyst for R&D works	14	0	0	1 1s	5 5s
8	Network membership provides companies with support in the operationalization of contacts (completion of R&D project, authentication, ICT integration, completion of business processes with international partners)	14	0	0	0	6 6s



The results of a detailed statistical suggest several implications on decision-makers in companies. The most important one is that R&D institutions and cooperation within the network should be proactively used to support innovative behaviors in order to acquire new recipients (inclusion in dynamic and international supply chains). Detailed conclusions can be drawn in a statistical analysis of the responses.

Table 2 - contingency (cross-tabulation) table serves as the direct basis for calculations carried out using the chi-square independence test. Separate tables (not presented in the article) were prepared for all variables, the values of which stood for encoded responses to individual questions. The values entered in the contingency tables included the number of respondents operating and not operating within networks, who responded to questions from the questionnaire. In each of the prepared tables, an expected value was prepared as the quotient of the product of the total for the row and for the column, in which the element is situated, by the sum of all table elements.

If a statistically significant dependence is identified between the tested features, the force of this dependence was also tested. V-Cramer and T-Chuprov coefficients based on the chi-square statistics were used for this purpose, as their value was calculated. V-Cramer and T-Chuprov coefficients take on values from 0, which stands for the absence of interrelation among the tested features, to 1 - which stands for a total interrelation among the features tested. The results of the chi-square independence test are presented in **Table 3**.

Table 3 Results of the chi-square test for the study carried out among companies from the automotive industry [own study]

Question	Average answer		χ ² independence test				Interrelation strength	
			Test statistics value		p-value (α = 0,05)	Interrelation acc. to T-Chuprov coeff.	V-Cramer coeff.	T-Chuprov coeff.
	In the network		Empirical	Theoretical				
	Yes	No						
1	2.333	1.583	40.000	9.488	< 0.001	v. strong	0.598	0.707
2	4.536	3.750	13.529	9.488	0.009	average	0.348	0.411
3	2.333	1.583	40.000	9.488	< 0.001	v. strong	0.598	0.707
4	4.357	2.333	22.540	9.488	< 0.001	strong	0.598	0.707
5	4.536	3.750	13.529	9.488	0.009	average	0.348	0.411
6	2.333	1.583	40.000	9.488	< 0.001	v. strong	0.598	0.707
7	1.643	1.917	1.215	9.488	0.876	v. weak	0.104	0.123
8	1.643	1.917	1.215	9.488	0.876	v. weak	0.104	0.123

The T-Chuprov coefficient was used to interpret the results of the study, as it provides the clearest results. The interpretation was included in the "Interrelation acc. to T-Chuprov coeff" column. For all questions, for which the interrelation strength verged on weak and very weak, the average values of responses to the question asked were higher for respondents operating within supply chains, compared with analogous responses for respondents carrying out R&D works with research institutions only. This means that the b hypothesis (stronger interrelations for respondents operating within supply networks) should be confirmed at varying strengths, depending on the T-Chuprov coefficient value obtained for individual questions. These conclusions confirm Dimitratos' studies, who indicated that operation within a network has direct impact on the inclusion in international supply chains [11].

Future studies could adopt a more detailed approach. Various types of automotive companies will be compared (e.g. different-tier suppliers or suppliers from different families of innovative components). At the same time, the data which has been empirically collected for this study is sectional. The reliability of the study is weakened

by the use of empirical data sourced from a single instrument, and the small sample group selected for the study.

5. CONCLUSIONS

In conclusion, the analysis illustrated the role of research centers and networks in supporting innovative behaviors and in internationalizing companies and including them in the structures of supply chains. The study has pointed to a conclusion that the companies which cooperated in R&D can achieve more by entering into interactions within networks, i.e. by sharing their financial, technological and resources Beamish and Lupton [12]. Many suppliers must strive to recruit systemic partners, as they are narrowly responsible for the development of a specific car component. These suppliers will have to cooperate with other suppliers. Working within innovation networks (clusters or networks created by OEMs) can be the key to success and the factor to increase their opportunities within international supply chains. Reconstructions of integrated supply chains towards dynamic structures is a strategic objective of innovative automotive concerns.

REFERENCES

- [1] KRAJ, K.M. Ewolucja funkcji B+R w korporacjach transnarodowych: od rangi operacyjnej do strategicznej. *Współczesne Zarządzanie*. 2006, no. 4, pp. 140-141.
- [2] POZNAŃSA, K., KRAJ, K.M. *Badania i rozwój w korporacjach transnarodowych Organizacja i umiędzynarodowienie*. Warszawa: PWN, 2015.
- [3] PAWŁOWSKA, E., STAWIARSKA, E. Supporting the internationalization of small and medium-sized enterprises in the Czech Republic. In *5th International multidisciplinary scientific conference on Social Science and Art SGEM 2018, Business and Management*. 2018, pp. 989-998.
- [4] *WORLD INVESTMENT REPORT 2005: Transnational Corporations and Internationalization of R&D*. New York and Geneva: UNCTAD, 2005.
- [5] BOUTELLIER, R., GESSMAN, O., von ZEDTWITZ, M. *Managing Global Innovation, Uncovering the Secrets of Future Competitiveness*. Berlin Haldenberg: Springer - Verlag, 2000.
- [6] PALiLZ, <http://www.paiz.gov.pl/sektory/motoryzacja> [viewed 2017-010-07].
- [7] STAWIARSKA, E., DZIKOWSKI, P., BARTCZAK, K. *Innowacyjność polskich przedsiębiorstw*. Warszawa: Texter, 2017.
- [8] WINCEWICZ-BOSY, M., STAWIARSKA, E., ŁUPICKA, A. *Współczesne wyzwania łańcuchów dostaw*. Warszawa: Texter, 2017.
- [9] http://www.paiz.gov.pl/sektory/badawczo_rozwojowy [viewed 2017-08-16].
- [10] <http://www.clusterobservatory.eu/index.html#!view=regionalmapping;i=V16140;y=2011;r=NC10;rsl=0;rp=NC10;s=CC20-it;sp=CC20-STND;p=map;ll=56.3,26.1;z=4> [viewed 2017-08-07].
- [11] DIMITRATOS, P., AMOROS, J.E., ETCHEBARNE, M.S., FELZENSZTEIN, C. Micro-Multinational or Not? International Entrepreneurship, Networking and Learning Effects. *Journal of Business Research*. 2014, vol. 67, no. 5, pp. 908-915.
- [12] BEAMISH, P.W., LUPTON, N.C. Managing Joint Ventures, Academy of Management. *Perspective*. 2009, vol. 23, no. 2, pp. 75-94.