Diffusion of knowledge in strategic alliance: empirical evidence

Rafał Drewniak¹ · Robert Karaszewski²

Published online: 26 June 2019
© The Author(s) 2019

Abstract

This article characterises theoretical problems regarding the essence and exchange of knowledge between enterprises within the framework of strategic alliances. The objective of the conducted empirical research was to identify the relationships between specific features related to obtaining and sharing knowledge and the specificity of cooperating enterprises and the characteristics of an alliance. We also investigated the relationship between the size of partner enterprises, the duration of an alliance, and the type of innovations implemented as a result of the alliance. We tried to predict the probability of introducing a product, process and organizational innovation depending on the size of the company and duration of the alliance, as well as other variables characterising the company and the knowledge obtaining process. The results indicate that the relationship between the size of enterprises participating in an alliance and a favourable evaluation of the acquisition and sharing of knowledge is closer than in the case of the duration of an alliance. The research results also demonstrate that the correlation between the implementation of innovations and the duration of an alliance is stronger than in the case of the enterprise size. Establishing the relationships between the assumed variables for acquiring and sharing knowledge, as well as considering them in relation with the enterprise size and the alliance duration offer an added value to what has already been achieved in this area.

Keywords Knowledge management · Knowledge diffusion · Strategic alliance · Innovations

✉ Rafał Drewniak
drewniak@utp.edu.pl

¹ UTP University of Science and Technology, Bydgoszcz, Poland

² Nicolaus Copernicus University in Torun, Toruń, Poland

Introduction

The development of economically leading countries into economies based on knowledge results in the increase of the role and position of knowledge management in building competitive advantage. Knowledge management consists in the development of current conditions for the operation of enterprises, which include: increased competitiveness, increasingly shorter lifecycles of products and highly informative offers of enterprises, high employee rotation, constantly changing needs of customers and also development of technologies and the latest methods of production. In such circumstances, information and knowledge capital play an essential role, which became as important in competitive battle as the products themselves, or the financial capital.

Enterprises are forced to search for innovative solutions in various areas of operation: organisational, product-related, technical, information-related and others. High-quality innovative projects require clearly defined resources (including knowledge), or own capabilities, including various practices for managing innovations at the strategic and operational level (Ernst 2002). To meet these requirements, enterprises should look for new ways to reach and obtain resources, as well as capabilities based on knowledge, which will not bear the risk of becoming obsolete quickly. Knowledge and the ability to use it are becoming an imperative of building competitive advantage (Nonaka 2000). In this sense, knowledge is a set of non-material resources of an entity, resulting from human activity, whose application can be the basis of creating competitive advantage (Zhang et al. 2009). Among numerous sources of obtaining knowledge by an enterprise, we can distinguish external sources (e.g. clients, suppliers, partner enterprises, institutions and others) as well as internal sources (e.g. employees, unions created by them, internal mergers and others). Thus, depending on the purpose of the alliance and thereby the type of complementary sought, companies can select to cooperate with various partners (Beers van and Zand 2014; Ashok et al. 2016). Various external sources (from clients and suppliers to competitors and government bodies) constitute very rich source of knowledge. However, in order to be able to use it, an organisation must know how to identify what is interesting and useful in the external environment, obtain that knowledge, spread it and apply commercially (Zahra and George 2002). One of the effective ways to obtain new knowledge, competences and skills consists in establishing and executing cooperation with other enterprises within strategic alliances. In fact, this activity has become a popular strategy in many industries (Teng 2005). The rationale behind this tendency is to minimise the risk of investment, distribute operating costs among a larger number of partners, and ensure a more flexible (faster) adaptation to the changing conditions in the international environment. Knowledge management in agreements between enterprises takes into account the bilateral process of learning by partners. This includes obtaining knowledge from partners, creating new knowledge together, and finally, using it to create the value of the whole alliance, as well as of each partner enterprise. In this context von Krogh et al. (2000) emphasise that creating knowledge cannot be managed, but enabled. Knowledge becomes a key element in the strategy of enterprises participating in a strategic alliance, which as a consequence favours strengthening the innovative potential of the allies, as well as that of the entire alliance. Most of the research in that field focuses on the cognitive aspects of knowledge-related processes, such as absorptive capability or complexity etc., as well as on how they can affect the transfer of knowledge between partners (Foss and

Pedersen 2004; Inkpen 2002; Capaldo and Messeni Petruzzelli 2015). There were few attempts to identify the determinants that support knowledge acquisition through a strategic alliance, or to determine if the obtained knowledge favours implementation of innovations. Although knowledge is very valuable and can help enterprises gain competitive advantage, the process of obtaining knowledge is a difficult task, and can lead to as many problems as expected benefits (Junni et al. 2013). Managers of alliances must deal with problems related to organisational mechanisms of knowledge acquisition and sharing within the executed agreements. Therefore, there is a need to fill this research gap, which would allow for a better understanding of the determinants of obtaining and diffusion of knowledge within an alliance.

The objective of this article is to characterise substantial aspects related to acquisition and exchange of knowledge in a strategic alliance. In this context, the results of our empirical research are presented, to determine the significance of selected aspects of obtaining and sharing knowledge within the formed alliance. This article also presents the effect of such knowledge on product introduction, process and organisational innovations implemented by the enterprises in the alliance. As a consequence, it was shown that obtaining, creating and sharing knowledge within an alliance determines the introduction of innovations by the partner enterprises. Based on our empirical research, we also indicate that product, process and organisational innovation may potentially depend on the alliance duration and the size of the participating companies, as well as on certain quantitative features and characteristics that could determine the knowledge obtaining process.

The essence and scope of the search for and use of knowledge within strategic alliances

Intellectual assets of companies constitute the driving force of innovation, and contribute to the increase of competitiveness by providing new opportunities to compete (Belderbos et al. 2018). Therefore, they can be the foundations for building, maintaining and/or strengthening competitive advantage by presenting new sources of obtaining it. Zack et al. (2009) suggest that the practices of knowledge management, which promote generating new knowledge and organisational learning, are of fundamental importance for achieving benefits based on innovation. Donate and Guadamillas (2011) also associate these practices mainly with product innovations, creating new sources of competitive advantage. This ability to create competitive advantages is determined by the flexibility of operations achieved through quicker introduction of new products/services adjusted to the changing needs and preferences of customers. The process of creating knowledge consists in transforming the intangible knowledge into a formalised form, updating and modifying learning routines to suit innovation efforts better (Walsh et al. 2016). The process of knowledge management serves this purpose, resulting in improvement of the strategic characteristics of an enterprise (value, intellectual potential, or competitive advantage). Knowledge management involves obtaining knowledge which is not easily available to the competition, sharing it and retaining key knowledge. As a result, the company gains advantage on the market due to the knowledge it possesses and uses, as opposed to its market competitors. Sarala et al. (2016) found that knowledge transfer between cooperating enterprises is universally considered an important source of competitive advantage and can be defined as successful exchange of

knowledge and the ability of the absorption of knowledge by the recipient. In this context, Ramadani et al. (2017) argues that innovation activities are inherently related to the enterprise's performance, which is also influenced by knowledge spillovers and innovation activities. Many authors focus on internal factors within the alliance, they emphasise the significance of social-cultural connections between companies and the relational capital that can help partners foster innovation and creativity (Subramanian and Soh 2017; Cuevas-Rodriguez et al. 2014; Ho and Wang 2015; Vlasisavljevic et al. 2016). These connections complement employees' skills, trust, effective management of cultural integration, the routine of sharing knowledge and HR flexibility (defined as adaptation to changing conditions). All these factors constitute another reason for considering the processes of knowledge management and sharing through strategic alliances. However, absorption capabilities and organisational inertia exert conflicting pressure on the search and exploration in relation to the function of the alliances value chain, partners' attributes and position (Lavie and Rosenkopf 2006). In this context, most research focused on the strength of the external industry, which suggests that turbulences and market uncertainty can generate both exploitation and exploration of knowledge (Beckman et al. 2004; Rowley et al. 2000). Only resource-limited enterprises create alliances based on utilising resources in turbulent industries (Park et al. 2002). However, even the research analysing the characteristics and features of a company resulted in outcomes different from the previous studies on search and exploration. For example, Rothaermel and Deeds (2004) noticed that exploration increases relatively to the size of a company, whereas Beckman et al. (2004) proved that the size of a company also contributes to searching for resources. Thus:

H1a: The longer the duration of the alliance, the greater the probability of developing and implementing process innovations, rather than product innovations
H1b: Longer duration of the alliance and larger size of the company increase the probability of innovation implementation.

Literature on alliances in a broad spectrum brings up issues related to searching for and exploitation of resources (Rothaermel and Deeds 2004; Li et al. 2008; Lavie and Rosenkopf 2006). The actions and motivations that led to the formation of an alliance determine whether it is characterised by exploration of knowledge, or by its exploitation. Exploratory agreements are usually concluded in order to explore new technological possibilities (searching for technologies), whereas exploitation alliances are the ones that utilise complementary competences of their partners. In this respect, alliances that contribute to generating knowledge are identified as searching alliances (research and development agreements), and marketing alliances are based on a knowledge lever as alliances utilising knowledge (Koza and Lewin 1998; Rothaermel 2001). Li et al. (2008) emphasise that the scope of prior alliances, or any differences in attributes between prior and new partners ultimately result from the differences in the scope of knowledge shared by cooperating enterprises.

A knowledge-based approach to alliance management

Knowledge Management is a set of actions, initiatives and strategies used by companies to create, store, transfer and apply knowledge with the purpose of exceeding organisational

efficiency (Zack et al. 2009). This process involves e.g. transfer of *know-how*, getting to know organisational procedures and programs, or the company's strategy. According to the knowledge-based view on business efficiency, organisations operate as mechanisms that help to transfer knowledge through the expansion of absorption abilities (Junni and Sarala 2013; Hong and Snell 2013). This constitutes a peculiar structure for transferring and sharing knowledge within the frame of concluded agreements. Enterprises enter a cooperation convinced that the transfer of skills and knowledge will be mutually beneficial – it is one of the essential factors affecting the success of a planned strategic alliance (Khamseh and Jolly 2014). For this purpose, a company can either cooperate fully, or within certain limits. Full cooperation incurs substantial costs related to teaching the ally, and as a consequence possibly strengthens one's future competitor. Due to the benefits resulting from such an exchange, full cooperation is more desirable than the one where both parties limit their cooperation (Kale et al. 2000; Liu et al. 2010; Yam and Cliff Chan 2015). The possibility to obtain missing competences and root resources through cooperation favours entering into strategic alliances, which provide a quick and relatively easy way to complement the desired resources and boost innovation by enhancing combinatory search (Lee et al. 2017; Asgari et al. 2017; Meng 2018). Beers van and Zand (2014) argue that accessing and combining the knowledge and capabilities of partners crucially contributes to innovation performance. However, alliances based on knowledge, founded on combining intellectual resources and mutual knowledge exploitation, need to be managed in a different way than traditional agreements. It is associated with a higher risk of uncontrolled takeover of intellectual assets by an alliance partner (Alcácer and Oxley 2014; Martínez-Noya and García-Canal 2015), than in the case of heavily guarded and evidenced tangible assets. This also requires significantly higher capabilities and better control of both alliance partners. In fact, the degree of differentiation regarding partners' characteristics (Jiang et al. 2010) can result in divergence from the anticipated outcomes, and it could act as a 'double-edged sword' for knowledge acquisition (Wang and Chen 2016). On the other hand, cooperation within an alliance does not require incurring as high costs as those related to a takeover or a merger. At the same time, the threat of unfair copying, as well as possible legal sanctions, are eliminated. The problem of enterprise convergence resulting from copying good examples is also avoided. Ahammad et al. (2014) emphasise that transferring knowledge to and from partner enterprises may lead to developing a permanent competitive advantage. Therefore, people engaged in managing such type of undertakings should provide support and resources in order to guarantee a steady knowledge transfer. Combining various resources and skills of enterprises within the alliance creates a synergy effect, and triggers the process of mutual learning of partners (Howard et al. 2016; Beers van and Zand 2014). Moreover, integration of internal and external innovation resources is the guidance for sustainable growth practices of entrepreneurial enterprises (Pan et al. 2018). That undoubtedly creates added value and facilitates strengthening of the competitive advantage of the allies.

These issues also include the concept of a learning organisation, which is perceived as a dynamic subject, characterised by a constant increase in its own operational flexibility, as well as a high degree of adaptation to changes in the environment. Cooperating within strategic alliances provides access to the sought for (missing) knowledge and enables achieving strategic flexibility (Schoorman et al. 2007; Park et al. 2002). The organisational process of learning through exchange and transfer of knowledge within strategic alliances can be analysed in four planes, which include various motivations of partner enterprises, and a range of possible benefits (Gulati

1999; Gupta and Mistra 2000; Contractor and Lorange 1988; Doz 1996; Simonin 1997). Therefore, the process of learning should not be perceived as a motivation to create strategic alliances, but as a determinant in the process of alliance management, as the obtained knowledge is of essential importance for the evolution of an alliance. Strategic alliances can generate knowledge, which then will be used by the ally partners to strengthen their own strategies, possibly unrelated with the areas of alliance operation (Khamseh and Jolly 2014; Junni and Sarala 2013). The so-called strategic alliance competences (Inkpen 2002) created in this way constitute an autonomous value of an agreement resulting from the transfer of partner's capabilities. These could bring unilateral benefits for enterprises in the future, such as creating knowledge concerning various aspects of organisational operations: from products and technological processes to managerial practices (Andreeva and Kianto 2012). This knowledge can be used for undertaking tasks other than the ones within the alliance, improving products or entering new markets. This resource of an enterprise constitutes a value that would not be obtained by the company without participating in a strategic alliance. Thus,

H2a: The knowledge acquired in alliance is mainly used to develop process innovations.

H2b: Strategic match facilitates knowledge obtaining process in alliance and increases the probability of introducing an innovation.

Companies that want to learn critical information or know-how from an alliance partner first need to understand how and where they are located in the partner's structure (Dyer and Singh 1998). Huang et al. (2015) emphasize that partner's ability to learn new knowledge through its cooperation within the alliance requires sufficient technical understanding to capitalise on that knowledge. A close, personal relationship between partners favours this and the quality of alliance relationship has a positive impact on the innovation performance of the enterprise (Xie and Jing 2017). Learning or transferring such *know-how* depends on the environment of the transfer, and on the mechanisms existing between alliance partners. *Know-how* is usually more difficult to codify than information, and therefore, it is more resistant to easy transfers, both inside and between companies (Szulanski 1996). However, Hippel von (1988) and Marsden (1990) argued that close and intense interactions between individual members of interested organisations work as an effective mechanism for transferring or learning of tacit knowledge. Tacit knowledge is very difficult to transfer outside the boundaries of an organisation, as it is based on common experience and is deeply rooted in everyday practices in the scope of learning, coordination and communication (Feinberg and Gupta 2004; Gupta and Govindarajan 2000; Nielsen and Nielsen 2009). Communication among enterprise members also has a direct impact on collective entrepreneurship, and contributes to broader understanding of markets, products, and technologies (Yan and Yan 2016).

Accumulation of knowledge obtained through an alliance is based on a conscious transfer of bilaterally contributed resources based on the needs of the partner enterprises, conducted through strategic meetings, staff exchange, directing the flow of knowledge etc. After the knowledge has been shared and accommodated in relation to routine operational procedures, it needs to be codified in organisational memory (keep or store knowledge). This codified process of organisational memory results in an effective distribution of organisational knowledge. This knowledge consists of previous

individual experience, existing and new internal operational procedures, and any type of knowledge related to organisational operations (Zollo and Winter 2002). It also leads to an increase in the capability to generate new ideas and own knowledge (Liu et al. 2010; Richter and Vettel 1995). Finally, it increases the extent of innovations implemented by the companies participating in the alliance.

Methodology and the course of research

Empirical research was conducted on a group of 70 enterprises that started cooperation in a strategic alliance. The selection of units for the study was purposeful, while the general population consisted of 76 enterprises belonging to one of the industrial clusters in Poland. The research sample consist of companies from different sectors. The major group (25 companies) are the companies manufacturing plastics and rubber products. The second biggest group (20) are the companies producing machines and equipment. Other companies operate in the following sectors: metal products manufacturing (9), wholesale trade (4), production of chemicals (3), architecture and engineering (3), activities related to software and IT consultancy (2), activities related to real estate (1), activities of head offices and consulting (1), repair, maintenance and installation of machinery and equipment (1), and production of computers, electronic and optical products (1). The enterprises were divided into 3 groups: small (employing up to 50 people) – 27 companies, medium (employing less than 250 people) – 31 companies and large (employing over 250 people) – 12 companies. Additionally, all the alliances formed by them were classified according to their duration: ones that have lasted for 1 year, from 1 to 3 years, and more than 3 years. The data was collected using an electronic questionnaire, and the representatives of management were asked to evaluate the influence of six previously specified categories (simplification of the alliance tasks, trust, strategic match, number of employees in a team, informal communication, complementarity of resources) on the exchange and sharing of knowledge with a partner enterprise within the formed strategic alliance. For this purpose, a score ranging from 1 to 5 was used, where 1 means no influence of the evaluated quality on obtaining and sharing of knowledge, 2 – low influence, 3 – medium influence, 4 – significant influence, 5 – essential influence. The conducted research provided data concerning the implementation of innovations (product, process and organisational innovations) that resulted from the new knowledge and skills obtained through the alliance. Additional characteristics of the investigated companies were acquired from the EMIS (Emerging Markets Information Service) corporate database. The data include financial variables, such as total revenues, EBIT, ROA, book value and other information, including employment, age of the company, and the sector it belongs to. All these measurable variables were included in the logistic regression models described below.

Table 1 presents basic statistics of quantitative variables that were taken into account in the analysis.

To achieve the research objective, the strength of correlations between the analysed variables was tested, and expressed numerically using *Czuprow's correlation coefficient*. This measure is based on the chi – squared test (χ^2). The value of χ^2 is the base for establishing a *normalised function of relationships characterising a feature*, called Czuprow's correlation coefficient. It is described by the following formula:

Table 1 Descriptive statistics of quantitative variables

	Mean	Median	SD	Min.	Max.
Total revenues (in thousands of PLN)	36647.09	19918.27	45584.99	1498	219684
EBIT (in thousands of PLN)	2905.66	2067.30	3148.69	−54	20626
ROA	0.19	0.12	0.30	−0.05	2.44
Book value (in thousands of PLN)	12,505.57	7659.24	14628.96	−2	73253
Employment (in numbers)	126.33	90.00	118.60	1	350
Age (in years)	10.34	11.00	5.55	2	29

$$T_{xy} = T_{yx} = + \sqrt{\frac{\chi^2}{n \sqrt{(r-1)(k-1)}}} \quad (1)$$

where:

- T_{xy} Czuprow's correlation coefficient between variables x and y
 χ^2 chi-square test result between variables x and y
n number of observations
r number of levels of the first variable
k number of levels of the second variable

This coefficient takes the value from the range of $[0, 1] \cdot T = 0$, if the tested variables are stochastically independent. With functional correlation of variables, $T = 1$. The closer the correlation coefficient is to zero, the weaker is the relationships between variables.

In the process of determination of the correlation coefficient, it is irrelevant whether the feature is considered dependent or independent – which is important when relationships are tested as correlations. This property is defined by the following symmetry:

$$T_{xy} = T_{yx} \quad (2)$$

The advantage of the correlation coefficient consists in the fact that it can be used to measure correlations of both measurable and non-measurable features. However, it does not show the direction of a correlation (it is always positive).

For evaluating the correlation strength between variables X and Y the *determination coefficient* is also used.

$$100 \cdot T_{xy}^2 \quad (3)$$

This measure shows what percentage of the variability of the dependent variable is determined by the variability of the independent variable. Therefore, while from the arithmetic perspective T evaluates both the dependency of feature X on feature Y as well as feature Y on X , interpretation of correlation coefficient must explicitly determine the character of variables, i.e. which of them is a dependent feature, and which one is independent.

As during the calculation of the correlation coefficient only the distribution of variables is taken into consideration, and not its parameters, the correlation coefficient is mainly the measurement of stochastic dependency between two variables. Since correlation has a narrower scope than stochastic relationship, it can be used to measure the strength of the correlation.

To draw conclusions based on the Czaprow's measure, first of all statistical significance between the tested variables must be determined.

In many cases, the decision-making processes are based on multiple regression models, i.e. in which we analyse the impact of several independent variables on one dependent variable of the measurable type. However, in a situation where the dependent variable is of the dichotomous type, we should apply logistic regression.

The logistic regression model is based on a logistic function. This function is defined by the formula (Hosmer and Lemeshow 2000):

$$f(z) = \frac{e^z}{1 + e^z} \quad (4)$$

The logistic function has values from the interval $0 < f(z) < 1$.

The logistic regression equation, like the linear regression equation (Ferguson and Takane 1998), allows us to calculate the expected value of the dependent variable. Because the logistic regression model applies to dichotomous dependent variables (taking only two values: 0 and 1), the expected value of the dependent variable Y has been replaced by the conditional probability value that the dependent variable Y will take the value 1 for the independent variables $x_1, x_2, \dots, x_k$. Based on the properties of the logistic function, it follows that both of these values (the expected values of the variable Y , and the conditional probability of assuming the value 1) are equal. Hence the logistic regression model for a dichotomous variable is expressed by a formula (Kleinbaum and Klein 2002):

$$P(Y = 1/x_1, x_2, \dots, x_k) = \frac{e^{a_0 + \sum_{i=1}^k a_i x_i}}{1 + e^{a_0 + \sum_{i=1}^k a_i x_i}} \quad (5)$$

where.

$P(Y = 1/$	conditional probability of reaching the value of 1 by the dependent
$x_1, x_2, \dots, x_k)$	variable with specific values of variables $x_1, x_2, \dots, x_k$
a_0	regression constant for logistic regression
$a_1 - a_k$	logistic regression coefficient for the i -th independent variable
$x_1 - x_k$	independent variables, which can be both quantitative and qualitative

In logistic regression, apart from the interpretation of regression coefficients, one parameter still present - the odds ratio. It is the ratio of the probability that an event will occur to the likelihood that it will not. It can be expressed by the following formula:

$$S(A) = \frac{P(A)}{1 - P(A)} \quad (6)$$

The odds ratio for individual variables can be expressed according to the formula:

$$OR(x_i) = e^{a_i} = \exp(a_i) \quad (7)$$

When the selected independent variable increases for a unit, the odds ratio changes by $\exp. (a_i)$ times. If $\exp. (a_i) > 1$, it is expected to increase the odds ratio, whereas when $\exp. (a_i) < 1$, it is expected to decrease the odds ratio. In the case when the independent variable is a zero-one variable, the $\exp. (a_i)$ indicates how many times the ratio for a dependent variable equal to one increases.

Estimating logistic regression models we try to predict the probability of the introduction of product, process and organisational innovations, depending on quantitative and qualitative sets of variables. Quantitative variables include: total revenues (TR), EBIT, return on assets (ROA), book value (BV), employment (EMPL), age of the company (AGE), while qualitative variables include: alliance duration (DURATION), size of the company (SIZE), sector to which it belongs (SECTOR). As qualitative variables we also included those related to the process of acquiring knowledge through an alliance: simplification of alliance tasks (SIMPL), trust between allies (TRUST), strategic match (SM), smaller employee teams (SET), informal communication (IC) and complementary character of resources (CR).

We use three logistic regression models defined by:

$$P(Y_1 = 1|X_1, X_2) = \frac{e^{a_0 + \sum_{i=1, j=1}^{15} a_i x_j}}{1 + e^{a_0 + \sum_{i=1, j=1}^{15} a_i x_j}} = \frac{e^{a_0 + \sum a_1 x_1 + a_2 x_2 + \dots + a_{15} x_{15}}}{1 + e^{a_0 + \sum a_1 x_1 + a_2 x_2 + \dots + a_{15} x_{15}}} \quad (8)$$

$$P(Y_2 = 1|X_1, X_2) = \frac{e^{a_0 + \sum_{i=1, j=1}^{15} a_i x_j}}{1 + e^{a_0 + \sum_{i=1, j=1}^{15} a_i x_j}} = \frac{e^{a_0 + \sum a_1 x_1 + a_2 x_2 + \dots + a_{15} x_{15}}}{1 + e^{a_0 + \sum a_1 x_1 + a_2 x_2 + \dots + a_{15} x_{15}}} \quad (9)$$

$$P(Y_3 = 1|X_1, X_2) = \frac{e^{a_0 + \sum_{i=1, j=1}^{15} a_i x_j}}{1 + e^{a_0 + \sum_{i=1, j=1}^{15} a_i x_j}} = \frac{e^{a_0 + \sum a_1 x_1 + a_2 x_2 + \dots + a_{15} x_{15}}}{1 + e^{a_0 + \sum a_1 x_1 + a_2 x_2 + \dots + a_{15} x_{15}}} \quad (10)$$

Where.

X_1	total revenues (TR) in thousands of PLN,
X_2	earning before interests and taxes (EBIT) in thousands of PLN,
X_3	return on assets (ROA) in decimals,
X_4	book value (BV) in thousands of PLN,
X_5	employment (EMPL) in numerical values,
X_6	age of the company (AGE) in number of years from establishing till 2018,
X_7	sector belonging (SECTOR), taking 1 for production of chemicals, 2 for plastics and rubber products manufacturing, 3 for metal products manufacturing, 4 for production of machines and equipment, 5 for

	wholesale trade, 6 for activities related to software and IT consultancy, 7 for activities related to real estate, 8 for activities of head offices and consulting, 9 for architecture and engineering, 10 for repair, maintenance and installation of machinery and equipment, 11 for production of computers, electronic and optical products,
X ₈	size of the company (SIZE), taking 1, 2 or 3 values respectively for small, medium and large companies,
X ₉	alliance duration (DURATION), taking 1, 2 or 3 values respectively for agreements till one year, more than one year till 3 years and longest than 3 years,
X ₁₀	the level of simplification of alliance tasks (SIMPL), and, taking values from 1 to 5,
X ₁₁	the level of trust between allies (TRUST), taking values from 1 to 5,
X ₁₂	the level of strategic match (SM), taking values from 1 to 5,
X ₁₃	the level of smaller employee teams (SET), taking values from 1 to 5,
X ₁₄	the level of informal communication (IC), taking values from 1 to 5,
X ₁₅	the level of complementary character of resources (CR), taking values from 1 to 5,
Y ₁	introduction of product innovation (1 for successful introduction and 0 for an absence of product innovation),
Y ₂	introduction of process innovation (1 for successful introduction and 0 for an absence of process innovation),
Y ₃	introduction of organisational innovation (1 for successful introduction and 0 for an absence of organisational innovation),
a ₀ , a ₁ , a ₂ - a ₁₅	structural parameters of the model.

Results

The conducted research allowed to establish the percentage share of the researched features that determine obtaining and sharing knowledge within strategic alliances formed by the studied Polish enterprises. The outcomes are presented in Table 2.

The research results show that the studied enterprises most often reported strategic match between cooperating enterprises (obtained 48 evaluations of significant or essential influence), complementary character of resources (46 indications of significant and essential influence) and trust between allies (44 evaluations of significant and essential influence) as the features that, in the opinion of management staff, influenced the most their knowledge acquisition and sharing between partners in an alliance. Therefore, we can state that partner enterprises are aware of the fact that both the common mission, as well as vision and strategy of mutual agreement, and inherence of the resources contributed resources to the alliance constitute significant determinants for the process of knowledge management in a strategic alliance. Additionally, very interesting is the fact that the enterprises involved in the research valued the significance of the level of trust towards their allies regarding their intentions concerning development perspectives of the mutual agreement. There is a separate question of the

Table 2 Evaluation of the features that determine obtaining and sharing of knowledge within a strategic alliance (N = 70)

	No significance		Poor		Medium		Significant		Essential	
	Number of indications	Structure	Number of indications	Structure	Number of indications	Structure	Number of indication	Structure	Number of indications	Structure
Simplification of alliance tasks	14	20%	22	31%	11	16%	16	23%	7	10%
Trust between allies	0	0%	16	23%	10	14%	25	36%	19	27%
Strategic match	1	1%	9	13%	12	17%	32	46%	16	23%
Smaller employee teams	12	17%	25	36%	8	11%	16	23%	9	13%
Informal communication	2	3%	15	21%	26	37%	19	27%	8	11%
Complementary character of resources	0	0%	2	3%	22	31%	34	49%	12	17%

uncertainty and risk that one of the partners might take opportunistic actions. Among the factors which have the least influence or no influence on knowledge acquisition and sharing within an alliance, the researched enterprises chose the necessity to simplify the tasks of an alliance (36 indications as poor or no significant influence), and forming smaller teams of employees responsible for completing tasks (37 indications). This could be a consequence of diversity in the scope of the tasks, and frequently the engagement of different employees depending on the stage of a common undertaking.

Another objective of the conducted research was to identify the correlation between the evaluation of the extent of influence of individual factors on knowledge acquisition and sharing, and the size of the enterprise (Table 3) and the duration of the alliance (Table 4). The obtained data was divided into two groups: a correlation was found between the size of the enterprise and the duration of the alliance on one hand, and factors which were evaluated as having strong and very strong influence on obtaining knowledge on the other hand; another correlation was observed between the size of an enterprise or the duration of an alliance and the factors influencing it poorly or insignificantly.

The research results presented in Table 3 demonstrate that small enterprises highly evaluated the necessity to possess complementary resources by allies, which would facilitate the fulfilment of tasks of individual enterprises. In this group, simplification of tasks in an alliance, and forming smaller employee teams were also indicated. This could result from the expectations of small enterprises concerning flexibility of operations and the time of task completion. Evaluations were distributed differently for medium enterprises, which evaluated strategic match of partners (in the scope of mutual strategy of operations, missions and objectives) as the factor that determines knowledge acquisition in an alliance to the highest extent. At the same time, they indicated complementary nature of resources contributed to an alliance, which is closely connected with strategic match. Agreement between partners in these two areas should be, as evaluated by medium enterprises, supported by an increased degree of trust and being open to sharing knowledge, which would facilitate building long-lasting relationships between allies while executing common objectives. In fact, building the relationship of mutual trust influences the knowledge management process, and, indirectly, it can affect the success of the alliance in the long-term perspective (Khan et al. 2015). Large enterprises associated trust between allies with – frequently evaluated as essential – informal communication between partners, which would facilitate exchange of information and sharing knowledge by establishing closer relationships between allies.

The results of independence chi2- test (χ^2) (Table 5) also support the conclusions regarding the correlation between the evaluation of factors that determine knowledge acquisition in an alliance and its duration. Enterprises that have participated in the alliance for up to 1 year showed that simplification of tasks in the alliance, and forming smaller employee teams for completion of tasks were evaluated as facilitating knowledge acquisition and sharing in this type of arrangements. In alliances with a longer duration (from 1 year to 3 years), the results showed that they were mostly influenced by strategic match and complementary nature of resources of partner enterprises, as well as building trust between partners. This supports the conclusion that the longer an alliance lasts, the higher is the awareness of managers concerning strategic match and resource inherence of cooperating enterprises along with simultaneous increase of their significance. High level of trust was also highly evaluated relative to other factors by the group of large enterprises,

Table 3 Evaluation of factors determining knowledge acquisition in an alliance according to the size of the company (N = 70)

Factors	Simplification of tasks in an alliance	Trust between allies	Strategic match	Smaller employee teams	Informal communication	Complementary nature of resources	Total
Size of an enterprise							
The size of an enterprise and a significant or essential evaluation of factors influencing obtaining knowledge in an alliance							
Small enterprises	23	4	5	23	7	24	86
Medium enterprises	0	28	31	2	8	21	90
Large enterprises	0	12	12	0	12	1	37
Total	23	44	48	25	27	46	213
The size of an enterprise and the lack of or poor evaluation of factors influencing obtaining knowledge in an alliance							
Small enterprises	0	15	10	0	13	0	38
Medium enterprises	27	1	0	27	4	1	60
Large enterprises	9	0	0	10	0	1	20
Total	36	16	10	37	17	2	118

Table 4 Evaluation of factors determining knowledge acquisition in an alliance according to alliance duration (N = 70)

Factors Duration of an alliance	Simplification of tasks in an alliance	Trust between allies	Strategic match	Smaller employee teams	Informal communication	Complementary nature of resources	Total
Duration of an alliance and a significant or essential evaluation of factors influencing obtaining knowledge in an alliance							
1 year of alliance	14	2	4	15	1	16	52
1–3 years of alliance	7	26	28	7	12	26	106
Over 3 years of alliance	2	16	16	3	14	4	55
Total	23	44	48	25	27	46	213
Duration of an alliance and the lack of or poor evaluation of factors influencing obtaining knowledge in an alliance							
1 year of alliance	2	12	3	1	9	0	27
1–3 years of alliance	23	3	6	24	8	0	64
Over 3 years of alliance	11	1	1	12	0	2	27
Total	36	16	10	37	17	2	118

Table 5 Chuprow's correlation coefficients T_{xy} for relationships between the size of an enterprise, the duration of an alliance and evaluation of determinants for obtaining knowledge in an alliance ($N = 70$)

	Significant and essential importance				None or low importance			
	α	χ^2	$\chi^2_{0,01;10}$	T_{xy}	α	χ^2	$\chi^2_{0,01;10}$	T_{xy}
Size of an enterprise	0.01	119.24	23.21	0.42	0.01	101.29	23.21	0.52
Duration of an alliance	0.01	70.33	23.21	0.32	0.01	58.25	23.21	0.39

which, together with informal communication, shows that these companies base their success in obtaining knowledge on informal contacts and increased trust. This is favoured by a longer duration of an alliance, and the associated larger experience in managing such arrangements.

In order to show a correlation between the presented characteristics of enterprises and formed alliances, the Csuprow's independence coefficient (T_{xy}) was applied – Table 5 presents the results of the independence χ^2 (χ^2) test, together with critical values $\chi^2_{\alpha;s}$ with the significance level of $\alpha = 0.01$, and 10 degrees of freedom.

Based on the independence χ^2 (χ^2) test (Table 5) we can observe a correlation between the evaluation of importance of researched factors of obtaining knowledge in an alliance, and the size of an enterprise and the duration of an alliance. The obtained results indicate that the correlation between the size of enterprises participating in an alliance and evaluation of the factors influencing knowledge acquisition and sharing within an alliance as significant or essential is stronger ($T_{xy} = 0.42$) than in the case of the duration of the alliance ($T_{xy} = 0.32$). This may result from perceiving an alliance as a source of essential and missing knowledge. It is similar in the case of the evaluation of correlations between these factors (the size of an enterprise and the duration of an alliance), and the lack of or poor influence of the researched factors on obtaining and sharing knowledge. The obtained results indicate a stronger correlation between the size of an enterprise and a poor evaluation ($T_{xy} = 0.52$) than for the duration of an alliance ($T_{xy} = 0.39$). However, we need to emphasise that this type of correlations affect other factors (uncertainty, competitive environment, business cycle and others). The observed correlations indicate a connection between these features of enterprises or alliances and a strong or poor evaluation of factors which influence knowledge acquisition and sharing.

Another very interesting effect was found in the conducted research, It was related to the data demonstrating the correlation between characteristics of an enterprises and formed alliances and the type of implemented innovations as a result of executing an agreement (Tables 6 and 7). In this case the correlations were also analysed in terms of the size of an enterprise (small, medium, large) and the duration of an alliance (up to 1 year, 1–3 years, over 3 years).

The data presented in Table 6 shows that the most implemented innovations were process and product innovations. Most of such type of innovations were implemented by medium enterprises, which might result from their high development potential, whereas fewer of those innovations were implemented by large enterprises. Perhaps they aim at different effects resulting from a formed alliance than innovations. In 11 instances of formed alliances no innovations were found. However, it is noteworthy that this mainly concerns small enterprises, which may not possess the competitive

Table 6 Implementation of innovations as a result of forming an alliance (N = 70)

Size of an enterprise	Small	Medium	Large	Total
Type of innovation				
Product innovations	9	21	12	42
Process innovations	9	29	12	50
Organisational innovations	2	5	5	12
None	10	1	0	11
Total	30	56	29	115
Duration of an alliance	1 year	1–3 years	Over 3 years	Total
Type of innovation				
Product innovations	3	23	16	42
Process innovations	2	31	17	50
Organisational innovations	0	5	7	12
None	11	0	0	11
Total	16	59	40	115

potential yet, or the duration of an alliance is still too short for effective development and implementation of innovative solutions. We can also observe that the majority of innovations (product and process innovations) were implemented by enterprises that have been engaged in an alliance longer than 1 year (alliances from 1 to 3 years and over 3 years). Therefore, it can be concluded that developing and implementing innovations within an alliance requires time, whereas frequent disappointments in this type of agreements result from not gaining quick benefits related to quick joint implementation of innovations.

Table 7 presents the results of independence χ^2 (χ^2) test, together with critical values $\chi^2_{\alpha;s}$, with the level of significance at $\alpha = 0.01$ and 6 degrees of freedom.

The independence test results T_{xy} allow stating that there is a stronger correlation between implementing innovations and the duration of an alliance ($T_{xy} = 0.53$) than for the size of an enterprise ($T_{xy} = 0.32$). Therefore, implementation of innovations as a result of participating in an alliance requires time, whereas the size of cooperating enterprises is of less significance in this regard than the duration of an alliance. However, we need to emphasise that the success related to the development and implementation of innovations (process or product innovations) is determined by many other variables rather than only the duration of an alliance or the size of allies. Certainly, this will be influenced by both internal factors (e.g. motivation system, role of leadership, organisational structure, available R&D resources and others), as well as

Table 7 Cuzprow's correlation coefficients T_{xy} for correlations between the size of an enterprise, the duration of an alliance and the number and type of implemented innovations (N = 70)

	Implemented innovations			
	α	χ^2	$\chi^2_{0.01;6}$	T_{xy}
Size of an enterprise	0.01	28.58	23.21	0.32
Duration of an alliance	0.01	78.13	23.21	0.53

external factors (e.g. condition of national/global economy, intensity of competition, technological progress and others).

We estimated logistic regression models for dependent variables that refer to the introduction of innovation. The structural parameters of the models were estimated using the Quasi-Newton method (with the level of significance $\alpha = 0.10$). The R^2 coefficient of determination is a statistical measure of how well the regression predictions approximate the real data points. It can be used for linear regression models. In case of logistic regression we can use pseudo R^2 measures by Cox & Snell or Nagelker. In logistic regression we can also present a prediction accuracy measure.

Table 8 presents 3 models of logistic regression for a dependent variable of product innovation. Model 1a is estimated on the basis of all the analysed independent. Model 1b presents the results of estimation for significant variables only. Finally, model 1c presents the influence of only two variables (size of the company and duration of an alliance) on the probability of introduction of a product innovation.

According to model 1b, only 3 variables are significant: duration of the alliance, strategy match and informal communication. Increasing the alliance duration increases the probability of introducing a product innovation by 3.85 times. Increasing the level

Table 8 Logistic regression parameters for product innovation models (N = 70)

	Model 1a			Model 1b			exp(b)	Model 1c			exp(b)
	Coeff	p value		Coeff	p value			Coeff	p value		
Intercept	-21.1523	0.0242	**	-6.7864	0.0002	***	0.0011	-4.0582	0.0003	***	0.0173
TR	0.0001	0.1329									
EBIT	0.0002	0.5332									
ROA	-2.0588	0.3272									
BV	-0.0001	0.1599									
EMPL	-0.0103	0.3985									
AGE	-0.1103	0.2690									
SECTOR	0.3127	0.0909	*								
SIZE	4.8140	0.1655						1.2104	0.0208	**	3.3548
DURATION	2.0585	0.0088	***	1.3488	0.0093	***	3.8530	1.2302	0.0228	**	3.4219
SIMPL	1.8320	0.0210	**								
TRUST	-0.1462	0.7981									
SM	1.0180	0.1878		0.7359	0.0372	**	2.0874				
SET	0.0714	0.9045									
IC	0.6621	0.1960		0.7242	0.0415	**	2.0630				
CR	-0.1481	0.8347									
R-Sq (L)	0.46			0.30				0.26			
R-Sq (CS)	0.46			0.33				0.30			
R-Sq (N)	0.62			0.45				0.40			
Prediction accuracy	0.83			0.80				0.76			

Signif. codes: 0 '***' 0.01 '**' 0.05 '*' 0.1 '+' 0.12 '.' 1

of strategic match and informal communication has a similar effect on introduction of a product innovation, increasing the probability more than 2 times. The final form of the model 1b is expressed by the formula:

$$P(Y_1 = 1|DURATION, SM, IC) = \frac{e^{-6.7864+1.3488 \text{ DURATION}+0.7359 \text{ SM}+0.7242 \text{ IC}}}{1 + e^{-6.7864+1.3488 \text{ DURATION}+0.7359 \text{ SM}+0.7242 \text{ IC}}} \quad (11)$$

Table 9 presents 3 models of logistic regression for the dependent variable of process innovation. Similarly to the product innovation models, model 2a is estimated on the basis of all independent variables considered in the analysis. Model 2b presents the results of estimation for significant variables only, and model 2c presents the influence of only two variables (size of the company and duration of an alliance) on the probability of introduction of a process innovation.

Model 2b after reduction of insignificant variables presents the probability of introducing a process innovation depending on the duration of an alliance, and simplification of alliance tasks. Increasing the duration of an alliance increases the probability

Table 9 Logistic regression parameters for process innovation models (N = 70)

	Model 2a		Model 2b		exp(b)	Model 2c		
	Coeff	p value	Coeff	p value		Coeff	p value	exp(b)
Intercept	6.2792	0.7039	1.9636	0.4567	7.1247	-7.0609	0.0001 ***	0.0009
TR	0.0000	0.9342						
EBIT	0.0003	0.4018						
ROA	0.7218	0.8091						
BV	-0.0001	0.3610						
EMPL	0.0214	0.4471						
AGE	0.0027	0.9863						
SECTOR	-0.1428	0.5975						
SIZE	-1.6776	0.7920				2.7105	0.0025 ***	15.0361
DURATION	2.4852	0.0378 **	2.5660	0.0050 ***	13.0139	2.2097	0.0051 ***	9.1128
SIMPL	-2.3454	0.1183	-1.6760	0.0021 ***	0.1871			
TRUST	-0.4502	0.6174						
SM	0.0196	0.9849						
SET	-0.0241	0.9857						
IC	0.3909	0.5834						
CR	0.1772	0.8529						
R-Sq (L)	0.64		0.58			0.54		
R-Sq (CS)	0.53		0.50			0.48		
R-Sq (N)	0.76		0.72			0.68		
Prediction accuracy	0.90		0.91			0.89		

Signif. codes: 0 '***' 0.01 '**' 0.05 '*' 0.1 '+' 0.12 '.' 1

of introducing a process innovation by more than 13 times, while increasing a simplification of alliances tasks results in reduction of the probability by more than 81%. The final form of model 2b is expressed by the formula:

$$P(Y_2 = 1|DURATION, SIMPL) = \frac{e^{1.9693+2.5660 DURATION-1.6760 SIMPL}}{1 + e^{1.9693+2.5660 DURATION-1.6760 SIMPL}} \quad (12)$$

Table 10 presents 3 models of logistic regression for the dependent variable of organisational innovation. Model 3a is estimated on the basis of all the analysed independent variables. Model 3b presents the results of estimation for significant variables only. Finally, model 3c presents the influence of only two variables (size of the company and duration of an alliance) on the probability of introducing an organisational innovation.

In model 3b we decided to include a third variable - smaller employee teams - that only slightly exceeds the level of significance $\alpha = 0.10$. Other significant variables include duration of an alliance and strategic match. Increasing the duration of an alliance

Table 10 Logistic regression parameters for organisational innovation models (N = 70)

	Model 3a			Model 3b			Model 3c		
	Coeff	p value		Coeff	p value	exp(b)	Coeff	p value	exp(b)
Intercept	-13.9857	0.0610	*	-11.8177	0.0014	***	0.0000	-5.3406	0.0004 ***
TR	0.0000	0.3164							
EBIT	-0.0001	0.6193							
ROA	0.8947	0.5379							
BV	0.0001	0.3988							
EMPL	0.0068	0.5793							
AGE	0.0281	0.7739							
SECTOR	-0.1096	0.7365							
SIZE	-0.4410	0.8750							
DURATION	1.7579	0.0321	**	1.6514	0.0153	**	5.2143	1.6599	0.0049 ***
SIMPL	0.1924	0.7956							
TRUST	-0.1176	0.8384							
SM	0.9498	0.2114		1.1031	0.0406	**	3.0135		
SET	0.5236	0.4437		0.6885	0.1185	+	1.9908		
IC	0.3089	0.5993							
CR	0.5503	0.5055							
R-Sq (L)	0.31			0.24			0.16		
R-Sq (CS)	0.25			0.20			0.13		
R-Sq (N)	0.42			0.33			0.22		
Prediction accuracy	0.90			0.90			0.83		

Signif. codes: 0 '***' 0.01 '**' 0.05 '*' 0.1 '+' 0.12 '.' 1

increases the probability of an introduction of an organisational innovation by more than 5.21 times, whereas increasing a strategic match of the partners increases the probability by more than 3 times. Finally, smaller employee teams result in increasing the probability by almost 2 times. The final form of model 3b is expressed by the formula:

$$P(Y_3 = 1|DURATION, SM, SET) = \frac{e^{-11.8177+1.6514 DURATION+1.1031 SM+0.6885 SET}}{1 + e^{-11.8177+1.6514 DURATION+1.1031 SM+0.6885 SET}} \quad (13)$$

Models 1b, 2b and 3b provide material for conclusions regarding not only the duration of an alliance, but also some features that can facilitate knowledge acquisition as a result of alliance agreement. The interpretation of this relations is presented in the discussion section.

In models 1c, 2c and 3c, only two independent variables were considered: the size of the company and the duration of the alliance. For product and process innovation models (1c, 2c), both independent variables (size and duration) are significant. In the case of organisational innovation (model 3c), only the duration variable is significant.

The final forms of the logistic regression models 1c, 2c and 3c are expressed by the formulas:

$$P(Y_1 = 1|SIZE, DURATION) = \frac{e^{-4.0582+1.210421 SIZE+1.2302 DURATION}}{1 + e^{-4.0582+1.210421 SIZE+1.2302 DURATION}} \quad (14)$$

$$P(Y_2 = 1|SIZE, DURATION) = \frac{e^{-7.0609+2.7105 SIZE+2.2097 DURATION}}{1 + e^{-7.0609+2.7105 SIZE+2.2097 DURATION}} \quad (15)$$

$$P(Y_3 = 1|DURATION) = \frac{e^{-5.3406+1.6599 DURATION}}{1 + e^{-5.3406+1.6599 DURATION}} \quad (16)$$

Increasing the size of the company, as well as extending the duration of the alliance, has a positive effect on implementation of product and process innovations. In the case of product innovation, increasing the size of the company from small to medium, and from medium to large, increases the probability of introducing an innovation by 3.35 times. Extending the alliance agreement's duration has a similar effect, increasing the probability of implementation of innovation by 3.42 times.

In the case of process innovation the effects are even more pronounced. Enlarging the size of the company increases the probability of implementation of innovation by 15.04 times. Respectively, extension of the alliance agreement increases the probability of implementation of process innovation by 9.11 times.

Analysing the probability of the introduction of organisational innovation, we can draw conclusions based on one significant variable – duration. Extension of alliance agreement increases the probability of introducing an organisational innovation by 5.26 times.

Using structural parameters of logistic regression models we can calculate the probability of introducing innovations determined by the size of an enterprise and the duration of alliance agreement. The results are presented in Tables 11, 12 and 13.

Duration of the alliance was the only statistically significant variable in model 3c. The data analysis of correlation to test H2 are reported in Table 6. As expected, there is a stronger correlation between implementing innovations and the alliance duration. The hypothesis can be also supported by the results in Tables 8 and 12. Extending alliance duration and simultaneously knowledge acquisition has a positive effect on implementation of process innovations. At the same time, implementation of innovations (including mainly product and process innovations) is more dependent on the duration of an alliance than on the size of an enterprise. The regression analysis of the alliance duration, as shown in Tables 7 and 8, supported the Hypothesis H1b ($R^2(\text{CS}) = 0.30$; prediction accuracy = 75.71% in the case of product innovation, and $R^2(\text{CS}) = 0.48$; prediction accuracy = 88.57% in the case of process innovation). This demonstrates that implementing innovations requires time, and longer duration of an alliance is more important than the size of the cooperating enterprises. Hypothesis H1a focusing on the relationships between the alliance duration and the probability of developing and implementing process innovations was supported, as the Impact variable was significant at $p < 0.05$ (see Tables 7, 8, 11 and 12).

Discussion

Intellectual assets are the driving force for innovations, and they could be obtained from the resources of a partner enterprise in a strategic alliance. In fact, strategic alliances are essential factors driving innovations, and help partner companies get access to essential resources, broaden their technological competences and build reputation (Lee et al. 2010; Brunswicker and Vanhaverbeke 2015). Bilateral exchange of knowledge, *know-how*, technologies and modern management systems between cooperating international enterprises results in releasing improved products on the market. Knowledge management and knowledge transfer associated with it is a condition for being competitive on a global market, sometimes contributing to active influence of business entities on global economy. The influence of this process on the competitiveness of economies, in which innovative enterprises function, is also significant (Cunningham and Link 2016).

The presented research results indicate that compatible missions, visions and strategies of mutual agreement (strategic match), as well as inherence of resources (complementary resources of partner enterprises) contributed to the alliance constitute

Table 11 Probability of introducing product innovation according to the company size and alliance duration

		Duration of alliance agreement		
		Up to 1 year	1–3 years	More than 3 years
Company size	Small	17%	40%	70%
	Medium	40%	69%	89%
	Large	69%	88%	96%

Table 12 Probability of introducing process innovation according to the company size and alliance duration

		Duration of alliance agreement		
		Up to 1 year	1–3 years	More than 3 years
Company size	Small	11%	52%	91%
	Medium	64%	94%	99%
	Large	96%	100%	100%

significant determinants of the knowledge management process in a strategic alliance. According to the logistic regression models (model 1b and 3b), we can conclude that strategic match is an important factor that increases the probability of introduction of product and organisational innovations. It means that the concept of new or significantly improved products should be an essential part of the strategy of both partners. Product development-oriented companies are much more effective in creating this kind of innovations. Moreover, strategic match is also important in developing organisational innovations, as it allows to implement the best practices in both entities. A common vision of the alliance, and therefore a better strategic match between partners, can be the basis for building long-term relationships. In turn, longer duration of the alliance and better strategic match determine the implementation of new organisational methods, including practices supporting mutual learning and knowledge sharing. It also promotes integration of partners and increases the probability of implementing product and process innovations. The concept of new product and organisational improvements should be an essential part of the common strategy planning process. In the case of product innovation, informal communication is an important feature. The more informal the communication between people engaged in creating a product innovation, the bigger the probability of introducing it. The researched enterprises also appreciated trust for an ally in the scope of their intentions as a determinant of obtaining and sharing knowledge. This constitutes an important reason for planning the development perspectives of a mutual agreement. On the other hand, simplification of alliances tasks is not a positive circumstance in the case of developing process innovation (model 2b). The process innovation engage much more efforts during the development, testing and final implementation of a new or significantly improved process. In fact, process innovations usually provide solutions to specific problems. This may require solving many more complex tasks. There are no shortcuts here, and all activities aimed at improving the process are closely related. Additionally, smaller employee teams also positively influence introduction of

Table 13 Probability of introducing organisational innovation according to alliance duration

		Duration of alliance agreement		
		Up to 1 year	1–3 years	More than 3 years
Probability		2%	12%	41%

organisational innovations. These structures can form basis for a more complex reorganisation of the company being more flexible for the changes. We can also conclude that depending on the size of an enterprise and the duration of an alliance, the evaluation of the analysed factors varied. We also need to emphasise that there is a correlation between the evaluation of the extent of the influence of the studied factors on knowledge acquisition in an alliance, and the size of partners, as well as the duration of an alliance. Over the course of an alliance, the managers' awareness increases in terms of strategic match and resource inherence of the cooperating enterprises along with the simultaneous increase of importance of trust between them. A longer duration of an alliance favours building informal contacts and increases the trust that contributes to the success of knowledge acquisition, and results in a larger experience in managing this type of agreements. However, it should be taken into account that the degree of variance in partners' characteristics can result in a decrease of alliance net benefits. Complexity and coordination costs begin to hamper the firm's ability to leverage the benefits the alliance offers for innovation (Nasiriyar et al. 2014; Martinez et al. 2017). Thus, Zhao et al. (2016) also emphasise that the knowledge flow has a positive influence on alliance innovation performance. Additionally, it was observed that a stronger correlation exists between the size of enterprises participating in an alliance and a strong evaluation of factors concerning knowledge acquisition and sharing within the alliance. The correlation between the duration of an alliance and a favourable evaluation of the influence of these relationships is weaker. This could be due to perceiving the alliance as a source of obtaining essential and missing knowledge. It is similar in the case of evaluating relationships between these characteristics (the size of an enterprise and the duration of an alliance), and the lack of or an unfavourable evaluation of the influence of the analysed factors on knowledge acquisition and sharing. Unfavourable evaluation of the extent of influence of factors on knowledge acquisition and sharing is more dependent on the size of an enterprise than on the duration of an alliance.

So far, empirical studies have been insufficiently contributing to the understanding of knowledge management practices in alliances and results in the field of innovation of cooperating enterprises (Natalicchio et al. 2017). Although this knowledge is well-established, this classification applies particularly to factors affecting knowledge management. There is a clear need to explore the analysis demonstrating the relationship between acquiring knowledge in the alliance and the results of cooperation at the level of individual partner enterprises measured by, for instance, development and implementation of innovative solutions (Meier 2011; Niesten and Jolink 2015). There is a surprising lack of consensus regarding the basic processes related to the transfer of knowledge within the alliance and its results. The analysis of the systematic literature review of the alliance management indicates the existence of a cognitive gap in this area. It suggests the need for in-depth research on factors supporting learning in the alliance and their impact on the results at the level of partner enterprises. This type of research would significantly expand the current knowledge base. In a broader context, there is also a cognitive gap regarding the way of transforming the knowledge absorbed in the alliance into innovations at the company level (Kohtamäki et al. 2018). Similarly, Audretsch and Belitski (2019) argue that cooperation between enterprises favors the implementation of innovations. However, some limitations should be considered, related to the duration of the alliance, the size of enterprises, the business sector or the geographic regions.

Conclusion

Following the analysis of the research outcomes in the discussed area, the authors have not found similar works that can be directly comparable with the presented paper. The research results lead us to formulate a few conclusions. **First**, small enterprises most of all expect simply defined tasks of an alliance, which should be fulfilled in small teams. This mainly results from limited human resources and expectations concerning achieving assumed objectives quickly. They also appreciate the complementary character of the contributed resources, whose development through the synergy effect is one of the motivations for entering a strategic alliance. Combining skills, knowledge, technology and other resources of partner enterprises creates an opportunity to strengthen particular links in a value chain, and facilitates strengthening or obtaining competitive advantage. Medium and large enterprises attribute acquiring and sharing knowledge to the trust and informal communication between partners. In this way, they can reduce potential opportunistic intentions in an alliance. Asymmetry in the access to partner's knowledge assumes asymmetry in the process of learning. This, in turn, results in a change of bargaining counters within an alliance, and in extreme cases leads to models of unilateral rather than bilateral relations between partners. In this regard some enterprises may be more opened than others. Openness in terms of access to knowledge is a function of skills, trust and informal communication. Another factor (apart from trust and informal communication) that strongly influences knowledge acquisition is strategic match. The equivalence of partners' potentials gives more opportunities for development than in the case of running individual operations through connecting value chains and optimal utilisation of the synergy effect, which exists in a newly formed alliance of a value chain. **Second**, with increased duration of an alliance, the importance of the following factors rises: strategic match, trust between allies and informal communication. Considering the above, the longer the duration of the alliance, the higher the awareness of the enterprises. This refers to the necessary concordance of attributes of enterprises that should provide bilateral and effective cooperation through strengthening of the process of learning, and as a consequence, ensure adaptation to the changing circumstances and constant improvement of partner enterprises. Knowledge as an immaterial resource, contrary to material assets, does not lose value, but its significance rather increases over time. **Third**, the characterised determinants of obtaining knowledge favour implementation of innovations especially for medium and large enterprises. Due to the fact that small enterprises rather seek to acquire missing resources, they are less interested in developing and implementing innovations within an alliance. After extending those resources, medium and large enterprises rather search for a match in strategic objectives and a common vision of the alliance, which favours developing innovative solutions by increasing mutual trust over time. This especially concerns the duration of an alliance. The longer the alliance cooperation, the larger the possibilities of developing and implementing innovation, especially process-related ones. Alliance lasting for a relatively short time (and rather formed by small enterprises) will be oriented at developing a new product or using a certain market opportunity by obtaining resources necessary for it. A longer cooperation provides an opportunity to improve a product offer through process innovations oriented mainly at strengthening or obtaining competitive position and striving for business perfection. This is manifested by autonomous strengthening of the learning process and acquiring discipline of operation in the scope of further continuous development of their capabilities and

knowledge. Furthermore, maintaining competitive advantage requires refining processes, entering new markets or raising barriers in present domains. **Fourth**, organisational innovations are also important. It mainly applies to large enterprises, which should decentralise decision making process in order to maintain efficient alliance management by assigning tasks to autonomous employee teams. Organisational innovations, and therefore strategic changes in organisational structure, are introduced during an alliance and have specific effects in other areas of functioning, leading to further structural changes. Their depth and scope are determined by, among others, strategic match, complementary nature of resources, or the level of trust between partners. Increasing structural compatibility of allies constitutes a condition for effective operation and success of an alliance in the future. **Fifth**, the longer the duration of the alliance, the easier the implementation of product and process innovations. This relationship is particularly noticeable in the case of process innovations. The knowledge acquired in the alliance can induce the development of innovative process solutions than the implementation of product innovations. At the same time, the alliance between medium and large enterprises results in a much higher probability of implementing product or process innovations than in the case of small enterprises. Moreover, complementary resources owned by larger enterprises seem to be the driving force of innovation within the alliance. The knowledge is the crucial one among these resources as a basis for the development and implementation of new or significantly improved production or delivery methods, new solutions in the field of technology or software. **Sixth**, for implementation of organisational innovations the most important are relationships created between partners during the agreement. The size of the enterprise is not such an important determinant as in the case of product or process innovations. However, we can find many examples of agreements between enterprises of different sizes following the same values and implementing or taking the advantage of the created innovations. Regardless of the company size, the partners have to follow some rules, organization culture, communication standards, etc. **Seventh**, increasing the level of strategic match between partners can not only facilitate the knowledge obtaining but also increase the probability of introducing innovations, especially product and organisational ones. On the other hand, simplifying the alliance tasks has a negative effect on introduction of process organization. At the same time, longer duration of the alliance determines the innovative activity in the field of new production methods, which in turn may lead to an increase in the quality of new or significantly improved products and services. Additionally, building smaller employee teams is conducive to creation of organisational innovations. Indeed, this factor is conducive to the effective development of new methods of organizing procedures and work methods.

The process of creating knowledge consists in transforming intangible knowledge into a formalised form available to others. This is facilitated by the process of knowledge management, as a result of which strategic characteristics of an enterprise can be improved (value, intellectual potential, competitive advantage). This concerns obtaining knowledge, which is difficult to obtain by the competition, sharing it and preserve essential knowledge. As a result, a company gains market advantage thanks to possessing and utilising knowledge, which other market competitor's lack. This constitutes another reason for considering knowledge management processes in business operation as well as obtaining it through forming strategic alliances.

The presented results and conclusions have some limitations. The research was conducted among the Polish enterprises, hence the conclusions could be applied to

other countries with a similar development level and innovation potential. Among the limitations that should also be taken into account are: the degree of enterprises' involvement in knowledge management, sources of technology transfer, models and systems of knowledge management and technology transfer, public support (from government and European Union) in technology transfer processes, the degree of cooperation between enterprises, universities and research institutions. The process of knowledge diffusion and implementation of innovations largely depends on the conditions for enterprises created by state and local government authorities. Pro-innovative legal regulations encouraging enterprises to increase the R&D expenditures as well as infrastructural solutions, e.g. by creating clusters or special economic zones should be considered as positive incentives. These factors are largely dependent on the economic policy and long term development strategy.

Undoubtedly, the presented research results do not exhaust the issues of knowledge management and innovation implementation by enterprises within the strategic alliance. An interesting direction of further research may be the importance of other characteristics of knowledge diffusion in alliance that differentiate between enterprises such as capital (foreign / domestic) and the geographical scope of activities (national / international). Further research should take into account other measures describing the level of innovativeness of enterprises related to the specific effects, such as cost savings or increasing market share. In addition, the fact of introducing a specific type of innovation is a relative term. The analysis ought to include more reliable variables, such as the number of obtained patents (innovation output measures).

Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

References

- Ahammad, M. F., Tarba, S. Y., Liu, Y., & Glaister, K. W. (2014). Knowledge transfer and cross-border acquisition performance: The impact of cultural distance and employee retention. *International Business Review*, 25(1), 66–75.
- Alcácer, J., & Oxley, J. (2014). Learning by supplying. *Strategic Management Journal*, 35(2), 204–223.
- Andreeva, T., & Kianto, A. (2012). Does knowledge management really matter? Linking knowledge management practices, competitiveness and economic performance. *Journal of Knowledge Management*, 16(4), 617–636.
- Asgari, N., Singh, K., & Mitchell, W. (2017). Alliance portfolio reconfiguration following a technological discontinuity. *Strategic Management Journal*, 38, 1062–1081.
- Ashok, M., Narula, R., & Martínez-Noya, A. (2016). How do collaboration and investments in knowledge management affect process innovation in services? *Journal of Knowledge Management*, 20(5), 1004–1024.
- Audretsch, D. B., & Belitski, M. (2019). The limits to cillaboration across four of the most innovative UK industries. *British Journal of Management*. <https://doi.org/10.1111/1467-8551.12353>.
- Beckman, C. M., Haunschild, P. R., & Phillips, D. J. (2004). Friends or strangers? Firm-specific uncertainty, market uncertainty, and network partner selection. *Organization Science*, 15, 259–275.
- Beers van, C., & Zand, F. (2014). R&D cooperation, partner diversity, and innovation performance: An empirical analysis. *Journal of Product Innovation Management*, 31, 292–312.

- Belderbos, R., Gilsing, V., Lokshin, B., Carree, M., & Sastre, J. F. (2018). The antecedents of new R&D collaborations with different partner types: On the dynamics of past R&D collaboration and innovative performance. *Long Range Planning*, 51, 285–302.
- Brunswick, S., & Vanhaverbeke, W. (2015). Open innovation in small and medium-sized enterprises (SMEs): External knowledge sourcing strategies and internal Organisational facilitators. *Journal of Small Business Management*, 53(4), 1241–1263.
- Capaldo, A. M., & Messeni Petruzzelli, A. (2015). Origins of knowledge an innovation in R&D alliances: A contingency approach. *Technology Analysis & Strategic Management*, 27(4), 461–483.
- Contractor, F., & Lorange, P. (1988). *Cooperative strategies in international business*. Lexington, MA: Lexington Books.
- Cuevas-Rodriguez, G., Cabello-Medina, C., & Carmona-Lavado, A. (2014). Internal and external social capital for radical product innovation: Do they always work well together? *British Journal of Management*, 25, 266–284.
- Cunningham, J. A., & Link, A. N. (2016). Exploring the effectiveness of research and innovation policies among European Union countries. *International Entrepreneurship and Management Journal*, 12(2), 415–425.
- Donate, M. J., & Guadamillas, F. (2011). Organisational factors to support knowledge management. *Journal of Knowledge Management*, 15(6), 890–914.
- Doz, Y. (1996). The evolution of cooperation in strategic alliances: Initial conditions or learning processes? *Strategic Management Journal*, 17, 55–84.
- Dyer, J., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganisational competitive advantage. *Academy of Management Review*, 23(4), 660–679.
- Ernst, H. (2002). Success factors of new product development: A review of the empirical literature: A review of the empirical literature. *International Journal of Management Reviews*, 4(1), 1–40.
- Feinberg, S. E., & Gupta, A. K. (2004). Knowledge spillovers and the assignment of R&D responsibilities to foreign subsidiaries. *Strategic Management Journal*, 25, 823–845.
- Ferguson, G. A., & Takane, Y. (1998). *Statistical analysis in psychology and education*. San Francisco: McGraw-Hill.
- Foss, N. J., & Pedersen, T. (2004). Organizing knowledge process in the multinational corporation: An introduction. *Journal of International Business Studies*, 35, 340–349.
- Gulati, R. (1999). Network location and learning: The influence of network resources and firm capabilities on Alliance formation. *Strategic Management Journal*, 20, 397–420.
- Gupta, A. K., & Govindarajan, V. (2000). Knowledge flows within multinational corporations. *Strategic Management Journal*, 21(4), 473–496.
- Gupta, A., & Mistra, L. (2000). The value of experiential by organizations: Evidence from international joint ventures. *Journal of Financial Research*, 23, 77–102.
- Hippel von, E. (1988). *The sources of innovation*. New York: Oxford University Press.
- Ho, M. H. W., & Wang, F. (2015). Unpacking knowledge transfer and learning paradoxes in international strategic alliances: Contextual differences matter. *International Business Review*, 24, 287–297.
- Hong, J. F. L., & Snell, R. S. (2013). Developing new capabilities across a supplier network through boundary crossing: A case study of a China-based MNC subsidiary and its local suppliers. *Organization Studies*, 34(3), 377–406.
- Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression* (2nd ed.). New York: Wiley Inc.
- Howard, M., Steensma, H. K., Lyles, M., & Dhanaraj, C. (2016). Learning to collaborate through collaboration: How allying with expert firms influences collaborative innovation within novice firms. *Strategic Management Journal*, 37(10), 2092–2103.
- Huang, K. F., Lin, K. H., Wu, L. Y., & Yu, P. H. (2015). Absorptive capacity and autonomous R&D climate roles in firm innovation. *Journal of Business Research*, 68, 87–94.
- Inkpen, A. C. (2002). Learning, knowledge management and strategic alliances: So many studies, so many unanswered questions. In F. J. Contractor & P. Lorange (Eds.), *Cooperative strategies and alliances* (pp. 267–289). Amsterdam: Pergamon.
- Jiang, R. J., Tao, Q. T., & Santoro, M. D. (2010). Alliance portfolio diversity and firm performance. *Strategic Management Journal*, 31, 1136–1144.
- Junni, P., & Sarala, R. (2013). The role of absorptive capacity in acquisition knowledge transfer. *Thunderbird International Business Review*, 55(4), 419–438.
- Junni, P., Sarala, R., & Vaara, E. (2013). Knowledge transfer in M&As: An integrative framework and future research agenda. In Y. Weber (Ed.), *Handbook for mergers and acquisitions research*. London: Edward Elgar Ltd.

- Kale, P., Singh, H., & Perlmutter, H. (2000). Learning and protection of proprietary assets in strategic alliances: Building relational capital. *Strategic Management Journal*, 21, 217–237.
- Khamseh, H. M., & Jolly, D. (2014). Knowledge transfer in alliances; the moderating role of the alliance type. *Knowledge Management Research & Practice*, 12(4), 409–420.
- Khan, Z., Shenkar, O., & Lew, Y. K. (2015). Knowledge transfer from international joint ventures to local suppliers in a developing economy. *Journal of International Business Studies*, 46, 656–675.
- Kleinbaum, D. G., & Klein, M. (2002). *Logistic regression: A self-learning text second (2nd) edition*. New York: Springer Science & Business Media.
- Kohtamäki, M., Rabetino, R., & Möller, K. (2018). Alliance capabilities: A systematic review and future research directions. *Industrial Marketing Management*, 68, 188–201.
- Koza, M. P., & Lewin, A. Y. (1998). The co-evolution of strategic alliances. *Organization Science*, 9, 255–264.
- Krogh von, G., Ichijo, K., & Nonaka, I. (2000). Enabling knowledge creation: How to unlock the mystery of tacit knowledge and release the power of innovation. New York: Oxford University Press.
- Lavie, D., & Rosenkopf, L. (2006). Balancing exploration and exploitation in alliance formation. *Academy Management Journal*, 49(4), 797–818.
- Lee, S., Park, G., Yoon, B., & Park, J. (2010). Open innovation in SMEs—an intermediated network model. *Research Policy*, 39(2), 290–300.
- Lee, D., Kirkpatrick-Husk, K., & Madhavan, R. (2017). Diversity in alliance portfolios and performance outcomes: A metaanalysis. *Journal of Management*, 43, 1472–1497.
- Li, Y., Vanhaverbeke, W., & Schoenmakers, W. (2008). Exploration and exploitation in innovation: Reframing the interpretation. *Creativity and Innovation Management*, 17, 107–126.
- Liu, C. L., Ghauri, P. N., & Sinkovics, R. R. (2010). Understanding the impact of relational capital and organisational learning on alliance outcomes. *Journal of World Business*, 45, 237–249.
- Marsden, P. (1990). Network data and measurement. *Annual Review of Sociology*, 16, 435–463.
- Martinez, M. G., Zouaghi, F., & Garcia, M. S. (2017). Capturing value from alliance portfolio diversity: The mediating role of R&D human capital in high and low tech industries. *Technovation*, 59, 55–67.
- Martinez-Noya, A., & Garcia-Canal, E. (2015). The framing of knowledge transfers to shared R&D suppliers and its impact on innovation performance: A regulatory focus perspective. *R&D Management*, 46(2), 354–368.
- Meier, M. (2011). Knowledge management in strategic alliances: A review of empirical evidence. *International Journal of Management Reviews*, 13, 1–23.
- Meng, X. (2018). The influence of Alliance innovation network structure upon Enterprise innovation: A case study of China's energy-saving and environment-protection industry. *International Journal of Business and Management*, 13(2), 208–220.
- Nasiriyar, M., Nesta, L., & Dibiaggio, L. (2014). The moderating role of the complementary nature of technological resources in the diversification–performance relationship. *Industrial and Corporate Change*, 23, 1357–1380.
- Natalicchio, A., Ardito, L., Savino, T., & Albino, V. (2017). Managing knowledge assets for open innovation: A systematic literature review. *Journal of Knowledge Management*, 21(6), 1362–1383.
- Nielsen, B. B., & Nielsen, S. (2009). Learning and innovation in international strategic alliances: An empirical test of the role of trust and tacitness. *Journal of Management Studies*, 46, 1031–1056.
- Nielsen, E., & Jolink, A. (2015). The impact of alliance management capabilities on alliance attributes and performance: A literature review. *International Journal of Management Reviews*, 17(1), 69–100.
- Nonaka, I. (2000). Dynamic theory of knowledge creation. *Organizations Science*, 1, 47–50.
- Pan, X., Zhang, J., Song, M., & Ai, B. (2018). Innovation resources integration pattern in high-tech entrepreneurial enterprises. *International Entrepreneurship and Management Journal*, 14(1), 51–66.
- Park, S. H., Chen, R., & Gallagher, S. (2002). Firm resources as moderators of the relationship between market growth and strategic alliances in semiconductor start-ups. *Academy of Management Journal*, 45, 527–545.
- Ramadani, V., Abazi-Alili, H., Dana, L. P., Rexhepi, G., & Ibraimi, S. (2017). The impact of knowledge spillovers and innovation on firm-performance: Findings from the Balkans countries. *International Entrepreneurship and Management Journal*, 13(1), 299–325.
- Richter, F. J., & Vettel, K. (1995). Successful joint ventures in Japan: Transferring knowledge through organisational learning. *Long Range Planning*, 28, 37–45.
- Rothaermel, F. T. (2001). Incumbent's advantage through exploiting complementary assets via interfirm cooperation. *Strategic Management Journal*, 22, 687–699.
- Rothaermel, F. T., & Deeds, D. L. (2004). Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal*, 25, 201–222.

- Rowley, T., Behrens, D., & Krackhardt, D. (2000). Redundant governance structures: An analysis of structural and relational embeddedness in the steel and semiconductor industries. *Strategic Management Journal*, 21, 369–386.
- Sarala, R. M., Junni, P., Cooper, C. L., & Tarba, S. Y. (2016). A sociocultural perspective on knowledge transfer in mergers and acquisitions. *Journal of Management*, 42, 1230–1249.
- Schoorman, D. F., Mayer, R. C., & Davis, J. H. (2007). An integrative model of organisational trust: Past, present, and future. *Academy of Management Review*, 32, 344–354.
- Simonin, B. L. (1997). The importance of collaborative know-how: An empirical test of the learning organization. *Academy of Management Journal*, 20, 1150–1174.
- Subramanian, A. M., & Soh, P. H. (2017). Linking alliance portfolios to recombinant innovation: The combined effects of diversity and alliance experience. *Long Range Planning*, 50, 636–652.
- Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal*, 17, 27–43.
- Teng, B. S. (2005). The emergence and popularization of strategic alliances: Institutional and entrepreneurial views. *International Entrepreneurship and Management Journal*, 1(1), 61–82.
- Vlaisavljevic, V., Cabello-Medina, C., & Perez-Luno, A. (2016). Coping with diversity in alliances for innovation: The role of relational social capital and knowledge codifiability. *British Journal of Management*, 27, 304–322.
- Walsh, J. P., Lee, Y. N., & Nagaoka, S. (2016). Openness and innovation in the US: Collaboration form, idea generation and implementation. *Research Policy*, 45, 1660–1671.
- Wang, M. C., & Chen, M. H. (2016). The more, the better? The impact of closure collaboration network and network structures on technology-based new ventures' performance. *R&D Management*, 46, 174–192.
- Xie, Y. P., & Jing, W. (2017). Research on the influence of alliance relationship on innovation performance under technological uncertainty. *Science and Technology Management*, 5, 60–71.
- Yam, R. C. M., & Cliff Chan, C. (2015). Knowledge sharing, commitment and opportunism in new product development. *International Journal of Operations & Production Management*, 35(7), 1056–1074.
- Yan, J., & Yan, L. (2016). Individual entrepreneurship, collective entrepreneurship and innovation in small business: An empirical study. *International Entrepreneurship and Management Journal*, 12(4), 1053–1077.
- Zack, M., McKeen, J., & Singh, S. (2009). Knowledge management and organisational performance: An exploratory survey. *Journal of Knowledge Management*, 13(6), 392–409.
- Zahra, S. A., & George, G. (2002). Absorptive capacity: A review reconceptualization, and extension. *Academy of Management Review*, 27(2), 185–203.
- Zhang, Y., Dolan, S., Lingham, T., & Altman, Y. (2009). International strategic human resource management: A comparative case analysis of Spanish firms in China. *Management and Organization Review*, 5, 195–222.
- Zhao, Y., Feng, W. Y., & Zheng, X. J. (2016). Influence of coupling of factions and knowledge flows on innovation capability of alliance networks. *Research Management*, 37(3), 51–58.
- Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organisation Science*, 13(3), 339–351.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.