SCIENCE, TECHNOLOGY AND INNOVATION DEVELOPMENT

Knowledge Transfer to High-Tech Sector Organizations: Factors, Problems and Prospects

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Abstract. The article investigates the features and drivers of development of knowledge transfer to organizations of the high-tech sector from the academic sector. We systematize methods for obtaining and transferring knowledge by the organization, and the types of knowledge transfer. We highlight knowledge transfer factors from the perspective of process-based, network and system approaches. In order to confirm the theoretical conclusions obtained, we analyze knowledge transfer factors on the example of a large high-tech enterprise. The empirical basis of the study includes the results of a survey of employees (Rostov-on-Don, Russia) carried out in April – May 2023. According to the results of the questionnaire survey, we carry out correlation and regression analysis to establish actual relationship between the factors characterizing the parameters of knowledge transfer from the academic environment. It is shown that all groups of factors have a direct positive impact on the results of knowledge transfer. At

the same time, it is emphasized that the factors such as the recipient of knowledge, knowledge providers and mutual trust of the transfer participants, that is, the factors characterizing the internal motivation of the participants, have a stronger impact on the result of the knowledge transfer as compared to the factors like the organization of interaction, which reflect external motivation. According to the conclusions obtained, we put forward some recommendations aimed at improving the effectiveness of factors affecting the transfer of knowledge to an enterprise. There are five main directions for the development of knowledge transfer: improving the efficiency of organizing the interaction between the supplier and the recipient of knowledge; strengthening the level of trust between them; expanding the circle of knowledge providers; increasing their ability to transfer knowledge and the ability to perceive new knowledge by the recipient, increasing the effectiveness of the application of acquired knowledge. We emphasize the importance of the professional and educational ecosystem as an open non-hierarchical stable relationship of the enterprise with educational, scientific, and nongovernmental organizations in the development of knowledge transfer.

Key words: knowledge transfer, interaction, trust, knowledge providers, knowledge recipients, absorbing capacity of the organization, high-tech sector, academic sector.

Introduction

Rapid development and introduction of new technologies, their continuous complication and updating reinforce the need for real economy entities, especially high-tech ones, to acquire new knowledge. Innovative solutions are based on knowledge to ensure the growth of the company's income (Andreevskii et al., 2019). Without obtaining advanced knowledge, it is impossible to develop new technologies that ensure the competitiveness of modern high-tech organizations. Thus, enterprises are interested in expanding the channels through which new progressive knowledge can flow.

A number of studies have shown that knowledge transferred from universities is not always used by enterprises (Abreu et al., 2008), however, the value of interaction between the real sector and universities in this area is emphasized (Gitel'man et al., 2020; De Silva et al., 2023). The development of such interaction is the object of increased attention from both researchers and practitioners who manage human capital and knowledge at the enterprise as its component part. The interest of managers is due to the understanding of the importance of knowledge in increasing the competitiveness and profitability of the organization (Orlova, 2021), the need for continuous development of human capital in the conditions of turbulence of the socio-economic environment and the complexity of the scientific and technical sphere.

The scientific literature is increasingly discussing ways and factors to strengthen the interaction of enterprises with universities. It is emphasized that the amount of funds for financing R&D at universities, their territorial proximity, state stimulation of the development of various channels of interconnection, etc. have a great influence (Brunel et al., 2015; Azagra-Caro et al., 2017). At the same time, the possibilities of enterprises themselves to expand and strengthen cooperation with universities in order to obtain new knowledge require more in-depth research. Studying drivers and opportunities of enterprises for the development of cooperation and strengthening of interaction with the academic sector will allow working out a strategy that promotes the development of human capital and knowledge, increasing the efficiency of their use.

The purpose of the research is to identify priority factors affecting the acquisition of new knowledge by an enterprise through their transfer from the academic sector.

Research methods

This study is based on the provisions of the resource approach (Kat'kalo, 2006), in which knowledge is a source of formation of the organization's competitive advantage (Barney, 1991; Zavyalova et al., 2017). According to the knowledge-based approach (Kogut, Zander, 1992), obtaining knowledge from the outside and using it contributes to increased labor productivity and lower transaction costs (De Silva, Rossi, 2018).

Knowledge transfer between organizations is a complex phenomenon characterized by many factors. In this regard, we consider the knowledge transfer from the positions of several approaches. In particular, we used the provisions of the project approach (Thiel, 2002), emphasizing the focus of knowledge transfer on results; the process approach (Meng et al., 2019; Szulanski, 2000), representing knowledge transfer as a process, and the provisions of the network approach (Hansen, 2002; Sun et al., 2019), characterizing the factors affecting the interrelationships of knowledge transfer participants.

We preceded the empirical study by literature analysis, as a result of which we identified the key factors influencing knowledge transfer. The empirical basis was the survey results of employees of a large machine-building enterprise (Rostov-on-Don). The survey conducted in April — May 2023 made it possible to assess the impact of various factors on knowledge transfer from the academic sector. As respondents, we involved two categories of employees: highly qualified specialists (engineers) and managers (heads of departments, workshops, bureaus) — 53 and 47%, respectively. The choice of groups is due to the fact that the activities of these employees are more associated with obtaining new knowledge in the process of solving professional tasks.

Based on the survey results, we carried out a correlation and regression analysis, which allows establishing the actual relationship between the factors characterizing the key parameters of knowledge transfer from the academic environment.

The results obtained make it possible to form an idea of the specifics of the knowledge transfer, received by the enterprise from the academic environment, and to identify reserves for improving its efficiency.

We carried out the systematization of the survey data and their visualization in Microsoft Office Excel spreadsheets.

Literature review

Knowledge transfer is a complex multidimensional phenomenon. It is believed that D. Teece is at the origin of the knowledge transfer concept (Teece, 1977), but more intensively research and practical interest in knowledge transfer and management began increasing since the 1990s. However, there is still no unified understanding of knowledge transfer in the literature. A number of researchers define it as "the process by which one department (for example, a group, a department) is influenced by the experience of another" (Argote et al., 2000). Other authors (Nonaka, Takeuchi, 1995) note that knowledge transfer is a process of assimilation, acceptance, modification, transformation and dissemination of knowledge. These definitions, in fact, consider different types of knowledge transfer. The first definition focuses on the knowledge transfer carried out within the organization, and the second — on the external transfer, understood as the transfer of knowledge from the outside.

In addition, there is a direct and reverse transfer of knowledge, i.e. knowledge can be transferred not only from the academic sector to enterprises, but also in the opposite direction (Ankrah, Al-Tabbaa, 2015). At the same time, enterprises, as a rule, transfer knowledge about the specifics of the industry and the market, new opportunities for the use of technologies (Meng et al., 2019). The object of direct transfer (from the academic environment) is fundamental
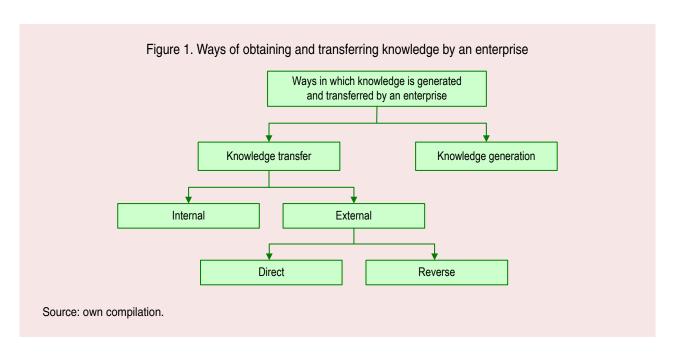
Table 1. Types of knowledge transfer

Recipients / Suppliers	Enterprise	Academic sector
Enterprise	Internal transfer	Inverse external transfer
Academic sector	Direct external transfer	Internal transfer
Source: own compilation.		

knowledge, and the object of reverse transfer is applied knowledge. In general, *Table 1* presents the various processes of knowledge transfer, depending on the role of their participants.

Nevertheless, knowledge transfer is not the only way for organizations to obtain it. An enterprise can acquire new knowledge by jointly creating (generating) them with scientific organizations or universities, in order to jointly solve specific tasks (De Silva, Rossi, 2018). Knowledge generation is also a kind of transfer in the context of the practice of communicative interaction between different scientific communities (Avdonin et al., 2020). P. Galison (1999) called such a transfer of knowledge "mutually interested". Joint knowledge generation occurs, as a rule, as a result of implementing joint projects aimed at obtaining a new product.

In the case of knowledge transfer, an enterprise and a university (or a scientific organization) play clearly defined roles as a supplier and recipient of knowledge, since knowledge is transferred unidirectionally from one to the other. In the case of knowledge creation, the roles of supplier and recipient are blurred (De Silva et al., 2023). In general, the analysis of the literature allowed identifying the following key ways of obtaining (and transferring) knowledge by the enterprise *(Fig. 1)*.

Since the knowledge transfer has more specific goals with a less vague result than the joint creation of knowledge, it seems more appropriate to assess the factors influencing this method of obtaining, and therefore the focus of this study is precisely the transfer of knowledge. At the same time, we should pay special attention to the mechanism of enterprises' interaction with the academic sector, that is, external transfer. It is more complex than the intra-organizational mechanism of knowledge transfer. At the same time, direct external transfer is the most important source of obtaining new knowledge by an enterprise.

Figure 1. Ways of obtaining and transferring knowledge by an enterprise

Source: own compilation.

The research interest consists in analyzing the factors influencing the direct external knowledge transfer (hereinafter referred to as knowledge transfer), which in this study is understood as the knowledge transfer to an enterprise from the academic sector that is subject to direct application.

Research results

Factors affecting knowledge transfer

Knowledge transfer is understood as a success factor in the development of a new product (Albers et al., 2019). To ensure successful knowledge transfer, it is necessary to understand what factors influence it (Klippert et al., 2022). In this regard, it is necessary to analyze the interrelationships of factors affecting knowledge transfer, which will facilitate the adoption of managerial decisions that prevent a shortage of knowledge in an enterprise.

In the course of the analysis of modern literature, we have identified about 250 factors affecting knowledge transfer (Klippert et al., 2022). Such diversity is due to the existence of different approaches to its understanding. There are three main approaches: process, network and project.

From the point of view of the process approach, knowledge transfer is characterized as a change of certain stages. For instance, G. Szulanski (Szulanski, 2000) distinguished four stages of knowledge transfer: the initial one, associated with awareness of the lack of knowledge; the implementation stage, characterized by the choice of a suitable means for transfer; the expansion stage, due to the verification of the applicability of the acquired knowledge; the integration stage, implying their inclusion in the organization's own knowledge. Within the framework of this approach, researchers agree that the most important factors influencing knowledge transfer are the ability of the knowledge provider to transfer them, the ability of knowledge recipient to perceive them, factors characterizing interactions between participants, as well as the nature of knowledge (Szulanski, 1996).

The factors characterizing the supplier's ability to transfer knowledge and the recipient's ability of knowledge to perceive them are understood as the degree of involvement in the process of individual representatives (carriers) of knowledge (Wu et al., 2007) and the presence of their internal motivation (Kalabina, Belyak, 2021). The factors characterizing the interaction between the recipient and the supplier of knowledge mean the possibility of cooperation through the exchange of knowledge (Edmondson, Harvey, 2018), coordination of actions, external incentives to cross existing barriers between employees of organizations – suppliers and recipients of knowledge.

From the point of view of the network approach (Hansen, 2002), knowledge transfer is viewed through the prism of connections and relationships between its participants. According to adherents of this approach, the most important factor contributing to the knowledge transfer development is the presence of mutual trust between participants (Rohrbeck et al., 2015). Trust is generally understood as "the conviction that another person or organization will act in accordance with their expectations (meaning expectations of positive behavior)" (Antonov et al., 2023). Trust in an organization is related to the motivation system and corporate culture. It is considered as an important condition for increasing the competitiveness of an organization by strengthening relations with business partners (Kornai, 2003).

The project approach gives an idea of knowledge transfer as a kind of project (Thiel, 2002) aimed at obtaining a specific result at a certain time (Kopytova, Pakhnina, 2023). It should be borne in mind that the result of the transfer depends, on the one hand, on the acquisition of new knowledge, its perception by the organization, on the other hand, on its application. In fact, the factors of the result of knowledge transfer characterize the absorbing ability of an organization, which means the ability to realize the value of new external knowledge,

assimilate it and apply it for commercial purposes (Cohen, Levinthal, 1990).

The above approaches to understanding knowledge transfer and the factors influencing it complement each other, therefore, in the aggregate, we can identify several groups of key factors influencing knowledge transfer *(Tab. 2)*.

In addition, the nature of knowledge and its content is important. Knowledge of a fundamental nature, as a rule, is transferred to enterprises from the academic sector. The presence or absence of cognitive affinity between participants in knowledge transfer also affects (D'Este et al., 2013), that is, their functioning within a similar knowledge base.
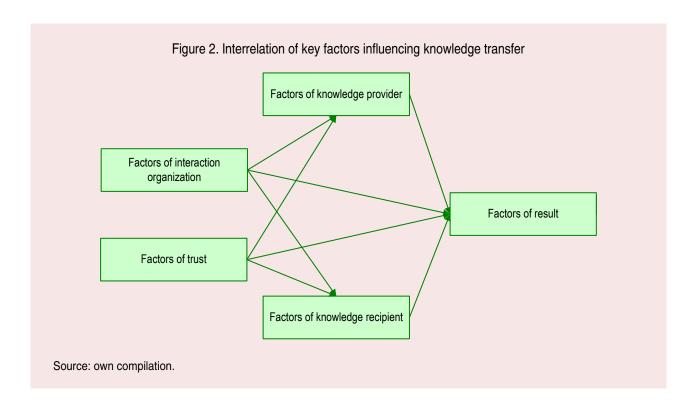
The knowledge transfer factors indicated in Table 2 are interrelated. Ultimately, they all have an impact on the result of the transfer. At the same time, as a research hypothesis, we denote that factors related to the organization of interaction and trust between participants in knowledge transfer affect factors related to the supplier and recipient of knowledge. This is due to the fact that knowledge providers and recipients interact in a certain environment, an important factor of which is trust. In addition, the mechanism of organizing interaction for knowledge transfer also has a great impact on these participants.

Based on the above, the theoretical basis of the research model of the interrelation of knowledge transfer factors will look as follows *(Fig. 2)*. We show that the factors of the recipient and knowledge providers characterizing the ability of their carriers

Table 2. Groups of key factors influencing knowledge transfer

Approac*h*	Process approach	Network approach	Project-based approach
Groups of factors	– Related to the knowledge provider; – related to the knowledge recipient; – related to organization of interaction between participants of knowledge transfer	Trust between knowledge transfer participants	Ensuring application of the acquired knowledge, the result of transfer
Source: own compilation.			

Figure 2. Interrelation of key factors influencing knowledge transfer

Source: own compilation.

(or recipients) to be involved in the process of knowledge transfer affect the result. We also emphasize that the factors of interaction and trust organization affect not only the result of knowledge transfer, but also factors related to suppliers and recipients. However, the impact of these factors will not be equivalent. Further, to test the research hypothesis and establish the impact of these factors on the results of knowledge transfer, their analysis was carried out on the example of a large industrial enterprise.

Knowledge transfer: high-tech enterprise experience

A large enterprise belonging to the field of high technologies was chosen as the knowledge recipient. This field most often feels the need for new knowledge due to the shortest half-life of high-tech knowledge (about 2.5 years). The company is located in the Rostov Oblast; it is a city-forming one. The total number of its employees is over 7 thousand people, 40% of them have higher education.

To analyze knowledge transfer factors in April – May 2023, we conducted a selective anonymous survey of the company's employees by means of a questionnaire. A total of 136 people was interviewed. The sample consisted of two categories of employees: highly qualified specialists (engineers) and managers (heads of departments, sections, bureaus) – 53 and 47%, respectively. Employees' activity of these groups is more connected with obtaining new knowledge in the process of solving professional tasks, which is why their choice for conducting the survey is conditioned.

The share of men was 53%. The age range of respondents is from 23 to 46 years, the average age is 37 years. The respondents' work experience at the enterprise is from 2 to 23 years, on average – 12 years.

In addition to general information about the respondents, the questionnaire contained two sections. The first section dealt with the general characteristics of knowledge acquisition at the enterprise, that is, the questions were aimed at identifying the presence of direct, reverse and internal knowledge transfer, as well as knowledge creation.
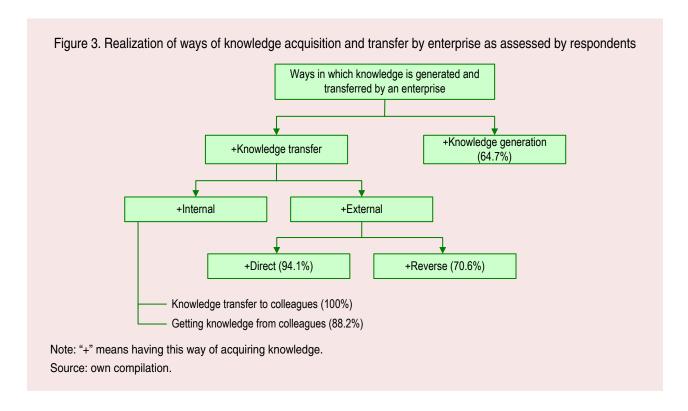
The second section is devoted directly to the characteristics of knowledge transfer factors in the five groups presented in Figure 2. The questionnaire questions were compiled with a focus on some literary sources (Sun et al., 2019) and experts' opinion in the field of HR management. The second section of the questionnaire assumed the choice of an answer to each question on a five-point Likert scale (Likert, 1932), where 1 is "completely disagree", and 5 – "completely agree".

The analysis of the state of knowledge transfer at an enterprise included three stages:

1) general characteristics of the ways of obtaining and transferring knowledge in an enterprise;

2) processing of primary data characterizing the knowledge transfer factors at an enterprise, verification of the research reliability (consistency of questionnaire questions) and factor analysis;

3) correlation and regression analysis, which allows establishing the actual relationship between groups of factors.

It is worth noting the limitations of the study. They relate to the nature of knowledge, since we consider only professional knowledge, which is necessary for employees to successfully implement their work in a high-tech enterprise. At the same time, they can be both fundamental and applied.

Since we are talking about professional knowledge, its transfer can be carried out only if the cognitive proximity of the transfer participants is ensured. At the enterprise under consideration, such cognitive proximity is conditioned by stable relations with the academic sector: with the Don State Technical University, which trains personnel for this organization, the Southern Scientific Center of the Russian Academy of Sciences, which carries out scientific research in areas related to the

Figure 3. Realization of ways of knowledge acquisition and transfer by enterprise as assessed by respondents

Ways in which knowledge is generated and transferred by an enterprise

+Knowledge transfer

+Knowledge generation (64.7%)

+Internal

+External

+Direct (94.1%)

+Reverse (70.6%)

Knowledge transfer to colleagues (100%)

Getting knowledge from colleagues (88.2%)

Note: "+" means having this way of acquiring knowledge.
Source: own compilation.

activities of the enterprise. As for the joint projects of the enterprise with the academic sector, they can be conditionally divided into two groups: joint educational projects (for example, aimed at training the personnel management reserve) and scientific and technical projects (for example, related to the manufacture of composite parts, computer modeling of vacuum infusion).

Within the framework of the first stage of the analysis, based on the questionnaire survey results, we have formed a general idea of the ways of knowledge acquisition by an enterprise. Both external and internal knowledge transfer is carried out. All respondents answered that they shared professional knowledge with colleagues, 88.2% of respondents received new knowledge from colleagues.

In terms of external knowledge transfer, 94.1% of respondents reported receiving knowledge and 70.6% reported transferring knowledge. Thus, there is both direct and reverse knowledge transfer. At the same time, the direct one is more pronounced.

Only 64.7% of respondents indicated that they had participated in creating new knowledge (for instance, making a patent proposal, applying for a patent, participating in joint strategy development, etc.).

Figure 3 presents the general view of the ways in which knowledge is generated (and transferred) by an enterprise as assessed by the respondents.

Thus, transfer is the predominant way of acquiring new professional knowledge. At the same time, in the external knowledge transfer, the direct one prevails over the inverse.

Further, we will discuss the factors affecting direct knowledge transfer, i.e. knowledge transfer to an enterprise from the academic sector.

The second stage of analysis is based on respondents' answers to the questions of the second section of the questionnaire. For each group of factors, experts prepared statement questions characterizing them. The respondents were asked to evaluate on a five-point scale how much this statement corresponds to the real situation at an enterprise.

Table 3. Survey results on the presence of knowledge transfer factors at an enterprise

Group of factors	Min	Max	Mean	Std. Dev
Factors of interaction organization	1	5	2.88	1.10
Factors of knowledge providers	1	5	3.79	0.82
Factors of knowledge recipient	3	5	4.51	0.46
Factors of trust	2	5	3.78	0.64
Factors of result	2	5	4.16	0.72
Source: own compilation.				

The factors of interaction organization include the presence of communication and close interaction on work issues and professional tasks with representatives of universities / scientific organizations, frequent exchange of scientific and technical information with them, as well as the availability of opportunities to discuss professional problems with them.

The factors of knowledge providers are characterized by the willingness of employees of universities and/or scientific organizations to share their knowledge and experience in the field of technology, the availability of constructive suggestions, the provision of training by employees of the academic sector, as well as their assistance in solving problems and overcoming difficulties arising in professional activities.

The factors of knowledge receivers are related to the readiness, willingness of employees to learn, to obtain new technological and managerial knowledge outside their enterprise, understanding the importance of obtaining new knowledge from external sources and undergoing training.

Trust factors are characterized by confidence that in the process of solving work tasks other participants will keep promises, their honesty, fairness to other participants, that other participants of knowledge transfer are trustworthy.

Factors of knowledge transfer result are determined by the acquisition of new technological, managerial and other related knowledge by the employees of the enterprise from external sources over the previous year, new methods of solving professional problems, reduction of dependence on others in solving professional problems due to active knowledge transfer.

Table 3 summarizes the results of the work.

We present the minimum (min), maximum (max), mean values (mean) given by respondents for each group of factors, as well as the standard deviation (Std.Dev). The standard deviation shows the spread of results relative to the mean. The more the value of the standard deviation, the greater the disagreement in the respondents' estimates. For instance, the greatest disagreement in the respondents' assessments is demonstrated in relation to the factors of organization of interaction between the participants of knowledge transfer (1.10). The least disagreement is about the factors influencing the knowledge recipient (0.46).

To test the research reliability, we calculated Cronbach's α-coefficient (Cronbach, 1951):

$$\alpha = \frac{N \times r}{1 + r \times (N - 1)} , \qquad (1)$$

where N − number of groups of factors under consideration,

r − average correlation coefficient between groups of factors.

The closer its value is to 1, the more reliable and consistent the components under study will be. If the α-coefficient is greater than 0.7, the result is reliable (Nunnally, 1978). Consequently, the above calculations of α-coefficient *(Tab. 4)* indicate the reliability of respondents' assessments of knowledge transfer factors.

Table 4. Reliability checks and factor loadings of groups of knowledge transfer factors

Group of factors	α-coefficient	Factor loading
Factors of interaction organization	0.97	0.88
Factors of knowledge providers	0.99	0.94
Factors of knowledge recipient	0.95	0.79
Factors of trust	0.95	0.78
Factors of result	0.98	0.91
Source: own compilation.		

Table 4 also shows the factor loadings of each group of factors calculated on the basis of the estimates received from respondents. Factor loading represents the values of correlation coefficients of each of the initial attributes with each of the identified attributes. The higher the connection of the analyzed group of factors with the knowledge transfer system at an enterprise, the greater the value of factor load. The load value lies within the range from -1 to 1. A positive sign indicates a direct and a negative sign indicates an inverse relationship of the given attribute with the factor. Factor loadings less than 0.3 are considered insignificant. There are no such factor loadings in Table 3. Factor loadings greater than 0.7 indicate strong relationships. Since this value for all groups of factors is more than 0.7, they all have a significant impact on the knowledge transfer system at an enterprise.

As part of the third stage, we performed correlation analysis by calculating the Pearson correlation coefficient. This coefficient allows determining the strength of correlation between two groups of factors. *Table 5* presents the calculations of the Pearson coefficient. Since all values are positive, the relationship between all factors is direct.

Values greater than 0.75 indicate a very strong positive relationship. This degree of strength of relationship is noted between knowledge provider factors and organizational interaction factors, as well as between knowledge provider factors and outcome factors. If the value of the correlation coefficient is between 0.5 and 0.74, it indicates a strong positive relationship (Borodyuk et al., 1983). All other pairs of correlations between groups of knowledge transfer factors are in this range, hence are strong. Thus, it is worth emphasizing the importance of knowledge providers' factors, as the correlation with them of other factors is characterized as very high.

Since the relationship between all groups of factors is characterized as strong and very strong, it is advisable to perform regression analysis to establish the causal relationship. The calculation of the regression coefficient shows the influence of some variables on others. According to the theoretical model (see Fig. 2), all other factors

Table 5. Correlation matrix of groups of knowledge transfer factors

Group of factors	Factors of interaction organization	Factors of knowledge providers	Factors of knowledge recipient	Factors of trust	Factors of result
Factors of interaction organization	1.00	**0.80**	0.63	0.51	0.72
Factors of knowledge providers	**0.80**	1.00	0.69	0.66	**0.90**
Factors of knowledge recipient	0.63	0.69	1.00	0.66	0.62
Factors of trust	0.51	0.66	0.66	1.00	0.69
Factors of result	0.72	**0.90**	0.62	0.69	1.00
Source: own compilation.					

(independent variable) have been selected as variables affecting the knowledge transfer outcome factors (dependent variable). In addition, it is necessary to assess the influence of the factors of interaction organization and trust on knowledge providers and recipients. It is the paired regression coefficients that show the influence of the explanatory independent variable on the dependent variable.
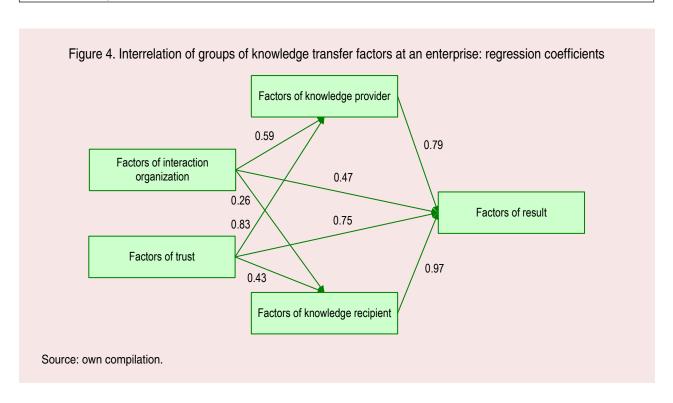
Checking the validity of the model by the level of significance of Fisher's criterion (F significance) confirms the significance of the model because the F significance for all pairs of regression estimation is significantly less than 0.05 *(Tab. 6)*.

The calculation of the paired regression coefficients showed *(Fig. 4)* that knowledge receiver factors (0.97), trust factors (0.75) and knowledge provider factors (0.79) have the highest impact on the outcome factors.

As for the impact on knowledge transfer participants, we can note that trust factors have the greatest impact on knowledge providers (0.83), as well as on knowledge recipients (0.43). At the same time, the impact of trust factors on knowledge providers is more pronounced than on recipients. Interaction organization factors have the least impact on knowledge recipient (0.26 is the lowest value of the paired regression coefficient).

Table 6. Significance level of the Fisher criterion

Group of factors	F significance
Factors of interaction organization → Factors of knowledge providers	0.000
Factors of trust → Factors of knowledge providers	0.003
Factors of interaction organization → Factors of knowledge recipient	0.005
Factors of trust → Factors of knowledge recipient	0.002
Factors of knowledge providers → Factors of result	0.000
Factors of knowledge recipient → Factors of result	0.008
Factors of interaction organization → Factors of result	0.001
Factors of trust → Factors of result	0.002
Source: own compilation.	

Figure 4. Interrelation of groups of knowledge transfer factors at an enterprise: regression coefficients

Source: own compilation.

This result can be explained by the fact that external stimulation, interaction and cooperation organization have less impact on knowledge transfer participants than the trust factor. Similarly, the trust factor has a significantly greater impact on the result of knowledge transfer than the factors of organization of interaction of participants (paired regression coefficients of 0.75 and 0.47 respectively). But the greatest impact on the results of knowledge transfer has the capabilities and abilities of the participants of this process, i.e. the factors of recipients and suppliers of knowledge.

In general, the conducted empirical study confirmed the hypothesis that the factors of suppliers, recipient, interaction organization and trust have an impact on the result of knowledge transfer (all the coefficients of paired regression are positive). However, in the analyzed enterprise, some factors have a stronger impact than others. We can conclude that the analyzed enterprise should pay special attention to the impact of factors related to the organization of interaction of transfer participants and trust of the recipient of knowledge.

Practical relevance of assessing the impact of knowledge transfer factors

The obtained results allow formulating a number of recommendations aimed at improving the effectiveness of factors that influence knowledge transfer at an enterprise. In general terms, we can present five main directions that should be used to influence the development of knowledge transfer:

— increasing the efficiency of the organization of interaction between knowledge provider and recipient;

— raising the level of trust between knowledge transfer participants, contributing to both attracting new knowledge providers and strengthening relations with existing partners;

— attracting knowledge suppliers required by the enterprise, development of their ability to transfer knowledge;

— promoting the ability to perceive new knowledge by its recipient (enterprise);

— increasing the efficiency of implementation of the acquired knowledge into practical activities.

Table 7 reflects possible ways of implementing key directions of knowledge transfer development at an enterprise. They are selected based on the results of in-depth interviews with ten managers of the enterprise's structural units. The main criterion for the selection of ways to implement the key directions in the development of knowledge transfer is the real possibility of their implementation. All respondents noted that an important factor in the

Table 7. Main directions of knowledge transfer development at an enterprise

Direction	Possible ways of implementation
Improving the efficiency of organization of interaction between knowledge provider and knowledge recipient	Development of collaborative projects; organizing collaborative learning; development of partners' motivation for knowledge transfer
Increasing the level of trust between knowledge transfer participants	Formation of positive image, business reputation; development of corporate culture; development of corporate training
Engaging knowledge providers	Holding joint events aimed at sharing knowledge and expanding business contacts (workshops, conferences, master classes, coaching sessions, exhibitions, etc.).
Enhancing recipient's ability to absorb knowledge	Mentoring development; planning for training needs; development of flexible forms of learning; improvement of motivation system to training for company's employees
Improving utilization of acquired knowledge	Formation of "knowledge repositories" (databases of structured data); improvement of motivation system of employees to introduce new knowledge into company's activities
Source: own compilation.	

development of knowledge transfer at the enterprise is the internal motivation of the participants involved in it.

Undoubtedly, the implementation of all these directions will contribute to the development of external knowledge transfer for any enterprises. However, we should pay special attention to measures related to the factors that have the least impact, due to the need to strengthen them. Based on the empirical results obtained, we note that the analyzed enterprise should consider measures related to improving the efficiency of interaction between the supplier and the recipient of knowledge, as well as strengthening the level of trust, since these groups of factors have shown different degrees of influence (sometimes weak) on suppliers, the recipient of knowledge and the final result. Increased attention to these areas should be paid in the strategy for the development of knowledge management in the enterprise.

The development of all the directions, mentioned in Table 7, can be facilitated by the formation of professional-educational ecosystems. A professional-educational ecosystem is "a spatially localized, complex dynamic system consisting of a set of interrelated independent subjects, the environment in which they function, interacting with each other and this environment, as well as the products (results) of their activities. The product is formed as a result of the above-mentioned coordinated (cooperation) and/or uncoordinated (competition) interaction" (Flek, Ugnich, 2022a). Such an ecosystem is based on an open non-hierarchical sustainable relationship of the enterprise with educational, scientific, social organizations. It allows for the implementation of continuous training, starting from school, continuing in universities, colleges and within the framework of professional development programs, taking into account the current and future needs of the enterprise. Joint training programs and research projects are implemented in professional-

educational ecosystems due to the existence of sustainable links between partners. Such ecosystems also help to expand the circle of partners, increase the level of trust and provide flexible practice-oriented forms of training for employees, which can help to ensure the implementation of the knowledge gained by them.

The main product of the professional and educational ecosystem is the human capital of an enterprise. At the same time, socio-economic ecosystems can have additional products. In a professional-educational ecosystem, such a product is knowledge, which is channeled through interaction with scientific and educational organizations (Flek, Ugnich, 2022b).

Through close interaction between ecosystem organizations, knowledge transfer problems due to differences in participants' corporate culture, knowledge context (Inkpen, Tsang, 2005), and lack of cognitive proximity can be solved.

In general, the advantages of the professional-educational ecosystem include ensuring continuous training of enterprise employees, a customized approach to employee training — taking into account the specific needs of an enterprise due to the close relationship with educational organizations; providing a variety of forms of training (including flexible), focused on the needs of learners and taking into account their actual level of knowledge; high adaptability of training, contributing to the acquisition of new progressive knowledge.

Discussion of results

The growth of research interest in the topic of knowledge transfer is due to the understanding of knowledge as the most important resource of an organization and the need to improve the efficiency of its management for the development and implementation of new technologies and products that create a competitive advantage. Quite a large number of knowledge management models have been developed (Nosulenko, Terekhin, 2017), many of which are based on the ideas of I. Nonaka and

H. Takeuchi (Nonaka, Takeuchi, 1995). But at the same time, to date, there is virtually no best practice of knowledge transfer.

Many works are devoted to the study of universities' activities (Giuri et al., 2019) on knowledge transfer to the real sector, as well as intra-firm knowledge transfer (Argote et al., 2000). Works concerning knowledge sharing for the development of resource potential of an organization are of interest (Kalabina, Belyak, 2020; Kalabina, Belyak, 2021). However, knowledge sharing and knowledge transfer are not identical concepts. Knowledge sharing implies mutual transfer, in particular, it is applicable to team-level research, while knowledge transfer represents its movement from one participant to another and is more suitable for the inter-organizational level. It is the transfer of knowledge in order to increase the resource potential of the organization within the framework of interaction with the academic sector that is the focus of this paper.

Within the framework of strategic knowledge management, the most important is the concept of dynamic capabilities (Teece et al., 2033), which explains the mechanism of creating sustainable competitive advantages of an organization in a changing external environment. As a basic dynamic capability of an enterprise, absorptive (absorptive) capability is considered (Cohen, Levinthal, 1990), meaning the ability of an organization to realize the value of new external information, assimilate it and apply it for business purposes. This provision is the basis for understanding the direct external knowledge transfer (i.e., its transfer to the organization from the academic sphere) that serves as the subject of this study.

However, despite the variety of works, there are gaps in the literature in understanding what factors, conditions help organizations to gain knowledge from universities. Our study was an attempt to address this gap. Approaches to under-

standing the factors of knowledge transfer are different. For example, M. De Silva et al. (De Silva et al., 2023) cite groups of pull and push factors. But their identification in practice can be quite difficult. D. Meng et al. (Meng et al., 2019) elaborate on knowledge content factors (entrepreneurial norms, market information, etc.), which are of primary importance rather in reverse knowledge transfer (to the academic environment from industrial partners). Of interest is the study by M. Klippert et al. (Klippert et al., 2022), which proposes four clusters of knowledge transfer factors (people, organization, technology, knowledge and transfer). We have made an attempt, based on the literature analysis, to identify groups of factors characterizing the multidimensionality of knowledge transfer from the position of understanding it as a process, as a network interaction and from the position of the project approach. At the same time, factors characterizing both external motivation (factors of interaction organization) and internal motivation (factors of trust, the ability to transfer knowledge providers and its perception by recipients) are presented. In this, the findings of the present study are consistent with the results of E.G. Kalabina and O.Yu. Belyak (Kalabina, Belyak, 2021). At the same time, our results indicate the significance of the trust factor for knowledge transfer, which remains outside the scope of most approaches.

The limitation of our study is that the factors characterizing the nature of knowledge were not taken into account, since it focused on organizations of the high-tech sphere that primarily need professional knowledge. At the same time, knowledge can be both fundamental and applied in nature.

In terms of knowledge transfer practices, of interest is the experience of Chinese postdoctoral workstations (Ma, Li, 2022), which provide knowledge transfer between organizations and universities. As part of the establishment of such

workstations in large enterprises, cooperation with research institutes and universities is developed to support research work and obtain specific results for the enterprise's benefit with government support, including grants (Huang et al., 2021). The purpose of postdoctoral workstations is to search for and select qualified enterprise personnel capable of research and development, perform R&D to solve technological problems and realize innovations. However, such a mechanism is largely conditioned by China's state policy. We propose the formation of professional-educational ecosystems of a high-tech organization. They are initiated by an enterprise itself, without state support, unlike Chinese postdoctoral workstations. The self-organization mechanism embedded in the ecosystems allows them to develop regardless of external regulation by the state.

Conclusion

The acquisition of knowledge by an enterprise through interaction with the academic sector, which plays a major role in terms of competitiveness, can take place through knowledge transfer and co-creation. Knowledge transfer implies its unidirectional movement from the academic sector to the real sector (from the researcher to the employee of the enterprise). Co-creation (generation) implies the integration of advanced, up-to-date knowledge of researchers with sectoral, practical knowledge possessed by employees of the enterprise in order to jointly solve specific problems. In addition, an enterprise itself can act as a supplier of knowledge to the academic sphere, i.e. carry out the so-called reverse transfer.

Among the ways of knowledge acquisition by an enterprise, transfer has more specific goals and clear results, therefore, it is expedient to study the factors affecting knowledge transfer. The analysis of the literature allowed identifying several approaches to knowledge transfer and key groups of factors affecting it. These are factors related to the supplier

of knowledge; related to the recipient of knowledge; related to an organization of interaction between the participants of knowledge transfer; factors of trust between the participants of knowledge transfer; factors that ensure the application of acquired knowledge, the result of transfer.

The initial data for the assessment can be the results of a survey of employees involved in knowledge transfer at an enterprise. Such an assessment includes a general characterization of the ways of knowledge acquisition by an enterprise; analysis of factors characterizing knowledge transfer; correlation and regression analysis that allows establishing the actual relationship between the knowledge transfer factors.

This assessment can result in concrete proposals for enhancing the positive impact of factors on knowledge transfer.

As a general recommendation aimed at improving the efficiency of knowledge transfer, we can suggest the formation and development of professional and educational ecosystems of enterprises, the main purpose of which is the formation of enterprise's human capital. They have a direct impact on the strengthening of interaction and form a high level of trust between the participants of this process.

The scientific novelty of our work consists in systematizing the ways of knowledge acquisition by an enterprise and its transfer to the academic sector, as well as in the way of analyzing the factors affecting the external knowledge transfer in order to determine the strength of the impact on its results. The importance of the professional and educational ecosystem of the enterprise in the development of knowledge transfer is emphasized. The prospects of the study are seen in the evaluation of the ways of knowledge transfer, in particular, taking into account their division into explicit and implicit. In addition, it is of interest to analyze the sources and methods of knowledge transfer of different nature.

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