Identification of Knowledge Management Barriers in Scientific R&D Projects in Czech Academic Environment

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Abstract

The primary aim of the presented paper is the identification of barriers to knowledge sharing by scientific R&D project team members in a Czech academic environment. In order to fulfill this aim, secondary analysis was used to process the literature search in the context of the problem being solved, and qualitative and quantitative research in the form of a structured interview and a questionnaire survey were used to identify the barriers to knowledge sharing by scientific R&D project team members. The essential output of the presented paper is the identification of barriers to knowledge sharing by members of the scientific R&D project team in Czech public and private universities and the discussion of their causes and impacts in scientific R&D projects. With regard to the aim of the presented paper and the formulated research questions, our effort is that the presented discussion outputs are not only academic considerations but scientific analyses and outputs capable of concrete life. Above all, we propose an innovation of Riege's model of barriers to knowledge sharing, as it was chosen as a comparative basis for our research; however, it was found that it is not applicable in the current conditions of scientific R&D project management in the Czech academic environment.

Keywords: Project Management; Knowledge; Knowledge Management; Knowledge Sharing Barriers.

1. Introduction

Science and research carried out at universities should be a key factor in every country, both for the production and, above all, for the dissemination of new scientific and technological knowledge, as well as for the development of qualified human resources. These factors subsequently significantly influence the economic and technological development of the organization and its competitiveness through both applied research and experimental development and innovation, which are mainly carried out in the business sector. Overall R&D spending in the Czech Republic is growing in the long term; in 2021, a record 111.6 billion CZK was spent on research and development carried out in the Czech Republic. In relation to GDP, expenditure on R&D increased to 1.94%, and the Czech Republic thus again approached the EU average. A significant part of research is carried out in the Czech Republic, specifically at universities.

The cooperation of the university education sector, as a supplier of new knowledge and qualified human resources, with the business sector, as their consumer, should thus be a matter of course in every developed society. Therefore, the implementation of scientific R&D projects and their success in fulfilling the triple imperative parameter become a key topic at almost all Czech universities, both public and private. However, the success of the project is not solely determined by the fulfillment of the parameters of the triple imperative; the transparency and efficiency of knowledge sharing not only among the project team members but also across project teams, belong among the important factors in the project's success.

Knowledge sharing is an area that has been on the rise in recent years. *"Knowledge is one of the key strategic resources that can bring competitiveness to today's companies"* [1]. Project-based organizations, among which universities undoubtedly belong, are generators of knowledge in themselves, but if not effectively captured and shared, it passes through the organization unnoticed. However, the organization's ability to effectively use its knowledge depends primarily on the organization's employees, who are the ones who create, share, and use knowledge. *"The use of knowledge is therefore only possible if workers are willing to share the knowledge they have and build on the knowledge of others"* [2].

Many information sources about the importance of knowledge management can be found [3-5], but there are significantly fewer sources on processes for identification, capture, or sharing and analysis of barriers to knowledge sharing within the organization, from older sources, for example [6], and of the more recent ones we found only [7, 8].

Despite the fact that the world is becoming more aware of the growing benefits of knowledge sharing, the availability of knowledge is still limited. Most knowledge is still only in people's heads, in documents, or in repositories that are not easily accessible to others [9]. From the available studies, it is not clear whether there are different barriers to knowledge sharing that are more significant for large organizations compared to small and medium-sized enterprises and vice versa, or for state and commercial organizations. We confirm the lack of research and studies on barriers to knowledge sharing, especially at universities or in the management of scientific R&D projects, and based on this fact when formulating the aim of the presented paper.

Riege (2005) [9], whose work on knowledge sharing barriers has more than 2,500 citations, divides knowledge sharing barriers into three categories: individual barriers, i.e., individual or employee barriers; organizational level barriers (organizational barriers); and technological barriers. The barriers for an individual or an employee are mainly linked to a lack of communication skills and social networks, differences in national cultures, a lack of time and trust, concern about personal value to the organization, and age and gender differences. Lack of time seems to be the number one barrier. Even if managers are aware of the benefits of knowledge sharing, the time-consuming nature of implementation does not allow them to pursue them further [9]. At the organizational level, these are barriers associated with economic viability, lack of infrastructure and resources, lack of management, lack of transparency in evaluation systems, accessibility of formal and informal meeting spaces, and the physical environment [9]. Organizational structure may (or may not) help knowledge sharing. The organizational structure can act as a repository of knowledge, but it may no longer be shared and disseminated within the organization [10].

Technology-level barriers include the reluctance to use applications; difficulties in building, integrating, and modifying technology systems; unrealistic expectations of employees from technology; insufficient compatibility between systems in the enterprise; and insufficient training of employees on new systems and processes. Technology acts only as an intermediary in the knowledge-sharing process, making it easier and more efficient. The problem arises in the very implementation of a suitable technology that will be friendly to both people and organizational purposes. At the same time, it is necessary to add that the technology implemented in one organization may not work in another [9]. This Riege´s model of barriers to knowledge sharing presented in Riege (2005) [9] is used in our research as the basis for the identification of knowledge sharing barriers by scientific R&D project team members, and at the same time we will try to confirm its applicability in the environment of scientific R&D projects implemented at Czech universities.

The essential output of the presented paper is the identification of barriers to knowledge sharing by members of the scientific R&D project team in Czech public and private universities and the discussion of their causes and impacts in scientific R&D projects. With regard to the aim of the presented paper and the formulated research questions, our effort is that the presented discussion outputs are not only academic considerations but scientific analyses and outputs capable of concrete life.

2. Material and Methods

The primary aim of the presented paper is the identification of barriers to knowledge sharing by scientific R&D project team members in the Czech academic environment. With regard to the formulated aim, the following research questions were set:

RQ1: "How is knowledge managed and shared in the scientific R&D project team?"

RQ2: "What are the barriers to knowledge sharing in scientific R&D projects?"

The secondary aim of the paper is to confirm or refuse the applicability of Riege's model of knowledge management barriers in the scientific R&D project environment at Czech universities. The theoretical part of the paper is processed using the analysis of relevant information sources, secondary analysis was used. Electronic resources in the databases EBSCOhost, Web of Science, Science Direct and WebofKnowledge, as well as Connected Papers, were examined. The selection of individual sources was made as follows:

1. Keyword searches using automated electronic searches in the online databases mentioned above. The following were mainly selected: academic texts, eBooks, materials from conferences, electronic resources and scientific journals.

2. In the second stage, articles were selected based on their title.

3. In the last phase, abstracts of individual articles were read to assess their relevance to the topic.

Through this method of searching for relevant sources, a literature review was written, which forms the theoretical framework of the presented paper. The second phase was the search for scientific studies, where it would be possible to be inspired by the questions for the questionnaire survey and the semi-structured interview. Data for the research was collected through questionnaire survey and the semi-structured interview. For the implementation of semi-structured interviews, 54 project managers of scientific R&D projects operating in both private and public universities in Czech Republic were approached. Through these interviews, RQ1 and partially RQ2 will be answered. Part of the questions for these research questions were taken from Kashif & Kelly [11], Boh (2007) [12], and Santos et al. [13].

All interviews were conducted in the period July - August 2022, were recorded with the consent of the respondent and then transcribed. The transcribed interviews were then printed, read several times, and comments were added to interesting or important excerpts. Codes were generated through these annotated excerpts. In our qualitative analysis *"the code is most often a word or phrase that expresses the most significant or summarizing feature of a certain group of textual data"* [14].

Subsequently, the codes were grouped and used to answer the research questions.

The following codes were identified:

- Knowledge management system.
- Source of knowledge and information.
- Capturing / documenting knowledge.
- Knowledge sharing and management experience.

471 respondents, members of scientific R&D project teams of Czech public and private universities, took part in the survey. Members of scientific R&D project teams at 63 Czech private and public universities were approached. The return rate of the questionnaires was 58.7%. The most numerous age group is in the range of 40 to 49 years, then 30 to 39 years. Through this questionnaire survey, the aim of the paper will be partially fulfilled, as well as the second research question regarding barriers to knowledge sharing.

The questionnaire was inspired with knowledge sharing model framework cited in Riege (2005) [9], through which barriers were assessed in three areas (individual, organizational and technological). Therefore, 13 individual barriers were identified and subsequently examined, from the perspective of project managers and project team members:

1. Lack of time to share knowledge and time to identify colleagues who need specific knowledge.

2. Fear that knowledge sharing may reduce or threaten job security.

3. Low awareness and awareness of the value and benefit of the acquired knowledge for others.

4. Dominance in sharing explicit over tacit knowledge, such as know-how and experiences that require hands-on learning, observation, dialogue and interactive problem solving.

5. Inadequate capture, evaluation, feedback, communication and tolerance of past mistakes to increase individual and organizational learning effects.

6. Differences in experience level.

7. Lack of time for contact and interaction between knowledge sources and recipients.

8. Poor verbal/written communication and interpersonal skills.

9. Age differences.

10. Lack of social networks.

11. Differences in level of education.

12. Lack of trust in people because they can misuse knowledge or take unfair credit for it.

13. Untrustworthiness of knowledge towards the source.

The following organizational barriers were also analysed:

1. Lack of formal and informal space for sharing, reflection and creation of (new) knowledge.

2. Lack of transparent reward and recognition systems that would motivate people to share their knowledge more.

3. Existing corporate culture does not provide sufficient support for sharing practices.

4. Retaining the knowledge of highly qualified and experienced employees is not a high priority.

5. Lack of appropriate infrastructure supporting sharing practices.

6. Lack of corporate resources to provide adequate sharing opportunities.

7. Workspace layouts and geographic distance limit the effective sharing practices.

In the context of technological barriers, the following were analysed:

1. Insufficient integration of IT systems and processes prevents effective work on projects.

2. Lack of technical support (internal or external) and immediate maintenance of integrated IT systems hinders workflows and communication flows.

3. Unrealistic employee expectations about what technology can and cannot do.

4. Lack of compatibility between different IT systems and processes.

5. The mismatch between individual needs and integrated IT systems and processes limits the sharing practices.

6. Reluctance to use IT systems due to insufficient knowledge and experience with them.

7. Lack of training in familiarizing employees with new IT systems and processes.

8. Lack of communication and demonstration of all the advantages of any new systems over existing ones.

9. The software platform LimeSurvey2 was used for the online survey.

At the beginning of the questionnaire, the respondent was approached with a request to fill out the questionnaire with short information about the purpose of the entire research. The next part was questions about individual, organizational and technological barriers to knowledge sharing, where respondents answered on a scale from 1 to 7, where 1 means that they do not encounter this barrier at all to 7, when they encounter this barrier very often. Identification questions followed. At the end of the questionnaire, there was a thank you for filling it out together with an e-mail address, in case of questions or interest in the results.

After completing the research on the LimeSurvey2 web portal, all responses were exported to Excel, which is a suitable format for subsequent data editing and statistical analysis. After cleaning the data, basic statistics were performed, which are used for quantitative signs (measurable numerical values). They can be used in this research, because questions with scales were mainly used. Mode, variance, 4th standard deviation, 1st and 3rd quartile, mean were examined here. Relative and absolute frequencies were used to evaluate demographic questions.

Before the questionnaire survey a pilot was conducted to ensure clarity of all questions and terminology used. For this purpose, one project manager was approached to help to define unclear terminology. An explanation of these terms was then added immediately below the question, in the help area. After editing some questions, the questionnaire was distributed via e-mail. The survey was made available for 14 days to allow as many workers as possible to fill it out.

Validity means the extent to which the collected data are valid, relevant, and at the same time determine whether the researchers are actually measuring what they want [15]. The respondents here are considered to be the holders of relevant information and at the same time are able to describe how knowledge is managed and shared in the organization. The questions were taken from already existing research, which increases the validity of the research. After the interviews were conducted, they were carefully transcribed and later analysed sentence by sentence to find relevant details that were interpreted in context. After exporting the responses from the LimeSurvey2 software, the questionnaire was cleaned of incomplete responses and incomplete questionnaires.

Reliability refers to the extent to which a study can be repeated and the same results obtained. It is difficult to determine whether a qualitative study can ever be replicated because its responses are highly subjective in nature. The study was conducted using a qualitative approach, so reliability is difficult to assess. The study conducted provides a limited amount of empirical data and is therefore a schematic picture of reality. The reason was the limited time frame. There is always a risk of a subjective image of the reality of individual respondents, who could distort this reality more positively in such a way that they want to put the organization or themselves in a favourable light.

The social context is never fixed and is constantly changing. Reliability is more suitable for quantitative research also for the reason that the subjective perspective also changes [15]. For this reason, the outputs of the given research should be considered as a kind of snapshot at the current moment in time.

2.1. Methodology Process

Figure 1, shows the flowchart of the research methodology through which the objectives of this study were achieved.
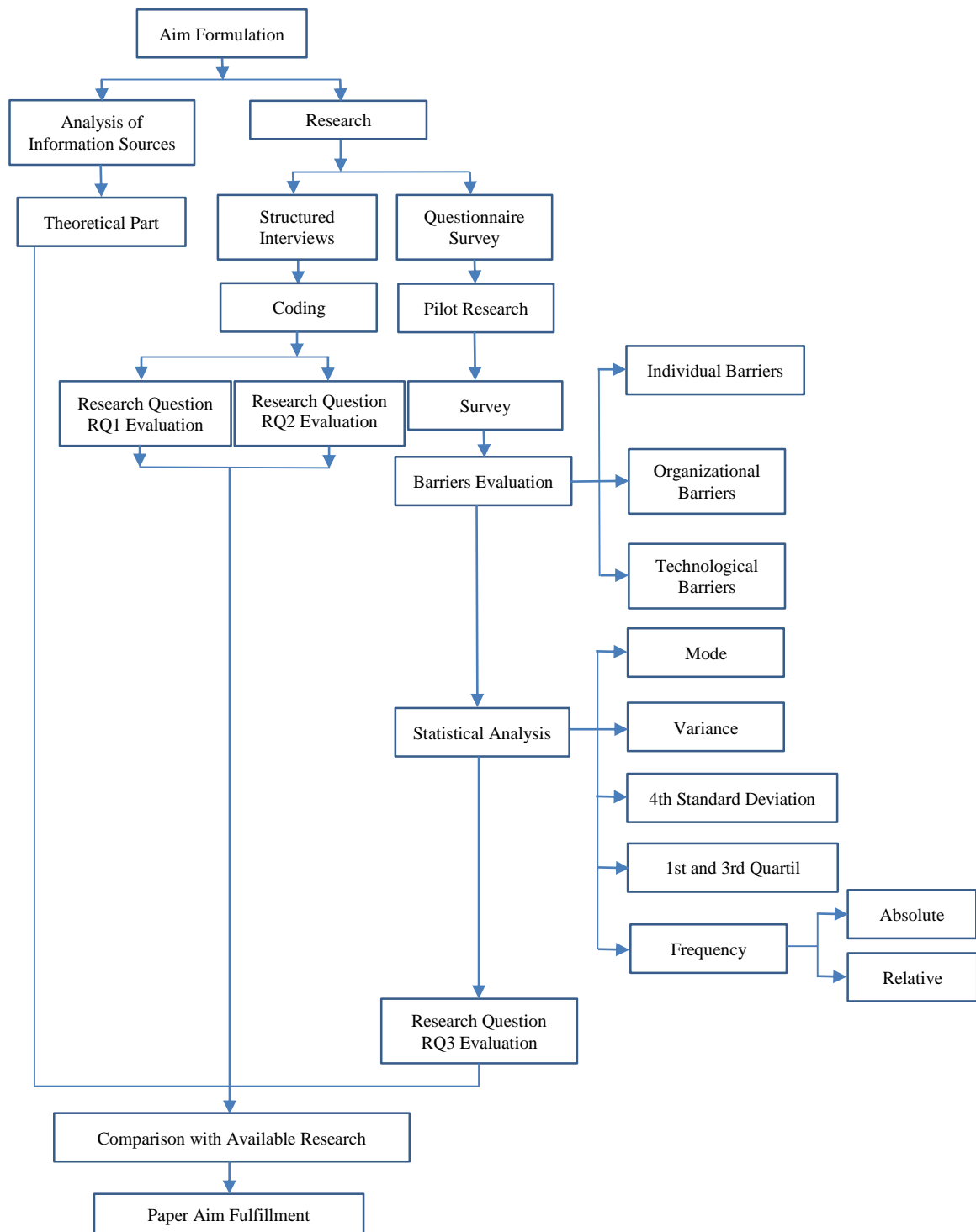

Figure 1. Methodology process workflow flowchart

3. Literature Review

3.1. Specifics of Scientific R&D Projects

The project is a temporary effort to create a unique product [16]. The unique nature means that no project is exactly the same [17]. A project is a *"temporary endeavor to create a service, product or exclusive results"* [18]. Projects are future-oriented forms of organizing [19]. They must adapt quickly to the environment, such as providing new infrastructure or adapting transport [20]. Achieving the desired results through projects requires the ethical decision-making [21], especially when companies face the environmental risks, whether due to a virus pandemic or a changing climate. Scientific R&D projects solved at universities, as well as projects from other spheres of human activity, e.g.

construction or industry, have their own specific features [22]. Research projects can be defined as sets of activities exhibiting the standardly described features of projects, but their goal is to achieve an increase in the level of knowledge through a creative systematic work and to propose new ways of applying available knowledge, regardless of the method of their financing [23].

A more detailed definition of a R&D project is provided by Act No. 130/2002 Coll., on the support of research and development from public funds, where a research, development and innovation project is defined as *"activities that are intended to fulfill an indivisible task of a precise economic, scientific or technical nature with clearly defined in advance determined objectives, formulated by a candidate in a public competition in research, development and innovation, or by a provider in the framework of the award of a public contract".* This definition serves the purposes of the aforementioned law and limits the concept of R&D project to externally financed projects that must be announced in a public tender or awarded by public order. Financing of scientific R&D projects from public funds of the Czech Republic is implemented through institutional and targeted support. In addition to national financing, international financing schemes (bi- and multilateral projects) and projects financed from structural funds are also applied.

Research and development (R&D) have a long-standing tradition at universities in the Czech Republic, where they play an important role in terms of the development of basic and applied scientific disciplines, student education, school prestige and national reputation. In addition, scientific R&D projects are important for ensuring of sufficient financing of universities, and they also enter as a key factor in the evaluation for the accreditation of study programs.

3.2. Knowledge Management

Knowledge management in projects came to the fore at the turn of the 21st century [24]. Knowledge management and project management are very often inseparable and should go hand in hand [25]. The project work is a knowledge-based practice because all work in a project environment requires some form of knowledge [26]. Effective knowledge management practices can be used to reduce project duration, to improve customer satisfaction and general project management [27]. Knowledge management processes in a project environment were identified in Owen & Burstein (2005) [26] and focused on how team members working on a project transfer, acquire and reuse knowledge. Lessons learned from previous projects were applied in the planning stages of the project to avoid mistakes [28]. Project knowledge is generated from two sources – internal and external. Internal sources include risk identification, lessons learned, while external sources include seminars, benchmarking and competitive analysis [29].

The uniqueness of the project is probably exaggerated, as several projects of a similar nature can be found in the implementation process [30]. Project similarity refers to the degree to which a task has something in common between projects, or the similarity in the workflows and implementation methods embedded in the execution of project tasks. It is a prerequisite for successful knowledge transfer between projects [31]. Project similarity can promote knowledge transfer between projects [32]. The more one project has in common with another, especially in terms of the problems they face and the decisions they make, the more likely the lessons and examples of one will be applied to other projects [33]. Research by Zhao et al. (2015) [31] contradicts the above research. The effect of the project similarity on knowledge transfer depends on the types of knowledge that are transferred between projects [31]. Although similarity has an effect on knowledge transfer, the impact of the mechanism needs to be studied.

Sharing knowledge within a project can help to ensure successful outcomes. A certain guide to achieving the consistently successful projects is simply learning from experience, also known as lessons learned [34]. Knowledge reuse is extremely important, but very difficult to practice. While the definition of a project contains an element of uniqueness, there are various similarities within projects [35] and thus knowledge can be reused and shared between projects. Individual project managers and organizations have many tools at their disposal that enable the reuse of knowledge across individual projects [36].

3.3. Barriers to Knowledge Sharing

Just like project management, knowledge sharing in organizations that work with projects is different and includes certain specificities. Knowledge sharing in projects is divided into knowledge sharing within project teams and knowledge sharing across project teams. Knowledge sharing in teams is usually at a good level because companies focus their interest on individual knowledge and each individual team supports this sharing [37, 38]. However, sharing between individual teams is often complicated [39, 40].

Project-oriented organizations have the advantages in the employees being members of multiple project teams [41]. As a result, they are members of more social groups, so they interact with more people who have more knowledge. However, this is again related to individual knowledge, not group knowledge. Therefore, team members who are members of multiple groups are important for successful knowledge sharing between organizational groups such as departments or projects [42]. In the case of project knowledge sharing, we are partly talking about individual knowledge, but group knowledge plays a key role. It is through the transfer of group knowledge that it is possible to prevent certain problems associated with the incorrect sharing of knowledge [7].

Once top management recognizes the drivers of knowledge sharing, teams are then able to find ways to eliminate the prevailing barriers. It is important to study and to understand all the barriers that prevent this knowledge sharing within teams [43, 44]. There are various barriers to knowledge sharing that can be categorized into three levels: individual, organizational and technological [9]. This Riege´s model of knowledge sharing barriers cited in Riege (2005) [9] has been well discussed and tested across a number of different domains such as human resources, workplace learning, learning organizations, project management, IT and systems, hospitality, tourism, higher education and many others [45-47].

Kukko & Helander [43] categorize these barriers in the same way. Indrajit & Hafiza [44] emphasize the individual and technological barriers as the main factors. One of the biggest barriers is mistrust, then lack of communication, lack of leadership, lack of formal and informal mechanisms and space for sharing, lack of qualified personnel, finance and information technology [48]. The biggest barrier to knowledge sharing an insufficient motivation within the project team to share information [49]. A poor organizational culture leads to the unsuccessful knowledge sharing [43]. Organizations try to adapt their organizational culture to the relevant knowledge sharing plans, which leads to difficulties. The biggest barriers to knowledge sharing are the dysfunctional behavior and organizational culture [46].

An excessive hierarchy, which prevents employees from sharing knowledge across organizational boundaries, is also a problem in knowledge sharing [10, 50]. It is better for businesses to have a flat structure, which would ensure a horizontal communication and more interactions between workers, which would facilitate links for informal communication in which knowledge is shared [51]. Another barrier can be a misalignment between the project's short-term goal and the organization's long-term goals and the risk that the project will leave the organization with new knowledge that the business has put into it, but which at the same time has not yet been captured by the business and archived in the organization's repository [10].

Communication, cultural context, the role of the project manager and technology are also problematic factors in knowledge sharing [50]. It is necessary to realize that all of them, on the one hand, can act as barriers preventing the effective sharing of knowledge, and on the other hand, as activators that support and simplify the transfer of knowledge.

Wiewiora et al. (2009) [52] interviewed five executive managers to identify practical barriers to knowledge sharing. Interviewees acknowledged that although there is a constant talk about the importance of capturing and sharing new knowledge, in reality there is still a lack of an effective approach to its acquisition and transfer. According to the interviewees, the process is carried out in a hurry and the administrative staff are not involved in it in order to achieve a proper analysis of the findings and their embedding in the organization [52]. The lack of time, work pressure and failure to consider this activity in the budget are the main reasons why the acquired knowledge is not transferred. In addition, most organizations do not even have clear procedures for acquiring and storing shared knowledge. According to the interviewees, employees learn only in their minds [52].

In project-based organizations there are barriers of these categories: barriers related to social communication (lack of communication, time, willingness), barriers in the transfer of documented knowledge (not including knowledge capture activity in the budget, insufficient storage, lack of time to capture new knowledge) and barriers related to business management (willingness to share, acquired experience has little value for management) [52]. Managers have to deal with many barriers that prevent an effective knowledge sharing in the organization [53]. The important thing is that each business has to deal with the barriers on its own, as there is no proper guide on how to remove individual barriers [9]. Companies will achieve continuous growth only if knowledge sharing becomes an integral part of the organization's daily existence [54]. The most important base for knowledge sharing is the synergy of the following factors: motivation, flat and open organizational structures and modern technology [9].

Knowledge sharing among employees creates many benefits for the business. The ability to build on previous knowledge and experience, respond more quickly to problems, develop new ideas, support innovation, helps to use the organization's resources effectively, improves the work performance, increases the intellectual capital and changes the competitiveness of the organization [48]. However, knowledge sharing has value only for those organizations and employees who need the useful knowledge and are willing to accept and use it. There is no general formula for a knowledge sharing strategy that is universally applicable to all businesses [55]. Each organization must act on its own to get the right information to the right people at the right time [9].

4. Research Results

Most of the barriers mentioned in Riege (2005) [9] were not confirmed in our research. Evaluation of research question *RQ1:* "How is knowledge managed and shared in the project team of a scientific R&D project?"

All interviewed project managers agreed that the knowledge management system is not generally established and standardized for scientific R&D projects in the organizations where the projects are implemented. Respectively, a wiki is available in organizations, but project managers and members of project teams use it minimally, some organizations

use Sharepoint, MS Teams, project meetings and their minutes, e-mails, a table with project milestones, OneNote, Easy Project, OneDrive and CodeBeamer. These mentioned systems are mostly used by members of the project team for their daily work.

Evaluation of research question *RO2:* "What are the barriers to knowledge sharing in scientific R&D projects?"

Identification of barriers and their evaluation are given in the following tables (Tables 1 to 6).

Table 1. Individual barriers of project team members

Barrier name	Mean	Median	Standard deviation	1st quartile	3rd quartile	Variance
Lack of time to share knowledge and time to identify colleagues who need specific knowledge.	3.75	4	1.65	3	4	3.25
Fear that knowledge sharing may reduce or threaten job security.	2.52	2	1.83	2	3	3.17
Low awareness and awareness of the value and benefit of the acquired knowledge for others.	3.42	3	1.51	2	4	2.09
Dominance in sharing explicit over tacit knowledge, such as know-how and experiences that require hands-on learning, observation, dialogue and interactive problem solving.	4.35	4	1.85	3	6	2.93
Inadequate capture, evaluation, feedback, communication and tolerance of past mistakes to increase individual and organizational learning effects.	3.71	4	1.52	2	5	2.87
Differences in experience level.	4.82	5	1.72	4	6	2.32
Lack of time for contact and interaction between knowledge sources and recipients.	4.52	5	1.52	3	6	2.82
Poor verbal/written communication and interpersonal skills.	3.87	4	1.67	2	5	2.87
Age differences.	2.43	2	1.53	1	3	2.31
Lack of social networks.	2.24	2	1.72	1	3	2.48
Differences in level of education.	3.23	3	1.45	2	4	2.25
Lack of trust in people because they can misuse knowledge or take unfair credit for it.	2.52	2	1.72	1	4	2.85
Untrustworthiness of knowledge towards the source.	2.43	2	1.42	1	4	1.81

Tables 1 and 2 show that project managers and project team members do not perceive the mentioned individual barriers very differently. It is evident from the tables below that six individual barriers were not confirmed at all. The fact that the barrier called "Lack of time to share knowledge and time to identify colleagues who need specific knowledge" is a key individual barrier was also confirmed in interviews with project managers. Given the nature of project work, this finding is not surprising. Qureshi and Evans (2015) [56] state that workload hinders knowledge sharing, which is also confirmed by the interview conducted.

Table 2. Individual barriers according to project managers

Barrier name	Mean	Median	Standard deviation	1st quartile	3rd quartile	Variance
Lack of time to share knowledge and time to identify colleagues who need specific knowledge.	5.63	6	0.34	5.6	6	0.18
Fear that knowledge sharing may reduce or threaten job security.	3.52	4	2.15	2.65	5	4.41
Low awareness and awareness of the value and benefit of the acquired knowledge for others.	4.31	5	1.76	3.62	5.52	2.79
Dominance in sharing explicit over tacit knowledge, such as know-how and experiences that require hands-on learning, observation, dialogue and interactive problem solving.	6.21	6	0	6	6	0.21
Inadequate capture, evaluation, feedback, communication and tolerance of past mistakes to increase individual and organizational learning effects.	6.27	6	0.51	6	6.2	0.27
Differences in experience level.	3.62	3	2.61	2	5	6.25

Lack of time for contact and interaction between knowledge sources and recipients.	5.52	6	0.41	5.3	6	0.33
Poor verbal/written communication and interpersonal skills.	3.02	2	2.18	1.6	4	4.72
Age differences.	1.0	1	0.0	1	1	0
Lack of social networks.	1	2	0	1	1	0
Differences in level of education.	2.42	2	1.32	1.6	3	1.63
Lack of trust in people because they can misuse knowledge or take unfair credit for it.	2.0	1.2	1.52	1	2.7	2.3
Untrustworthiness of knowledge towards the source.	2.42	2	0.53	2	2.6	0.31

Table 3. Organizational barriers according to project team members

Barrier name	Mean	Median	Standard deviation	1st quartile	3rd quartile	Variance
Lack of formal and informal space for sharing, reflection and creation of (new) knowledge.	3.62	4	1.71	2	5	2.85
Lack of transparent reward and recognition systems that would motivate people to share their knowledge more.	3.73	4	1.79	2	5	3.24
Existing corporate culture does not provide sufficient support for sharing practices.	3.26	3	1.73	2	4	2.87
Retaining the knowledge of highly qualified and experienced employees is not a high priority.	3.28	3	1.76	2	5	3.81
Lack of appropriate infrastructure supporting sharing practices.	2.69	2	1.72	1	4	3.33
Lack of corporate resources to provide adequate sharing opportunities.	2.64	2	1.48	2	4	2.31
Workspace layouts and geographic distance limit the effective sharing practices.	3.81	4	1.98	2	6	3.91

According to the statistical analysis, there is not much difference in the perception of barriers on an individual level between project managers and members of the project team. As can be determined from Tables 1 and 2, the barriers at this level are perceived very similarly and no great variation in responses was found. Project team members are not concerned that sharing knowledge would threaten their job security. Another barrier is "Poor verbal/written communication and interpersonal skills". Many researchers state that the employees' ability to share knowledge depends primarily on their communication skills. Effective communication, whether written or verbal, is a kind of basis for effective knowledge sharing [57]. This also involves a common language that everyone involved should know. In this barrier, a big difference can be seen between the perception of project managers and project team members, who see this barrier as problematic.

Table 4. Organizational barriers according to project managers

Barrier name	Mean	Median	Standard deviation	1st quartile	3rd quartile	Variance
Lack of formal and informal space for sharing, reflection and creation of (new) knowledge.	5.6	7	1.39	5.7	6	2.4
Lack of transparent reward and recognition systems that would motivate people to share their knowledge more.	6.2	7	0.79	5.4	6.3	0.69
Existing corporate culture does not provide sufficient support for sharing practices.	3.21	2	2.18	1.42	3	4.63
Retaining the knowledge of highly qualified and experienced employees is not a high priority.	3.65	4	2.12	2.4	4	4.23
Lack of appropriate infrastructure supporting sharing practices.	1.59	2	0.61	1.4	2	0.32
Lack of corporate resources to provide adequate sharing opportunities.	1.1	1.2	0.2	1	1	0
Workspace layouts and geographic distance limit the effective sharing practices.	3.62	3	4.23	2.4	5	4.38

Table 5. Technological barriers according to project team members

Barrier name	Mean	Median	Standard deviation	1st quartile	3rd quartile	Variance
Insufficient integration of IT systems and processes prevents effective work on projects.	3.65	2	1.82	2	5	2.98
Lack of technical support (internal or external) and immediate maintenance of integrated IT systems hinders workflows and communication flows.	2.63	2	1.52	2	4	2.15
Unrealistic employee expectations about what technology can and cannot do.	2.89	2	1.78	1	4	3.41
Lack of compatibility between different IT systems and processes.	4.12	4	1.91	2	6	3.41
The mismatch between individual needs and integrated IT systems and processes limits the sharing practices.	3.49	3	1.58	2	5	2.82
Reluctance to use IT systems due to insufficient knowledge and experience with them.	2.93	2	1.82	1	4	3.41
Lack of training in familiarizing employees with new IT systems and processes.	3.46	3	1.75	2	5	2.49
Lack of communication and demonstration of all the advantages of any new systems over existing ones.	3.73	4	1.76	2	5	3.44

The statistical analysis of organizational barriers (Tables 3 and 4) shows that project team members were most inclined to the following barriers:

- Lack of formal and informal space for sharing, reflection and creation of (new) knowledge,

- Workspace layouts and geographic distance limit the effective sharing practices,

- Lack of transparent reward and recognition systems that would motivate people to share their knowledge more.

For these barriers, the mean is the highest, and 25% of respondents rated this question on a scale of at least 5 and above. For the barrier "Work space layouts and geographic distance limit effective sharing practices", 25% of respondents were inclined to answer a scale of 6 and above, indicating a large barrier that exists here.

Respondents also favored the barrier "Retaining the knowledge of highly qualified and experienced employees is not a high priority". Conversely, the mean for the following barriers:

- Lack of appropriate infrastructure supporting sharing practices,

- Lack of corporate resources to provide adequate sharing options,

is low, which means that the respondents did not agree with these two barriers and these are not relevant barriers, also the median and deviation are lower. Therefore, these are not barriers that would bother them or that they would encounter.

Table 6. Technological barriers according to project managers

Barrier name	Mean	Median	Standard deviation	1st quartile	3rd quartile	Variance
Insufficient integration of IT systems and processes prevents effective work on projects.	4.15	5	2.18	3	5.23	4.68
Lack of technical support (internal or external) and immediate maintenance of integrated IT systems hinders workflows and communication flows.	3.59	3	2.51	2	5	6.28
Unrealistic employee expectations about what technology can and cannot do.	2.31	1	1.92	1	3	3.67
Lack of compatibility between different IT systems and processes.	3.35	3	2.11	2	4.5	4.21
The mismatch between individual needs and integrated IT systems and processes limits the sharing practices.	3.11	2	2.03	1.42	4	4.73
Reluctance to use IT systems due to insufficient knowledge and experience with them.	2.27	2	0.39	2	2.6	0.26
Lack of training in familiarizing employees with new IT systems and processes.	6	6	0	6	6	0
Lack of communication and demonstration of all the advantages of any new systems over existing ones.	5.52	6	0.56	5.46	6	0.31

From the point of view of project managers, the following organizational barriers are especially important:

- Lack of formal and informal space for sharing, reflection and creation of (new) knowledge

- Lack of transparent reward and recognition systems that would motivate people to share their knowledge more,

where 25% of the respondents answered on a scale of 1 to 7 with the number 7, which means the highest rating and at the same time the most problematic barriers. The following barriers should also be mentioned:

- Lack of appropriate infrastructure supporting sharing practices,

- Lack of corporate resources to provide adequate sharing options,

- Which do not seem relevant from the point of view of project managers in the organization and are not encountered by them.

Most barriers to knowledge sharing at the technology level include:

- Lack of knowledge about new technology and its insufficient acceptance in the workplace [58],

- Reluctance to adopt existing technologies [59],

- Incompatible technology with work processes [60].

As highlighted earlier, technology is primarily used to coordinate the project work, to use the social networks and applications to facilitate knowledge sharing. Respondents of the questionnaire and the interview were primarily concerned with problems arising from the use of certain technology. Table 5 shows that the main technological barrier for the project team members is the barrier called "Lack of compatibility between different IT systems and processes". This statement is confirmed by the higher mean and especially the 3rd quartile.

Other barriers are:

- Insufficient integration of IT systems and processes prevents effective work on projects,

- Lack of training in familiarizing employees with new IT systems and processes,

- Lack of communication and demonstration of all the advantages of any new systems over existing ones.

In the group of technological barriers, all the mentioned barriers seem to be problematic in a certain way. It cannot be said that none of the mentioned barriers would not trouble the members of the project team or that they would not occur in the organization, as was the case with individual and organizational barriers. According to the answers of the project managers (Table 6), the biggest barrier is "Lack of training in familiarizing employees with new IT systems and processes", which everyone unanimously agreed on, and this is also confirmed by the monitored values such as standard deviation, quartiles, median and variance. Other barriers are:

- Lack of communication and demonstration of all the advantages of any new systems over the existing ones,

- Insufficient integration of it systems and processes prevents effective work on projects,

- Lack of technical support (internal or external) and immediate maintenance of integrated it systems hinders workflows and communication flows.

The responses of the project managers cannot be said to have faced any of the selected barriers. According to the interview, it can also be said that greater barrier in organization is hardware rather than software.

5. Discussion

Knowledge management in projects is specific, because projects are unique, unrepeatable, time-limited, and mostly different groups of people work on them [22]. Despite the uniqueness and unrepeatability of projects, the situations faced by managers and team members can be repeated. Therefore, knowledge sharing between projects is important [2, 61]. Proper knowledge sharing in projects ensures a successful project output [62]. At the same time, it helps to reduce risks in projects by preventing errors [63]. However, there is a number of barriers that makes this sharing complicated. Barriers often arise from the nature of the project, namely from their short-term orientation in the context of the organization, which is also confirmed by our research. This means that, in contrast to the continuous and routine work in an organization, the benefit from the knowledge sharing is only visible after a while, when a similar problem is solved.

Another barrier resulting from the nature of the projects is the specifics of the projects for the external customer, where there is a great pressure to deliver as quickly as possible. This finding of ours is also confirmed by Disterer (2002) [64]. Very often the time it takes to properly record knowledge, is better invested in getting it done faster. In addition to the time aspect, the human factor also plays a role here [65]. Since project teams do not stay the same, it is very complicated to create group-level knowledge. The same findings are also reported by Hanisch et al. (2009) [24]. Table 7 identifies barriers to knowledge sharing in scientific R&D projects in the environment of Czech universities.

Both project managers and project team members agreed that the greatest barrier to knowledge sharing was a lack of time. This is not a surprising finding. Related to this is the lack of time to identify colleagues who might need certain knowledge or whom to turn to in case of need, but also the lack of time for contact and interaction between knowledge sources and recipients. Another barrier to mention is the lack of capture, feedback, communication, and tolerance for past mistakes.

These findings are related to the culture of the organization, which very often becomes a barrier to effective knowledge sharing [66]. The organizational behavior depends more on its culture than on the leadership style of top management. The day-to-day practices of an organization are accumulated into its culture, and a strong culture is the key success factor for high performance and effectiveness [67]. The lack of transparent reward and recognition systems that would motivate workers to share knowledge more is another organizational barrier. The knowledge-sharing culture of an organization depends on interpersonal trust and communication between employees [68]. Another dependence is formed by information systems, rewards, and organizational structure [69]. These elements play a key role in describing the relationships between employees and also in overcoming barriers to knowledge sharing.

Another barrier is the sharing of mostly explicit rather than tacit knowledge. Nakano et al. (2013) [70] emphasized that individuals are an important asset for organizations in terms of knowledge resources. Individuals are the primary resource for maintaining and transmitting this tacit knowledge. Explicit knowledge sharing and organizational performance have a significant relationship [70]. It is essential to understand why this tacit knowledge is crucial and necessary to measure the invention and economic performance of the organization [71]. Knowledge sharing also influences innovation, which in turn directly contributes to organizational performance. Although explicit knowledge sharing has a greater impact on innovation speed and financial performance. Tacit knowledge sharing has an impact on innovation quality and operational performance. Both explicit and tacit knowledge sharing facilitate innovation and performance [72]. Technology is currently becoming the main tool for knowledge sharing. Social media has become a platform for sharing knowledge. However, it would not be effective if individuals did not have sufficient knowledge of the technology in use and did not know how to apply the technology in the organization's environment [73]. This is related to the identified technological barriers, which point to the insufficient integration of IT systems and processes, which prevent an effective work on projects.

Table 7. Identified barriers to knowledge sharing in scientific R&D projects

	Barrier name	Confirmed by project managers	Confirmed by project team members
	Organizational barriers		
1	Lack of formal and informal space for sharing, reflection and creation of (new) knowledge	x	x
2	Workspace layouts and geographic distance limit the effective sharing practices		x
3	Lack of transparent reward and recognition systems that would motivate people to share their knowledge more	x	x
4	Lack of appropriate infrastructure supporting sharing practices		x
5	Retaining the knowledge of highly qualified and experienced employees is not a high priority	x	x
	Technological barriers		
1	Lack of compatibility between different IT systems and processes		x
2	Insufficient integration of IT systems and processes prevents effective work on projects	x	x
3	Lack of training in familiarizing employees with new IT systems and processes		x
4	Lack of communication and demonstration of all advantages of any new systems over existing ones	x	x
5	Lack of technical support (internal or external) and immediate maintenance of integrated IT systems hinders workflows and communication flows.	x	
	Individual barriers		
1	Differences in experience level		x
2	Lack of time for contact and interaction between knowledge sources a recipient		x
3	Dominance in sharing explicit over tacit knowledge such as know-how and experience that requires hands-on learning, observation, dialogue and interactive problem solving	x	x
4	Lack of time to share knowledge and time to identify colleagues who need specific knowledge	x	x
5	Inadequate capture, evaluation, feedback, communication and tolerance of past mistakes to increase individual and organizational learning effects	x	x
6	Poor verbal/written communication and interpersonal skills	x	x

Another serious barrier is the reluctance of the project team members to use IT systems due to their insufficient knowledge and experience with them; at the same time, the lack of training on the mentioned IT systems is also related to these barriers. Damodaran & Olphert (2000) [74] emphasize and confirm that a system is difficult to use when employees do not know how to use it and how to control it [74]. Failure to provide training and user support is one of the reasons that lead to low use of the IT system [74]. This statement is also confirmed in Ardichvili (2008) [59], where an author argues that a lack of technological knowledge and perhaps an aversion to using technology could be a major barrier to knowledge sharing. Human resources professionals, process specialists, or other designees should provide appropriate initial training and user support in the use of a particular technology [59].

We clearly confirm the finding that organizational capabilities, knowledge, and resources are developed and improved through the process of project implementation and the sharing of lessons learned from project implementation. After sharing knowledge with each other, this knowledge can be used by other project teams or by anyone in the organization [10]. Knowledge is the most important resource needed for project management, and a lack of knowledge management is one of the main reasons for project failure [75]. The same was confirmed in our research, so we agree with the statements of Gasik (2011) [75], Moud & Abbasnejad (2012) [50], and Emiliano de Souza et al. (2022) [76] that during the implementation of the project, various forms of information and knowledge are generated in the organization, which must be captured and shared with other projects because, if this does not happen, they will be irretrievably lost.

The experience gained should represent valuable knowledge for current and future projects and should be comprehensively transferred [77]. The loss of such knowledge can be reflected in the resulting costs of project implementation, and resources such as time and money will be spent unnecessarily to capture the knowledge that already existed in the organization [78]. However, based on our findings, we add that project teams are often composed of people who have never worked together and did not even expect to have to work together, and managing knowledge in these circumstances is not easy. The failure of many knowledge transfer systems is often the result of cultural factors rather than technological oversight, which is further confirmed by Ajmal & Koskinen (2008) [79] and Stadler (2021) [80].

6. Conclusions

In projects, knowledge sharing is undoubtedly specific, which is determined by the nature of the project or the uniqueness of the project. Therefore, it is necessary to share information about ongoing and completed projects so that, for example, it is not necessary to invent a solution that has already been devised in the past. In our research, we found that project managers are well aware of the importance of sharing knowledge not only in projects and the project team, but this awareness alone is not enough if certain measures are not taken. Knowledge is managed and stored in different places, and each project manager uses different tools and methods. A knowledge/information management system is not in place at all in most universities, but all research participants agreed that it is useful and something like this should be created. Therefore, knowledge management and sharing in the project team may not be effective and may lead to the loss of valuable knowledge.

According to project managers and project team members, among the most serious barriers to knowledge sharing is mainly the lack of time, which is related to the lack of time to identify colleagues who need certain knowledge and whom to contact if certain knowledge is needed, but also the lack of time for contact and interaction between knowledge sources and recipients. Another serious barrier is insufficient capture, feedback, communication, and tolerance of past mistakes. This finding is related to the culture of the organization, which very often becomes a barrier to effective knowledge sharing [66]. Another barrier is the sharing of mostly explicit rather than tacit knowledge. Project team members also perceive differences in the level of experience differently, which they see as a serious barrier compared to project managers, who do not see it as a problem.

Project managers and project team members perceive differently the barriers called workspace layouts and geographic distance that limit effective knowledge sharing practices. Project team members perceive it as problematic, but project managers do not perceive it as a barrier at all. Another barrier that both research groups agreed on was the lack of transparent reward and recognition systems that would motivate workers to share their knowledge more. This barrier is related to the culture of the organization. Lack of space for sharing, reflection, and the creation of (new) knowledge is related to a lack of time.

Social media and information technology are becoming major tools for knowledge sharing. In the organization, however, hardware is also a problem, i.e., cooperation with ICT, which ensures the delivery of notebooks and at the same time enables the functioning of the software used. The difference in perception between project managers and project team members is in the barrier, which describes the reluctance to use IT systems due to insufficient knowledge and experience with them. Related to this barrier are also barriers related to the lack of training of employees with new systems and processes and the lack of demonstration of all the advantages of any new systems compared to the existing ones.

A suggestion for a further procedure may be to modify the Riege's model cited in Riege (2005) [9], as part of it was not applicable to this research. We chose this model because a sufficient number of studies confirming the validity of this model have been published, for example, Vuori et al. (2018) [81] or Aljaaidis et al. (2020) [82], and this model is considered by professional literature, for example, Paulin & Suneson (2012) [44], to be pivotal for knowledge sharing research and the identification of barriers to knowledge sharing in organizations. However, further research should probably use other models for identifying barriers to knowledge sharing, which may be more intuitive for medium-sized universities, or for the specifics of R&D projects, or for the culture of the Czech Republic [83]. Cultural barriers are mentioned in detail by Goh (2002) [51] or Veer Ramjeawon & Rowley (2020) [84], and after the experience of our research, we identify with his concept. Our preliminary proposal is to use models from Bell (2016) [10] or Moud & Abbasnejad (2012) [50], which specifically deal with project-based organizations. It would be appropriate to examine what barriers exist in this modern age when HomeOffice is more commonly used. The new upgraded model could reflect what barriers there are in this direction. Our research examined established theoretical models in the field of scientific R&D projects with a limited sample size.

The work is rather qualitative and based on a relatively small sample, therefore certain findings cannot be generalized. Future research could consider testing the mentioned model in another area or in a larger sample, where our results could be verified or reconfirmed. Specific findings from this work could serve as hypotheses for awakening research. Despite minor limitations and complications, the aim of the work was achieved through qualitative and quantitative research.

7. Declarations

7.1. Author Contributions

Conceptualization, V.G. and K.B.; methodology, V.G. and K.B.; investigation, V.G. and K.B.; resources, V.G. and K.B.; writing—original draft preparation, V.G. and K.B.; writing—review and editing, V.G. and K.B.; project administration, V.G. and K.B. All authors have read and agreed to the published version of the manuscript.

7.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7.3. Funding

7.4. Acknowledgements

7.5. Institutional Review Board Statement

Not applicable.

7.6. Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

7.7. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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