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# Barriers of knowledge management in virtual project teams: a TISM model

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**Abstract**

In an era of global integration, especially after the release of covid-19, more and more project teams have started working from home. However, the creation of virtual teams is not without barriers for which leaders should be especially prepared. There is a lack of research on knowledge management in the context of virtual project teams. This study aims to reduce the identified gap by identifying the main barriers as well as analyzing their impact on the functioning of virtual teams. The study used analysis of the literature, TISM and MICMAC models, and research among experts. The results indicate key barriers, that are plan of work and collaboration among team members.



*Keywords:* knowledge managment; project; virtual team; barrier; TISM model.

## 1. Introduction

In the beginning, virtual teams were created to enable the collaboration of global or regional experts who did not have enough time to travel. When defining the concept of virtual teams, many authors emphasize this property. They define a virtual team as groups of people or work teams whose members are dispersed geographically and often in time [24, 36, 38, 62]. They were most popular in the IT industry, which used a diverse culture, time zones, and talents in different geographic areas to fulfill the specialized project tasks that required them. Hence, in many definitions of the term, the aspect of using various forms of communication with the use of information and communication technology is emphasized [4, 21, 24, 46, 48]. Among the various definitions of the term, one of the most popular and cited describes virtual teams as groups of geographically, organizationally and / or temporarily

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dispersed employees who are joined by information technologies in order to perform one or more organizational tasks [38].

Global integration, the development of information and communication technology, as well as changes in partnership models and structures, have led to the increasing use of virtual project teams. [6, 10, 45] After the covid-19 pandemic, virtual teams began to be used also in other industries and fields. [20, 55] According to research, 80% of international organizations have changed face-to-face work to virtual or hybrid work, and 64% admitted that this change has caught on and will remain even after the pandemic. [41] Both, members of virtual teams and employers, mention many advantages of using virtual teams. Employees mention as the most important advantages [22]: flexible scheduling (52%), lack of commute (38%), cost savings (35%), able to care for family, pets or aging / sick relatives (34%), reduced anxiety / stress (32%), improved health (26%), freedom to relocate (22%). And employers indicate an increase [22]: productivity (52%), efficiency (48%), employee morale (44%) and employee loyalty / retention (43%).

However, apart from the advantages, working in virtual teams also has many disadvantages that affect various spheres of work of a project team. One of the key areas is knowledge management, which is define as a process, in which individuals exchange their implicit and overt knowledge and jointly create new knowledge [64]. It is also the ability to transfer the formed experiences, information and expert insights into practice [69]. Knowledge management is critical to creating and applying knowledge and solving complex problems.

In practice, organizations invest enormous funds in activities related to analyzing, storing and acquiring knowledge [25], but this usually applies only to overt, not implicit knowledge. Implicit knowledge management depends to the greatest extent on the project team members themselves and the relationships between them. According to Ajmal, Kekäle and Takala [2], 80% of knowledge management activities relate to people and culture, and only 20% are related to technology. Therefore, the effectiveness of knowledge management increases when team members have the option of personal, not virtual, collaboration [8]. Thus, working in virtual teams significantly reduces the possibilities of knowledge management. Although the lack of direct contact is only one of the many barriers that virtual teams must take into account in order to manage knowledge more effectively. The literature describes the subject of knowledge management quite extensively, however knowledge management barriers among people have rarely been addressed in project teams in general, especially in virtual teams [3, 15].

The article will present barriers of knowledge management, that can appeared during work in virtual project teams. They will be analyzed to identify the relationship between them and to compare the level of strength and dependence of individual barriers. Article will answer on three research questions: 1/ What are the most important barriers of knowledge management in virtual project teams? 2/ Which barriers are considered to be at strategic level? 3/ How the barriers affect each other? On the basis of the obtained results, conclusions will be drawn on the dependencies of individual barriers and their impact on knowledge management. The article was based on the analysis of the literature on the subject and the analyzes using the TISM and MICMAC models, in which author used the knowledge and experience of the experts from different countries that work in virtual project teams.

## 2. Literature review

In the literature on the subject, the analysis of knowledge management barriers emphasizes the importance of the individual and the team in knowledge management [12]. Properly planned knowledge management should take into account all factors that may affect the process in the organization. This paper will focus on the factors that are barriers of knowledge management in virtual project teams. A systematic literature review has shown that barriers of knowledge management are analyzed only in a few scientific publications, as shown in the PRISMA diagram (Figure 1). From the collection of 876 literature items, those published later than in the last 10 years, as well as those in the field of biology, chemistry, pharmacology and health care, were excluded. Out of 171 articles, after the analysis of abstracts, 27 articles remained, which were subject to careful analysis. Most of the publications analyze barriers in project teams, without considering virtual cooperation or focus on one selected branch.

Most of the analyzed publications distinguish three groups of knowledge management barriers: individuals, organizations and technology [34, 51, 68], some articles add also project barriers [13, 23]. The first group is related to the attitude of project team members to sharing knowledge. Within this group of barriers, the literature discusses:

- mindset that concerns both the awareness of the context and a common understanding of the issues raised [32]. The authors emphasize that mindset is one of the key elements necessary to achieve success in implemented projects, including knowledge management [28] The research results show that the negative mindset and reluctance of team members result from obstacles of the nature of knowledge, individual and organization [3]. However, the authors emphasize that mindset is a plastic trait that can be improved through effort and that can shape the motivation and goals of an individual [17, 35, 52, 57].
- personality, referring to the characteristics of a team member that allow for unambiguous inference of a person's behavior [9]. The MBTI typology, developed on the basis of C. Jung's theory of personality, distinguishes sixteen personality types, each of which adapts differently to the tasks set in the project, including those related to project management [11, 43]
- lack of competences of team members, which are defined as the application of knowledge, skills and abilities to achieve the desired results [26]. Among the most important competences that members of a virtual project team should have, the authors indicate self-management, intercultural skills, technology skills, interpersonal trust [5, 32, 43]. These competences are obtained through education, participation in training, and gaining practical experience. Their lack may be a barrier to knowledge management.
- ethics that influences the decision-making by project team members to actively manage knowledge. According to the literature, ethics is about making an objective judgment, after considering all options, about the right decision and response to ethical situations. According to the authors, ethics primarily influences: distinguishing good from bad, assessing the way of proceeding, choosing the right beliefs and values, as well as determining the right reaction to a given situation [14, 27, 30, 54].
- Project Manager, as a person of great importance in the implementation of knowledge management in project teams. In virtual teams, the manager does not have the ability to closely supervise the work of individual employees, which triggers the processes of team self-organization. In such a situation, the project manager should have adequate competences to create a coherent vision and highlight common goals [7, 47]. In addition, project managers, having appropriate competences and knowledge of tools, can influence the transfer of tacit knowledge in order to improve the work of the virtual team. The Project Manager who does not have the appropriate competences or commitment will be a huge barrier to knowledge management in the project team [37, 42].

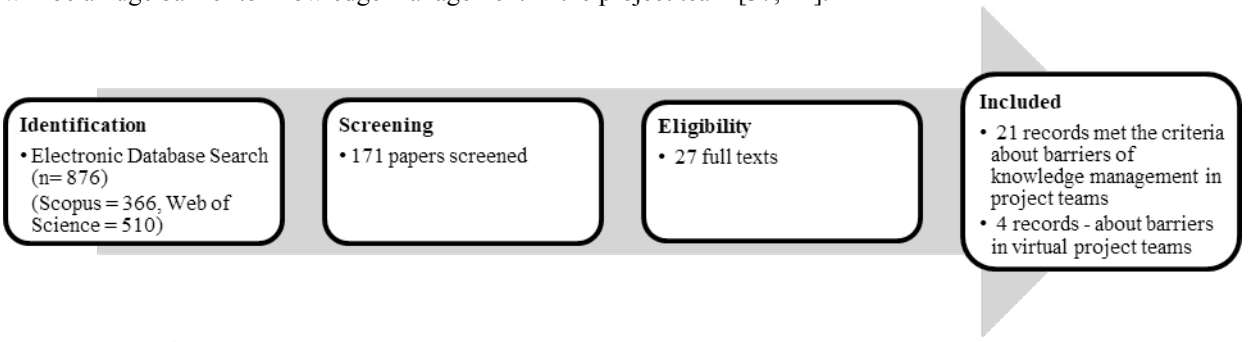


Figure 1 PRISMA diagram

The second group of barriers relates to technology. Here, in the literature on the subject, factors such as:
- the quality of communication resulting from the tools that were used. Many times, the quality of video channels may be poor, and their use requires effort and is tiring in the long run [5, 32] For these reasons, it may negatively affect the members of the project team and discourage their use.
- access to specific IT tools that allow to search, collect, select, analyze, process, manage and share information with other people [33, 63]. The lack of appropriate tools does not allow for effective and quick cooperation. Among IT tools, the authors mention are: computer hardware and software, memories, various physical devices, as well as technologies for the exchange of information, including the Internet, wireless networks, smartphones and other means of communication [50, 61].
- limited non-verbal cues that are replaced by emoticons make conversations and collaboration more impersonal. This, in turn, can lead to misunderstandings, ethical problems, certain illusions and a disturbance of self-presentation. [32] Team members focus on tasks, not social relations [5]

Another group is the organizational barriers among which are mentioned:
- lack of spontaneity as all meetings are planned in detail [5], thus some valuable ideas and initiatives related to knowledge management may escape and not be used.
- culture - a barrier that appears in teams in which members come from different countries. Nowadays, many companies work globally, hence the projects are carried out by multicultural teams that can collaborate virtually [18, 31, 70]
- a planning process that includes the formulation of goals and objectives that explain the work to be done, the project schedule and the necessary resources that are required to achieve the project's objectives [71]. It is the definition of the direction of action [29], as well as the goals and ways of achieving them by the project team [49].
- motivational tools that are used to achieve the effect of engaging a given person in the implementation of the tasks entrusted to him. The project manager has many financial and non-financial tools at his disposal, which he must select according to the needs of the team members [1, 19, 53, 67]. Lack of matching motivational tools to the individual needs of employees will have a negative impact on employee involvement, including knowledge sharing.
- collaboration within virtual project teams is short-term. It is characterized by goal orientation, the creation and monitoring of the knowledge sharing process and the cohesion process of team members [40]. It should include techniques and tools that will improve knowledge management in order to achieve goals more effectively, affecting the integration and better communication between team members.

Table 1 present the lists of barriers of knowledge management in virtual project teams. The lists were validated by 12 experts, five of whom came from a project teams, while seven were scientists from different countries (Poland, Germany and Italy) who work in virtual project teams. During the interviews, experts where asked to identify most important barriers, from those above, which will be analyzed further. From the obtained answers, a list of nine barriers was prepared, which were most often indicated by experts.

Table 1 Barriers of knowledge sharing in virtual project team

| Barrier | Definition |
|---|---|
| Information Technology | A set of methods, means and tools, as well as other technologies that are supporting knowledge management |
| Mindset | An attitude of team members to knowledge management |
| Technological competences | Competences of project team members relating to the ability to use IT tools in the process of communication and project implementation, including sharing knowledge |
| Motivation tools | All tools used to increase the motivation to work among members of the virtual project team, including knowledge management |
| Plan of work | Working time and division of tasks of individual members of the project team |
| Social competences | Ability to cope with social situations, i.e. the ability to cope with stress, be assertive and self-presentation |
| Ethics | Ethical norms and moral principles team members should consider to manage knowledge |
| Project Manager | Competences of project team leader to knowledge management |
| Collaboration | Processes and a combination of techniques that are used to involve team members in knowledge management |

## 3. Methods and results

### *3.1. Survey instrument and the sample*

In order to answer the first research question, the author has conducted a systematic review of the literature. In this review two databases were used - Scopus and Web of Science, as well as the following keywords: barriers, knowledge management, virtual teams, project teams. The literature review, followed by individual interviews among 12 experts from different countries, allowed for the identification of nine key barriers, which were defined in Table 1.

To determine the level and strength of the relationship between the identified barriers, the author used the TISM model (Total Interpretive Structural Modeling) described in detail by Sushil [59, 60]. To create a self-impact matrix (VAXO) and a reachability matrix (binary), the author conducted three focus interviews with 12 project management experts from different countries (Poland, Germany and Italy). In the TISM model, experts answer three general research questions, such as: what, how and why, which allows to show the relationship between the identified factors [16, 60]. The interviews took the form of on-line meetings. To illustrate the relationship between

the variables, the author used the MICMAC matrix (cross-impact matrix multiplication used for classification) [39, 65].

### *3.2. Research analysis*

The conducted focus interviews allowed for the creation of the VAXO matrix, which showed the contextual relations between the individual barriers. Experts had a choice of 4 types of relations: X - meaning a double relation, 0 - meaning no relation, V and A - meaning a one-sided relation (V - vertical to horizontal, A - horizontal to vertical). Research results was shown in table 2.

Table 2 Structural Self-interaction matrix (VAXO) matrix

| Barrier number | Barrier | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Information Technology | X | X | 0 | A | X | 0 | X | X | X |
| 2 | Mindset | X | X | 0 | X | X | V | A | X | X |
| 3 | Technological competences | A | X | 0 | 0 | A | V | X | V | X |
| 4 | Motivation tools | A | X | 0 | A | A | X | A | A | 0 |
| 5 | Plan of work | X | V | 0 | X | X | V | V | X | X |
| 6 | Social competences | A | X | V | X | X | V | 0 | X | V |
| 7 | Ethics | A | A | X | A | 0 | 0 | 0 | 0 | 0 |
| 8 | Project Manager | A | X | V | X | A | X | X | X | X |
| 9 | Collaboration | X | V | V | V | X | V | V | X | X |

The next step in the analysis was to convert the values obtained from the VAXO matrix into binary values. According to the rules presented by Singh and Kant [56], when transforming V, A, X and 0 into binary values, the relations V and X should always be replaced with the value 1, and A and 0 with the value 0. The achieved reachability matrix was presented in the form of Table 3. Summing up interaction entries across rows determines the barrier's driving level, and summing up interaction entries across columns determines the dependency level. These values will be used in further analysis to create the MICMAC matrix.

Table 3 Reachability matrix

| Barrier number | Barrier | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Driver Power |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Information Technology | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 6 |
| 2 | Mindset | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 7 |
| 3 | Technological competences | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 5 |
| 4 | Motivation tools | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 2 |
| 5 | Plan of work | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 8 |
| 6 | Social competences | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 7 |
| 7 | Ethics | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 8 | Project Manager | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 7 |
| 9 | Collaboration | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| | Dependence | 7 | 7 | 5 | 7 | 5 | 5 | 4 | 8 | 4 | |

On the basis of the reachability matrix for each of the barriers, the reachability set and the antecedent set can be determined. The reachability set consists of the item itself and other items in the row that can act as a barrier, while the antecedent set consists of the item itself and other items in the column that can act as the barrier. Then the intersection of these sets constitutes all common elements, as presented in Table 4.

Table 4 Partitioning the reachability matrix into different levels

| Enabler | *Reachability set* | *Antecedent set* | *Intersection set* | *Level* |
|---|---|---|---|---|
| Iteration 1 | | | | |
| E1 | 1,2,3,5,8,9 | 1,2,3,5,6,8,9 | 1,2,35,8,9 | I |
| E2 | 1,2,4,5,6,8,9 | 1,2,3,5,6,8,9 | 1,2,5,6,8,9 | |
| E3 | 1,2,3,4,8 | 1,3,5,8,9 | 1,3,8 | |
| E4 | 4,8 | 2,3,4,5,6,8,9 | 4,8 | I |
| E5 | 1,2,3,4,5,6,8,9 | 1,2,5,6,9 | 1,2,5,6,9 | |
| E6 | 1,2,4,5,6,7,8 | 2,5,6,8,9 | 2,5,6,8 | |
| E7 | 7 | 6,7,8,9 | 7 | I |
| E8 | 1,2,3,4,6,7,8 | 1,2,3,4,5,6,8,9 | 1,2,3,4,6,8 | |
| E9 | 1,2,3,4,5,67,8,9 | 1,2,5,9 | 1,2,5,9 | |
| Iteration 2 | | | | |
| E2 | 2,5,6,8,9 | 2,3,5,6,8,9 | 2,5,6,8,9 | II |
| E3 | 2,3,8 | 3,5,8,9 | 3,8 | |
| E5 | 2,3,5,6,8,9 | 2,5,6,9 | 2,5,6,9 | |
| E6 | 2,5,6,8 | 2,5,6,8,9 | 2,5,6,8 | II |
| E8 | 2,3,6,8 | 2,3,5,6,8,9 | 2,3,6,8 | II |
| E9 | 2,3,5,6,8,9 | 2,5,9 | 2,5,9 | |
| Iteration 3 | | | | |
| E3 | 3 | 3,5,9 | 3 | III |
| E5 | 3,5,9 | 5,9 | 5,9 | |
| E9 | 3,5,9 | 5,9 | 5,9 | |
| Iteration 4 | | | | |
| E5 | 5,9 | 5,9 | 5,9 | IV |
| E9 | 5,9 | 5,9 | 5,9 | IV |

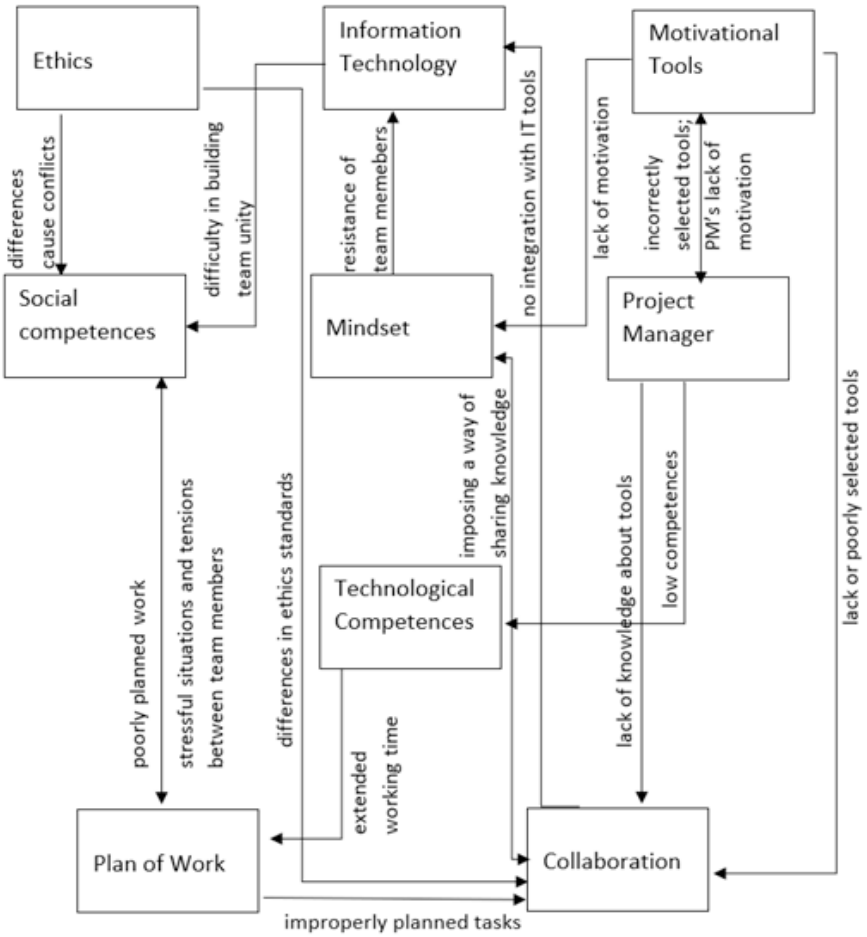

Figure 2 ISM-based model

The element for which the reachability and intersection sets are the same is the top-level element in the hierarchy. Once a top-level item is identified, it is separated from other items, and then the same process finds the next level. By identifying all levels, the final model can be created. According to the analysis carried out, barriers 1, 4 and 7 are at level I, i.e. at the top of the hierarchy. The next level are barriers: 2, 6 and 8, the third level is barrier 3, and the last, fourth level - barriers 5 and 9.

On the basis of the obtained levels and the assessment of the relationship between the variables made by experts, the connections between nodes were identified, as shown in Figure 2. Experts pointed to the most important impact that individual barriers have on each other. Of all the interviews, the most frequently repeated item was selected.

### *3.3. MICMAC analysis*

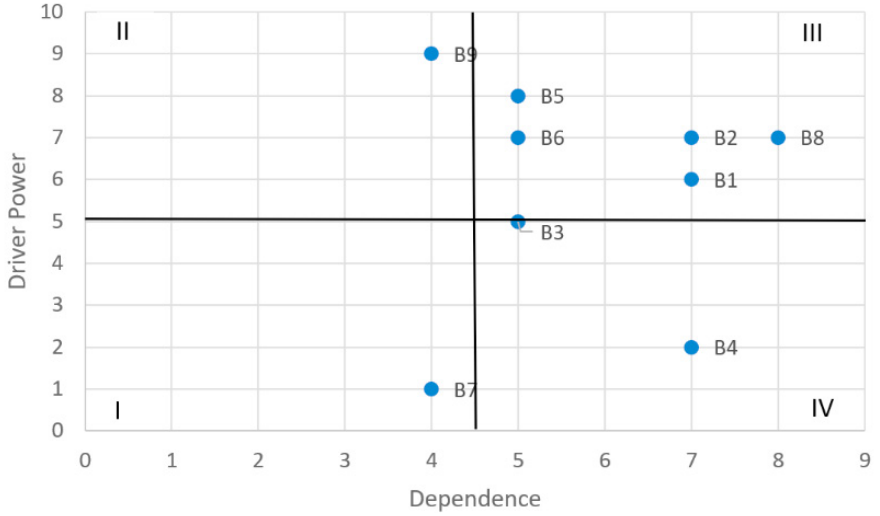


Figure 3 Driving power and dependence diagram

MICMAC analysis allows to compare the level of strength and dependence of individual barriers. The matrix is divided into four clusters:

- the first one contains barriers with a low strength of influence and a low level of dependence on other barriers. As a rule, they have a small number of high-strength links;
- the second one includes barriers with a strong force of influence, but a low level of dependence;
- the third one contains barriers that have both a strong force of influence and a high level of dependency. These barriers are highly unstable because whatever action is taken about them will affect the others as well as affect them themselves.
- the fourth includes barriers with a low potency but a high level of dependence.

The distribution of knowledge management barriers in virtual teams is presented in Figure 3. The barriers in the second and third clusters are key barriers, according to it, the key barriers are: Information Technology, Mindset, Technological competences, Plan of work, Social competences, Project Manager and Collaboration.

### *3.4. Results*

The conducted research made it possible to present the most important barriers to knowledge management, along with their hierarchy (Figure 2). The barriers at the lowest level are strategic factors. It is a poor work plan and the lack of collaboration of team members that have an impact on the final goal of the project and not effective knowledge management. At the middle levels of the hierarchy there are operational factors influencing the performance of teams. These are barriers that have a huge impact on the entire model due to numerous interrelations. Both the competences and mindset of team members and the leader should be on a similar level to

enable effective cooperation. The highest level, related to performance, covers all IT and motivational tools, including ethics. These are interdependent factors, as deficiencies in any of these three elements will have a destructive effect on the knowledge management of the team.

The research also made it possible to compare the level of strength and dependence of individual barriers. The results showed (Figure 3) that ethics is a barrier with low strength and dependence on other barriers. On the other hand, cooperation, which has a high impact on other barriers, is an independent factor. The largest group and at the same time the most important are high-strength and dependent barriers, which include: information technology, mindset, plan of work, social and technological competences, and Project Manager. All actions taken against these barriers will have an impact on the others. The last factor that has a low impact on the remaining barriers, but highly dependent on them, is motivational tools.

The comparison of both studies shows that the barriers at the lowest level of the hierarchy (Figure 2) have the highest impact on the remaining barriers (Figure 3). On the other hand, barriers at higher levels of the hierarchy are characterized by a lower impact on the remaining barriers.

## 4. Conclusions

Knowledge management is an important and difficult process that is implemented both at the level of the organization and individual projects. Knowing the barriers that may arise at its various stages is extremely important for all members of the project team. Virtual teams are characterized by a specific method of work that affects the number and type of barriers that appear in the knowledge management process. Identifying barriers to which attention should be paid, especially those with a strategic dimension, which have a high impact on other barriers, can significantly affect the appropriate preparation and prevention of the appearance of these barriers.

The article presents the key barriers to knowledge management in a virtual project team, which were selected and described thanks to the analysis of the literature on the subject and interviews conducted among experts. Nine most important barriers that have been identified are: Information Technology, Mindset, Technological competences, Motivation tools, Plan of work, Social competences, Ethics, Project Manager, Collaboration. The use of the TISM model allowed for the analysis of barriers in terms of dependence and impact strength, and also allowed to indicate which of the barriers are at the strategic, operational and results-based levels. The TISM method, which was used in the article, has already been used by other authors for research in other areas, such as e-government, strategy, competitiveness, sustainable enterprise, performance management. [44, 58, 66] It allows to present the analyzed issues in a simple and clear manner, thanks to which the logic of the model is transparent.

ISM-based model and the MICMAC analysis allowed to identify key barriers which are: Information Technology, Mindset, Technological competences, Plan of work, Social competences, Project Manager and Collaboration. However, barriers at the strategic level of the ISM-based model that have the highest impact on the remaining barriers deserve more attention. These barriers were - Plan of work and Collaboration, which are the basis for planning both activities and communication in the team. It is these two barriers that members of the virtual team should pay special attention to so that all tasks are realistically planned and that the cooperation takes into account all the available tools and competences of the team. The research also indicated an independent barrier - ethics, which has a low impact on other factors. According to experts, the most dangerous conflicts are those that may arise as a result of a mismatch between the ethical standards of individual team members. Another important conclusion from the conducted research is that the project manager is distinguished as a person who can constitute a barrier. The results of the analyzes showed that the most dangerous is the lack of competences of the leader, unfamiliarity with communication and motivational tools, as well as the low level of motivation of the manager himself. The project manager has rightly been singled out as often making key decisions about the team's work, including on issues related to knowledge management.

The research is limited by a small group of experts from only three countries. However, the research is an introduction to further analysis of knowledge management in virtual teams. It is recommended to conduct a case study that will allow to identify the existing barriers, and then compare them with the results obtained from presented analysis.

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