KNOWLEDGE SHARING BEHAVIORS IN VIRTUAL TEAMS – RESULTS OF EMPIRICAL RESEARCH

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Purpose: Working in virtual teams and realizing projects through ICT tools has become the usual way of collaboration, especially across knowledge workers. Therefore this paper has two research objectives. The first objective is to verify to what extent the virtuality level is correlated with knowledge sharing behaviors. The second objective is to verify to what extent methods of management projects are correlated with knowledge sharing behaviors in virtual teams.
Methodology: To achieve research objectives empirical research was conducted. Based on the previous research, the online survey was designed. The survey was filled out by 336 members of virtual teams. They worked using ICT tools and realize technology projects in the IT industry. Collected data were analyzed by IBM SPSS Imago Pro to test hypotheses.
Findings: The correlation between the level of virtuality and knowledge sharing behaviors did not confirm. The hypothesis that methods of project management are correlated with knowledge sharing behaviors in virtual teams was partly supported.
Research limitations: Research was conducted in technology teams in the IT industry. Virtual team members only from European companies have taken part in the research.
Practical implications: Results can be useful to manage virtual teams not according to overall beliefs but scientific evidence. Based on the results it is possible to identify which variables for knowledge sharing behaviors in virtual teams are significant and which are not.
Originality/value: Only a few studies have explored knowledge sharing in a virtual context. This paper supports scientific evidence of the level of virtuality and methods of managing projects concerning knowledge sharing behaviors as not discovered in earlier research.

Keywords: virtual teams, knowledge sharing behaviors, project management, virtual management, post-COVID era.

Category of the paper: Research paper – empirical research.

1. Introduction

Nowadays collaboration in virtual teams is not an unconventional or unusual way of working. Because of the COVID-19 remote work has become the obvious way of collaboration in many teams and organizations. During the pandemic period, a lot of them were forced to

arrange virtual meetings and conduct projects through information technology tools without face-to-face contact. However, despite the rapid development of virtual teams, still there are many unknowns about them (Kilcullen et al., 2021). Therefore deeper knowledge about virtual teams could be useful for researchers and managers in organizations as well.

Virtual teams usually consist of knowledge workers (Gupta, Pathak, 2018). Because of the geographical distance they use technology tools to share knowledge and work effectively. However, as researchers underlined "Providing technologies and tech support for remote work is necessary, but giving remote workers access to the information they need, when they need it, is mission-critical and may be more of a challenge" (Manko, Rosinski, 2021). This is obvious that providing the information is not only by means of written documentation. Using adequate information is possible only if team members are open to sharing knowledge. Moreover, knowledge sharing was identified as contributing factor to organizational performance (Olan, 2022). Therefore this paper is focused on the knowledge sharing behaviors in virtual teams.

In the literature, virtual team is defined as a group of people who are geographically or organizationally dispersed. They collaborate using communication technologies to accomplish a common and valued goal (Dulebohn, Hoch, 2017, Ford et al., 2017). Virtual team members communicate using technology rather than working during face-to-face meetings (Lim, 2018). It makes virtual cooperation different than traditional (Maduka et al., 2018). Moreover, they often function across the boundaries like proximity, time, space or even institutional affiliations (Schiller et al., 2014).

Virtual teams often are focused on knowledge-intensive tasks which are intrinsically based on information and knowledge (Havakhor, Sabherwal, 2018). Virtual team members create value and build competitive advantages, based on their intellectual resources and intellectual skills. As knowledge workers, they are able to integrate processes with their stakeholders like vendors, customers and suppliers (Gupta, Pathak, 2018). Therefore, researchers as well as business managers are interested in a deeper knowledge about management and functioning of virtual teams for today and for the future (Kauffeld et al., 2022). There is a wide range of collaboration aspects in virtual teams, however, openness to collaboration and sharing knowledge behaviors have significant meaning.

Sharing knowledge behavior in the literature is defined in different ways depending on different perspectives, which is caused by interdisciplinary uses (Shi, Wang, 2022). In some research it is defined as the degree to which employees share their tacit and explicit knowledge with members of their team (Huang, 2009) in others it is the willingness to share ideas openly with other team members (Chan, 2014). Knowledge sharing behaviors consist of knowledge creation, framing and targeting behaviors (Schwartz-Asher et al., 2020). This paper is focused on the collaboration in teams, therefore the used definition of knowledge sharing behaviors is the degree to which employees participate or conduct knowledge sharing activities in the team (Xue et al., 2011).

Currently, in the post-COVID era, organizations are facing the issue of the future way of working, to provide high quality of collaboration and high level of effectiveness (Kauffeld et al., 2022). Now, virtual work is not determined by medical or law factors. Therefore, a lot of managers are looking for the answer for the question "should we come back to the office or should we keep virtual way of working partly or even totally?". Some of them, simply assume that virtuality has a negative impact on the collaboration and they make a decision to come back. Some of them keep virtual teams because of cutting their office space costs. Others, maintain virtual work because of employees` pressure to collaborate remotely, without necessity to commute. However, there is no unambiguous measured evidence about relation between knowledge sharing behaviors and the virtuality. Therefore, it is necessary to have deeper scientist knowledge about it.

In the earliest research about virtual teams, the virtuality was analyzed in dichotomic way as virtual teams or non-virtual teams. However, in the course of time, researchers recommended that virtuality in teams should be defined as the continuum (Al-Ani et al., 2011, Cheshin et al., 2013, Kirkman, Mathieu, 2005). The level of the virtuality was presented as a more adequate and more relevant approach. Moreover, the level of team dispersion can determine the way of building relations between team members (Charlier et al., 2016). In view of the above, the first research objective is to verify to what extent the level of team virtuality is correlated with knowledge sharing behaviors. Therefore, the first hypothesis is as follows:

H1: The level of team virtuality is correlated with knowledge sharing behaviors.

The development of information and communication technologies have allowed to share remotely domain knowledge and status of virtual projects as well. Organizations adapt different kinds of approach to manage projects. One of the most popular approach is an agile, which includes agile methods like: Scrum, Kanban, Extreme programming or Lean. They are popular mostly in technology organizations but were also implemented in other sectors (Held, 2022). Virtual team members use a method or a few methods to manage projects and they often use supportive project management software solutions (Liebert, Zaczyk, 2019). Different project management approaches, e.g. the lean approach and the agile approach, were analyzed in empirical research, however, still their role is not clearly explicit (Srinivasan et al., 2020). Therefore, the second objective in this paper is to verify to what extent project management methods in virtual teams are correlated with knowledge sharing behaviors. In this regard, the second hypothesis is as follows:

H2: Project management methods are correlated with knowledge sharing behaviors in virtual teams.

Summarizing, the collaboration in virtual teams is used on a daily basis. The significance of knowledge sharing is also underlined. Therefore it could be useful to deliver knowledge on how deal with knowledge sharing in virtual teams and what kind of variables are truly significant. In business community, there is often the perception that information technology

tools and remote work blocks or decrease the level of knowledge sharing behaviors. Often there are also assumptions that some ways of project management methods are better than others.

Despite the fact that the scientist literature provides us with more and more research about virtual teams and knowledge sharing behaviors, still it is not unambiguous. Therefore, the above research objectives were formulated, to make managing of virtual teams easier, basing not only on theoretical assumptions but also on the scientific evidence. It can be useful for scientists and business managers as well. Due to the results, it will be possible to identify which variables really matter and which do not.

2. Research method

In order to realize research objectives, the quantitative research was conducted. The steps taken to achieve them were as follows: literature review, identifying the research gap, formulating hypothesis, preparing the research tool (the survey), collecting database, statistical analysis, conclusions.

The research tool was an available online survey, prepared in the English language. It consisted of four parts. The first section of the survey contained items designed to measure knowledge sharing behaviors. The survey included a validated scale to measure knowledge sharing behaviors (Xue, 2011) published also in empirical studies e.g. (Oliveira et al., 2015). The items in the knowledge sharing behaviors scale were as follow:

- KSB1: I often participate in knowledge sharing activities in my team.
- KSB2: I usually spend a lot of time conducting knowledge sharing activities in my team.
- KSB3. I usually share my knowledge with other members of my team.

In the survey a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used.

In the second part there were questions about the virtuality. According researchers` recommendations (Charlier et al., 2016, Marlow et al., 2018), the level of team virtuality was measured. In order to measure the level of team virtuality respondents defined to what extent they communicate using ICT (%) and to what extent they communicate face-to-face (%).

The third section of the survey included the list of different approaches and techniques to manage projects. There were: agile, scrum, kanban, lean, extreme programming. Respondents also could add an additional way of realizing projects. The answer "I do not know" also was available.

The fourth section was designed to characterize the team composition and respondents. In order to measure team size, respondents entered the number of team members. Apart from the team size, earlier research about virtual teams also included questions about: gender, age, education, work experience, work experience in the position, role in the team (Lim, 2018,

Liu et al., 2018, Lionel, Sangseok, 2018). Therefore, that kind of questions were also used. Team size and the profile of respondents are presented in Table 1.

Table 1.
Team size and the profile of the respondents

Measure	Frequency	Percent (%)
Team size		
Less than 4	48	14,29%
4-6 members	103	30,65%
7-9 members	68	20,24%
10-12 members	47	13,99%
13-15 members	36	10,71%
more than 15 members	30	8,93%
no answer	4	1,19%
Gender		
Male	277	82,44%
Female	51	15,18%
no answer	8	2,38%
Age		
Less than 20	7	2,08%
20-29	87	25,89%
30-39	121	36,01%
40-49	69	20,54%
50-59	18	5,36%
60 and more	5	1,49%
no answer	29	8,63%
Education*		
Student	37	11,01%
Bachelor IT Degree	130	38,69%
Bachelor non-IT Degree	52	15,48%
Master of Art IT Degree	109	32,44%
Master of Art non-IT Degree	72	21,43%
Undergraduate Degree	5	1,49%
MBA Degree	3	0,89%
Ph. D. Degree	2	0,60%
Work Experience		
Less than 1 year	24	7,14%
1-3 years	36	10,71%
4-6 years	54	16,07%
7-10 years	51	15,18%
11-15 years	73	21,73%
16-20 years	45	13,39%
21-25 years	20	5,95%
26-30 years	6	1,79%
More than 30	13	3,87%
no answer	14	4,17%
Work experience in the position		
Less than 1 year	97	28,87%
1-3 years	105	31,25%
4-10 years	94	27,98%
More than 4	25	7,44%
no answer	15	4,46%

Cont. table 1.

Role in the team*		
IT Developer / Programmer	160	47,62%
Leader/Manager	81	24,11%
IT Consultant	76	22,62%
IT Tester	72	21,43%
Project Manager	51	15,18%
IT Analytic	49	14,58%
IT Architect	41	12,20%
Product Owner	31	9,23%
DevOps	29	8,63%
Scrum master/ Agile Coach	18	5,36%
Graphic designer/UX designer	9	2,68%
IT Administrator	6	1,79%
Owner of the company	5	1,49%
Other/Administration post	4	1,19%

*Respondents could choose more than one answer.

Source: own work

Table 1 presents that 336 respondents took part in the research. They worked in IT sector. They were realizing technology project using ICT tools. The respondents in IT teams were chosen because in those teams virtual way of collaboration was the most popular.

After collecting the database, the answers were decoded from words into numbers. The data were imported to SPSS Imago Pro Software for statistical analysis (8.0 version). In SPSS frequent descriptions, descriptive statistics and Pearson correlation coefficient were used.

3. Results

To achieve the objectives of this study, statistical tools were used to analyze the data. All the data were imported to the statistical software system SPSS Imago Pro. The first step was to analyze the variable: knowledge sharing behaviors, as presented in Table 2.

Table 2.
Statistical characteristic of knowledge sharing behaviors (KSB) – frequency analysis

Item:	Min.	Max.	Median	Average	The standard deviation	Variance	Frequency
KSB1: I often participate in knowledge sharing activities in my team.	1	5	4	3,36	1,111	1,233	336
KSB2: I usually spend a lot of time conducting knowledge sharing activities in my team.	1	5	4	3,71	1,057	1,118	336
KSB3: I usually share my knowledge with other members of my team.	1	5	4	3,86	0,968	0,968	336

Source: own work.

As presented in Table 1, respondents` answers were from 1 to 5, the median was 4, the average was from 4,36 to 4,85, the standard deviation was from 0,968 to 1,111, and the variance was from 0,968 to 1,233. For all the items 336 answers were collected.

The next step was to identify the level of virtuality in teams. It was calculated basing on the answers to the question "to what extent do you communicate using ICT (from 0 to 100%)". The level of the virtuality in teams in this sample is presented in Table 3.

Table 3.
The level of the virtuality in virtual teams

The question	Level of virtuality	Frequency
	0-10%	27
	11-20%	40
	21-30%	44
To what extent do you	31-40%	44
communicate using ICT	41-50%	36
(from 0 to 100%)	51-60%	30
	61-70%	30
	71-80%	29
	81-90%	32
	91-100%	24
	Sum:	336

Source: own work.

As Table 3 shows, the level of virtuality across the virtual teams is diverse. Based on that, it is possible to see that the sample is heterogeneous and proves that team respondents with both low and high level of virtuality took part in the research.

The next step was to achieve the objective, the correlations between the virtuality level and knowledge sharing behaviors, calculated by Pearson correlation. The results of the analyses are presented in Table 4.

Table 4.
Correlations between the level of the virtuality and knowledge sharing behaviors (KSB)

		KSB1	KSB2	KSB3	Virtuality (V)
KSB1: I often participate in knowledge sharing activities in my team.	Correlation	1	0,476**	0,404**	-0,024
	Significance		< 0,001	< 0,001	0,662
KSB2: I usually spend a lot of time conducting knowledge sharing activities in my team.	Correlation	0,476**	1	0,567**	0,015
	Significance	< 0,001		< 0,001	0,787
KSB3: I usually share my knowledge with other members of my team.	Correlation	0,404**	,567**	1	0,054
	Significance	< 0,001	< 0,001		0,319
The level of the virtuality (V)	Correlation	-0,024	0,015	0,054	1
	Significance	0,662	0,787	0,319	
	N	336	335	336	336

** Correlation of significance at the 0.01 level (two-sided).

Source: own work.

As presented in Table 4, the correlations between the components of knowledge sharing behaviors are statistically significant ($p<0,001$), and the correlations are strong (0,404**; 0,476**; 0,567**). However, there is no statistical evidence that the level of the virtuality in team is correlated with knowledge sharing behaviors. **Based on those results it is possible to claim that *H1: The level of team virtuality is correlated with knowledge sharing behaviors,* was not supported.**

The second objective was related to methods of project management in virtual teams. The hypothesis was as follows: *H2: Project management methods are correlated with knowledge sharing behaviors in virtual teams*. In order to verify the hypothesis, collecting the database was a necessary step. In the Table 5 the list of project management methods which respondents used is presented.

Table 5.
Types of projects management methods in virtual teams

Projects management methods	Frequency	Percentage of responses
1. Agile	171	28%
2. Scrum	135	22%
3. Kanban	89	15%
4. I do not know	80	13%
5. Waterfall	39	6%
6. Pair Programming	31	5%
7. Lean Management	26	4%
8. Prince2	18	3%
9. eXtreme Programming	15	2%
10. Others: (holocracy, spotyfy, Long Term Support)	6	1%
Sum	610*	100%

*Respondents could choose more than one answer

Source: own work.

In Table 5 different types of projects management methods in virtual teams are presented. The most popular were: Agile (28%), Scrum (22%) and Kanban (15%). Part of respondents ticked the answer "I do not know" (13%). The survey included the list of five methods of project management: Agile, Scrum, Kanban, Extreme programming and Lean. However, it was possible to add additional answer, which the respondents used a lot. They indicated also: Waterfall, Pair Programming, Prince2, eXtreme Programming, holocracy, spotyfy and Long Term Support. Large number of respondents picked more than one answer to the question about project management methods.

In Table 6 correlations between methods of project management and knowledge sharing behaviors (KSB) in virtual teams are presented. The results are diverse for each component of knowledge sharing behaviors, therefore, each of them will be described separately. For those relations statistical significance (*p-value),* the strength of the relationship and direction will be taken into account.

Table 6.

Correlations between project management methods and knowledge sharing behaviors (KSB) in virtual teams

		KSB1	KSB2	KSB3	PMM
KSB1: I often participate in knowledge sharing activities in my team.	Correlation	1	0,476**	0,404**	0,210**
	Significance		< 0,001	< 0,001	< 0,001
KSB2: I usually spend a lot of time conducting knowledge sharing activities in my team.	Correlation	0,476**	1	0,567**	0,104
	Significance	< 0,001		< 0,001	0,058
KSB3: I usually share my knowledge with other members of my team.	Correlation	0,404**	0,567**	1	0,118*
	Significance	< 0,001	< 0,001		< 0,031
Project management methods (PMM)	Correlation	0,210**	0,104	0,118*	1
	Significance	< 0,001	0,058	< 0,031	
	N	336	335	336	336

** Correlation of significance at the 0.01 level (two-sided).
* Correlation of significance at the 0.05 level (two-sided).

Source: own work.

As presented in Table 6, the first component of knowledge sharing behaviors "I often participate in knowledge sharing activities in my team" is correlated with project management methods. This correlation is statistically significant ($p < 0,001$). The direction of the correlation is positive, however, the strength of the relationship is low. The second component "I usually spend a lot of time conducting knowledge sharing activities in my team" is not correlated with knowledge sharing behaviors. The third component of knowledge sharing behaviors "I usually share my knowledge with other members of my team" is statistically significant. However, it is necessary to emphasize that the strength of the relationship is very low.

Taking into account the ambiguous results, **the second hypothesis *H2: Project management methods are correlated with knowledge sharing behaviors in virtual teams* was partly supported**. The part of relations between project management methods and knowledge sharing behavior were statistically significant, however, the strength of the relationship was low.

4. Discussion

Today knowledge sharing behaviors play a key role and constitute a significant mediator between perceptions of the value in team members' contributions and team effectiveness. Better understanding of the knowledge sharing behaviors can be valuable in competitive and rapidly changing business environment (Lin, Huang, 2020). The question about modern virtual team now is particularly evident (Liska, 2022). Moreover, the COVID-19 influenced the increase in virtual teams work (Chai, Park, 2022). Additionally, different project management methods were popularized. Therefore, the research of the extent to which the level of the

virtuality is correlated with knowledge sharing behaviors was formulated and presented in this paper.

To achieve the formulated objectives, empirical research was conducted. 336 respondents working in ICT virtual teams has filled out the survey. Basing on the statistical analyses, the first hypothesis *H1: The level of team virtuality is correlated with knowledge sharing behaviors,* was not supported, and the second *H2: Project management methods are correlated with knowledge sharing behaviors in virtual teams,* was partly supported. The results inspired to formulate theoretical and practical implications.

Focusing on the theoretical contribution, it is possible to see a deeper understanding of knowledge sharing behaviors in virtual teams. The earlier research, focused on factors influencing knowledge sharing behaviors in virtual communities, included rewards (Wang et al., 2022) knowledge sharing intention (Chen et al., 2009), knowledge sharing self-efficacy, commitment and trust (Chan et al, 2015). In some publications also symbolic convergence perspective (Wei-Tsong, Hui-Hsiang, 2019), perspectives of well-being and organizational behavior (Chumg et al., 2016) and network perspective (Deng, Guo, 2021) were used.

Based on the literature review, project management methods and knowledge sharing behaviors were analysed separately and there was no empirical research about relation between them. It shows that different aspects of knowledge sharing behaviors are explored but this topic has not been fully discovered yet.

To sum up, in the conducted research there was no evidence that the level of the virtuality is correlated with the knowledge sharing behaviors. It is very unlikely that the level of virtuality could determine knowledge sharing behaviors. Moreover, project management methods are correlated with knowledge sharing behaviors in virtual teams only partially and this relation is not so strong. Therefore, the conclusion which could be valuable is that the significant impact and antecedence of knowledge sharing behaviors should be looked for in other variables, by means of more complex models.

Practical implications will be presented as case studies, which makes it easier to implement conclusions to business practice. It could be convenient for the management to tell employees: 'We will come back to the offices because virtual work has a bad impact on the collaboration (knowledge sharing, effectiveness, etc.)'. However, the results of the research did not confirm that assumption. It is less probable that coming back to offices 'just fixes' collaboration and increases the level of knowledge sharing behaviors. In business practice virtuality is often 'blamed for' the failures in the organization. However, this study suggests that such an interpretation is an oversimplification. The world is more complex. Deeper insights are required into the relations and behaviors among team members.

Practical implication related to the project management methods would be clear. Different methods of project management could be helpful to create a good environment to share knowledge behaviors. However, it is not the crucial factor which could determine and guarantee knowledge sharing behaviors and consequently effectiveness. It is not easy for organizations,

it means that managers should look deeper into their teams. It is necessary to search for antecedence of knowledge sharing behaviors in different areas and different variables. Therefore, the results of this study provide some implications for practitioners who are interested in knowledge sharing within virtual teams.

Despite some theoretical and practical contributions, the study has some limitations. Firstly, it is necessary to stress that the research was conducted in information technology sector. It could have an impact on the results. For the members in such teams, it is not unusual to use ICT tools to collaborate. Videoconferences, asynchronous communication is more common and the level of ICT skills is different from teams in other sectors. The generalization of the results need to be seen with caution but research tools can be adapted to other sectors.

The second limitation is related to the methodology. In this research, knowledge sharing scale (Xue et al., 2011) was used. As the researchers showed (Oliveira et. al., 2015) using different knowledge sharing behaviors scales had no effect on the results, however, it is unknown if using different scales in those research would give the same results. The third limitation is related to geographical and cultural aspects. The respondents have worked in European IT companies. It is possible that respondents from global virtual teams would deliver different results because of different time zones, more asynchronous communication and culture differences.

Future research should also be recommended. However, perhaps firstly it could be valueable to describe the assumptions about this research, that were established before the results have been known. The scientist literature presents only some piecemeal data about significance of virtuality. On the other hand, in daily practice, there is the overall belief about the impact of the virtuality and methods of project management on the collaboration and knowledge sharing behaviors. Therefore, for the research two steps were established. The first was to verify the correlation between variables and secondly, to establish the direction of their impact through using the technique of a structural equation modeling. However, as it turned out, in this research, only the first stage was reasonable. In reference to that and for the future research direction, it is worth to find other variables which could be correlated with knowledge sharing and verify which of them are truly significant and which of them are not. It would be relevant to conduct deeper analyses to check the correlation and also the directions of relations by using the technique of a structural equation modeling, which was not applicable in this research.

The achieved results also enabled to design recommendations on more complex future research and allowed for a more profound study of the knowledge sharing behaviors and virtual teams. Research models including not only variables like knowledge sharing self-efficacy, commitment, trust (Chang et al., 2015), team climate (Xue et al., 2011) competences and leadership (Maduka et al., 2018) artificial intelligence (Olan et al., 2022) but also others variables could be valuable as the future research. Especially as there are many unknows about knowledge sharing behaviors and virtual teams that still need to be explored.

5. Summary

As the researchers underlined, only a few studies have explored knowledge sharing in a virtual context (Wang et al., 2022). Moreover, working in virtual teams has become daily practice and way of collaboration because of COVID-19. Therefore, this study could help to bridge the gap. Summarizing the study, it is worth to remind that the evidence that the level of virtuality is correlated with knowledge sharing behaviors has not been found. That was an unexpected finding because it is commonly believed that it influences the knowledge sharing behaviors and collaboration in virtual teams. The methods of project management are correlated with knowledge sharing behaviors only partially and the relation is weak. This paper suggests that assumptions concerning the virtual work and sharing knowledge behaviors could largely be an oversimplification. This conclusion is coherent with the statement that 'the world is no flat' (Kramer et al., 2017) and the reality is more complexed. Therefore, it is necessary to acquire deeper knowledge about them and different dimensions of virtual teams should be explored, what could be valueable for researchers as well as managers in organizations.

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