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Project knowledge sharing mechanisms – an exploratory analysis

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Abstract: Knowledge is a key asset of companies; therefore knowledge sharing is vitally important. Knowledge sharing is no less important for project-oriented organisations; project team members often come from different departments and knowledge sharing enables them to work more efficiently. Although there is no doubt about the importance of knowledge sharing mechanisms (KSMs) and a number of tools and techniques for project knowledge sharing are available, to the best of our knowledge there is little information on the real use of such tools and factors affecting them. Therefore, the main goal of this paper is to empirically examine KSMs in projects, and through the exploratory analysis, to identify possible factors associated with KSMs as well as to outline the key areas where future research might help to improve knowledge sharing in projects. The results of this study shall contribute to better understanding knowledge sharing mechanisms and their functioning in project-oriented companies.

Keywords: project knowledge; knowledge sharing mechanisms; project management; knowledge management; project manager; exploratory study; knowledge sharing.

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1 Introduction

A growing number of companies use temporary forms of organisations (such as projects) to deliver change across a variety of industries (van Waveren et al., 2017). Project knowledge management (PKM) is an interconnection of project management and knowledge management (Ranf and Herman, 2018) and is widely accepted as an essential factor influencing the competitive advantage of these project-based firms (Anbari et al., 2008; Sense, 2008; Bakker et al., 2011).

Project-based learning comprises the creation and acquisition of knowledge within projects, and also the codification and transfer of this knowledge across project boundaries (Bakker et al., 2011). In project-based organisations, this type of learning is considered as a critical performance driver, because previous projects offer potentially valuable experience that can be applied in similar projects in the future (van Waveren et al., 2017).

Critical knowledge often resides in the minds of employees and is not always readily available to those who need it. Accordingly, organisations need to seek effective mechanisms for encouraging their employees to engage in knowledge sharing (Lin and Lo, 2015). Organisations are thus concerned with how experience can be transferred more efficiently and quickly, and also how to capture and document valuable experience so that it can be later reused (Du Plessis, 2005).

In order to make knowledge sharing more effective or sometimes even possible, it is important to study different KSMs which can be used to facilitate the transfer of knowledge across projects. Some of these mechanisms make use of information and communication technologies, others are more people-oriented with personal communication as the key feature.

For the correct functioning of KSMs in projects, it is crucial to know which factors may influence their application. This is essential during planning and implementation of such tools in companies. Many empirical studies provide recommendations for further research. Some of them call for future research to investigate the appropriate matching of

specific mechanisms and their clusters/groups and their characteristics to the needs of specific characteristics of projects (van Waveren et al., 2017) and project managers. Therefore, the goal of this article is to empirically examine KSMs in projects, and through the exploratory analysis, to identify possible factors that are associated with KSMs and outline the key areas where future research might help to improve knowledge sharing in projects.

1.1 Project knowledge management

Project knowledge management is widely accepted as an essential factor influencing the competitive advantage of project-based firms (Anbari et al., 2008; Sense, 2008; Bakker et al., 2011). Considering the importance of knowledge management for the project success, it is only natural that project knowledge management has developed its own line of research (e.g., van Donk and Riezebos, 2005; Ren et al., 2018). Project-based learning comprises the creation and acquisition of knowledge within projects, and also the codification and transfer of this knowledge across project boundaries (Bakker et al., 2011). In project-based organisations, this type of learning is considered as a critical performance driver, because previous projects offer potentially valuable experience that can be applied in similar projects in the future (van Waveren et al., 2017). The speed and accuracy of knowledge sharing in the project team influences significantly the success of the project (Graham, 2019). Moreover, knowledge sharing is positively related to project portfolio success (Jiao et al., 2020). Organisations are therefore concerned with how experience can be transferred more efficiently and quickly, and also how to capture and document valuable experience so that it can be later reused (Du Plessis, 2005).

To keep pace with the fast-changing world, an increasing number of organisations use projects to carry out their activities (Bakker et al., 2011; Rose, 2013) in a variety of industries. Projects are by definition temporary and unique structures characterised by instability of personnel ties and constellations, temporality of workload, limited possibility of applying repeated procedures (routines), increased focus on short-term goals and multi-disciplinary interconnections among internal and external experts. They are often carried out outside standard hierarchical organisational arrangements. Thus, organisations, their structures and processes are becoming more and more fragmented. Boundaries are erected between the permanent part of the organisation and temporary projects as well as between projects (Gann and Salter, 2000; Disterer, 2002). This creates barriers to the transfer of knowledge between projects.

The specificity of the project environment poses unique challenges to learning and knowledge accumulation (Landaeta, 2008; Bakker et al., 2011; van Waveren et al., 2017). The typical emphasis on time-bound deliverables in projects (Boh, 2007) goes against the focus on investment in long-term project competencies, which support long-term competitiveness (Anbari et al., 2008).

Projects often have problems in transferring knowledge during project execution to other projects or the parent organisation (Bakker et al., 2011; Love et al., 2015). Implementation of knowledge sharing frameworks in project-based organisations often fails due to numerous challenges and obstacles (Haass and Azizi, 2020). Project knowledge management experiences a so-called learning paradox (Bakker et al., 2011; Hartmann and Dorée, 2014). On the one hand, projects are ideal for knowledge creation. Project teams are often multidisciplinary, which enhances creativity and problem solving (Lampel et al., 2008). Due to disciplinarity and temporality, projects are perceived as

suitable organisational units for stimulating organisational learning and knowledge creation (Gann and Salter, 2000; Hobday, 2000; Grabher, 2004; Scarbrough et al., 2004). On the other hand, their temporality and the resulting discontinuities prevent the effective transfer and sharing of knowledge with other parts of the organisation such as projects (Bresnen et al., 2003; Swan et al., 2010). Within the project environment, teams are usually disbanded after project completion, and team members often start working on a new project without timely and effective knowledge transfer (Ren et al., 2018). The problem caused by the learning paradox has been recognised in both the academic and the practitioner literature (van Waveren et al., 2017). This might be the reason why only a few firms have established supporting procedures, processes, mechanisms, routines, and norms needed to systematically manage the project knowledge and transfer it to other projects or the parent organisation (Sense, 2007; Mainga, 2017).

1.2 Project knowledge sharing mechanisms

Gasik (2011) makes a distinction between knowledge sharing and knowledge transfer. Van Waveren et al. (2017) define knowledge transfer as the process of sharing, integrating, interpreting and applying knowledge.

Knowledge sharing is an act of the knowledge provider making knowledge available to others (Wickramasinghe and Widyaratne, 2012). Some authors (Davenport, 1997) identified knowledge sharing as a (solely) voluntary act, where the term ‘sharing’ implies that the provider voluntarily presents knowledge in a form that can be used by others, which involves some conscious action on the part of the provider who possesses the knowledge and actively participates in the sharing process even though there is no obligation to do so. Others (Teng and Song, 2011) define knowledge sharing as an act that can be either solicited or voluntary, where solicited knowledge sharing means making (and receiving) requests for knowledge and fulfilment of these requests.

From literature, and in the context of projects, we can define KSMS as means (both formal and informal) that facilitate sharing knowledge embedded in individuals and groups of individuals that will improve the performance of project tasks (van Waveren et al., 2017).

To facilitate knowledge sharing among projects, Boh (2007) introduces a framework for KSMS, based on two main dimensions: codification versus personalisation, and individualisation versus institutionalisation. The interaction between these two dimensions allows the analysis of different types of KSMS to be used to share different types of knowledge.

There are many varied mechanisms identified in literature, used for knowledge transfer. Van Waveren et al. (2017) conducted extensive literature review and identified 59 individual KSMS and clustered them into five classes with specific characteristics. Some of the commonly used KSMS include a long list of individual tools and techniques: brainstorming, collaborative problem solving (Berends et al., 2006), teamwork, storytelling, training, informal chatting, meetings (Boh, 2007; Wickramasinghe and Widyaratne, 2012), project reviews (Kashif and Kelly, 2013), lessons learned, debriefing, or communities of practice (Prencipe and Tell, 2001). These are supplemented with and facilitated by the use of IT-based tools and techniques: e-mail, phone, intranet, audio conference, instant (text) message, web-based (video) conference, groupware or group collaboration software, pagers, wiki or blog (Lee-Partridge and Snyder, 2012).

The right mix of KSMs is dependent on a number of factors such as the type of knowledge shared (Chai et al., 2003), different organisational level (Prencipe and Tell, 2001), or particular type of situation (Lee-Partridge and Snyder, 2012). Burgess (2005) divides the factors into the following groups: individual factors, inter-individual factors, relational factors, group-level factors and organisational-level factors.

1.3 Factors influencing project knowledge sharing

Since critical knowledge often resides in the minds of employees, project managers themselves are another relevant part of the equation. They have the potential to facilitate knowledge sharing and the use of a particular set of KSMs because they act as direct connections between project units and parent organisations (Wiewiora et al., 2009). They play a vital role in capturing and transferring knowledge (Moud and Abbasnejad, 2012). The project manager can improve knowledge transfer by increasing the social communication between team members (Wiewiora et al., 2009), through creating a suitable environment for sharing knowledge (Nonaka and Takeuchi, 1995, in Naftanaila, 2010) or by using standard methods for transferring knowledge (Hanisch et al., 2009).

Also, the characteristics of the project manager can influence knowledge transfer. Experience is an important variable in project- and knowledge-related research (Laanti et al., 2011). Wiewiora et al. (2009) found that less experienced project managers are less willing to share knowledge.

There are numerous studies recognising the project nature as an important factor (Abbasnejad et al., 2012). The temporality of projects is a factor usually negatively affecting knowledge transfer. The temporary nature of projects causes communication challenges and leads to the fragmentation of project knowledge (Zhao et al., 2015). Also with increasing uniqueness of project, teams are less likely to learn from one another (Abbasnejad et al., 2012). As for urgency, the results of previous studies are ambiguous. On the one hand, limited time motivates project team to seek knowledge from other teams; on the other hand, it raises difficulties in knowledge sharing (Zhao et al., 2015; Newell et al., 2006; Conelly et al., 2009; Ren et al., 2018). Other studies mention ambiguity (Mehta et al., 2014) or one-off characteristics of projects (Scarborough et al., 2004) as factors influencing project transfer. Particular project characteristics come into play with Ahonen et al. (2015), who mention the project duration and the number of project team members as relevant factors.

Another important group of factors affecting knowledge transfer is the quality of external environment and relationships with external stakeholders (Lee and Choi, 2003). Yan and Dooley (2013) and Sakka et al. (2016) focus on buyer-supplier relationships, which seem particularly important in the context of project management. Guofeng et al. (2020) point out the influence of the type of contract existing between individual stakeholders. Stock et al. (2021) notes the importance of coping with uncertainty in the context of knowledge sharing.

Literature search clearly suggests that:

- 1 knowledge sharing is an important factor in the success of projects
- 2 the availability of several different KSMs and the richness of these mechanisms influence the effectiveness of knowledge sharing behaviour (Wickramasinghe and Widyaratne, 2012)

- 3 the use of the specific KSMS depends on various factors existing at the levels of external environment, organisation and individual (project manager).

Therefore, our goal is to identify possible factors that are associated with the application of project KSMS by project managers.

1.4 Research questions

Based on the literature search conducted, the main research question is:

- RQ1 Which (selected) characteristics are associated with the use of various project knowledge sharing mechanisms?

Three areas of selected characteristics are examined: project characteristics, project manager's characteristics, and (project) external environment characteristics. We have developed particular measures for the purpose of their examination.

2 Research method

2.1 Development of measures

The examination of all or most mechanisms identified in literature would exceed the scope of this exploratory study. Therefore, we selected those mechanisms where the project manager's influence on the degree and manner of their use may be assumed. It was the project managers that were the target group of this survey. The focus was on tools which do not require a system or company-wide solution, their one-time application is possible, and they do not need cooperation with other departments. Operationalisation of PKM mechanisms is in Table 1.

Table 1 Operationalisation of PKM mechanisms

<i>Construct</i>	<i>Items</i>	<i>Adapted from</i>
PKM mechanisms	Meeting minutes	Prencipe and Tell (2001), Boh, (2007) and van Waveren et al. (2017)
	Meetings on specific issues (ad hoc meetings)	
	Lessons learned log	
	Group analysis of a recent crisis situation (debriefing)	
	Inter-project meetings (with other project teams)	
	Project review	
	Brainstorming	
	Project manager's daily log	
	Storytelling (workshops)	
Case writing – e.g., on the company blog		

We focused on those characteristics of project managers that describe their experience and skills (operationalisation details are in Table 2). Experience is expressed as the length of work as a project manager and the number of projects managed in the past. The formal certification in accordance with the most common comprehensive project management standards was used as a proxy measure of project management skills.

Table 2 Operationalisation of project manager's (PM) characteristics

<i>Construct</i>	<i>Items</i>	<i>Adapted from</i>
Individual characteristics of PM	Number of (completed) managed projects as a PM Number of years managing projects (current employer) Number of years managing projects (total) Number of projects managed in the past 3 years PM certifications (PRINCE2, IPMA, PMI)	Ahonen et al. (2015)

The next category includes those characteristics that are related to projects. The definitions of project size and project complexity have, at times, been hard to discern as project complexity is sometimes based on the size of the project; others strictly distinguish between the size and complexity of projects (Dunović et al., 2014). Project size may be based on the dollar value of the project, the number of people in the project team or the number of components comprising the final system (Martin et al., 2005). Dunović et al. (2014) developed a framework of project complexity which we adopted and used in our research. Since we are interested in knowledge sharing, and knowledge is often embedded in individuals, the number of project team members was chosen as the proxy measure of project size. Details are in Table 3.

Table 3 Operationalisation of project characteristics

<i>Construct</i>	<i>Items</i>	<i>Adapted from</i>
Project characteristics	Planned project length (months) Number of project team members Project complexity Product complexity (technological difficulty and uncertainty) Complexity of relations with the external environment (number of involved parties and measure of their potential conflicts) Complexity of finances (complicated budgeting, uncertain development of prices of outcomes) Complexity of legal aspects (complexity and uncertainty of legal environment, necessity and complexity of certification) Complexity of project organisation (number of entities, number of project team members, degree of correlation with external processes, number of contracts) Time planning complexity (quantity and correlation of activities, level of specialisation, capacity limitations)	Ahonen et al. (2015) and Dunović et al. (2014)

Environment is examined from the points of dynamics and hostility, following the example of earlier studies (Luo and Tan, 1998, Yan and Dooley, 2013). The complexity of the environment is already reflected in the project complexity. Operationalisation details are in Table 4.

Table 4 Operationalisation of (project) environmental characteristics

<i>Construct</i>	<i>Items</i>	<i>Adapted from</i>
Environmental characteristics (uncertainty)	Dynamics of relationships with customers	Luo and Tan (1998),
	Dynamics of relationship with suppliers	Stock et al. (2021),
	Dynamics of changes in the company	Yan and Dooley (2013) and Sakka et al. (2016)
	The level of competition in the environment	

The relationships between the variables were first examined individually. Subsequently, we created the INTENSITYSCORE variable, identifying the total intensity of using tools and techniques for the transfer of knowledge, and the ENVISCORE variable; the relationships between the total degree of using the tools and the overall characteristics of the environment were examined.

2.2 Sample and data collection

An initial version of the questionnaire was piloted with a sample of five project managers. The respondents were asked to answer all questions by following the instructions and to provide feedback and suggestions for improvement. A few minor modifications of the text were made based on the respondents' comments.

Our target population include people who currently work as project managers. We asked the project managers about their most recently completed project, following the example of earlier studies (e.g., Reich et al., 2012).

The sampling strategy was convenience sampling relying on personal contacts, the questions were distributed by the Regional Chamber of Commerce in Brno via e-mail with a link to the online questionnaire, and sent to online communities (LinkedIn, project management communities such as IPMA or PMI). The self-administered questionnaire was disseminated by e-mail and through on-site distribution. We asked the project managers about their most recently completed project, following the example of earlier studies (e.g., Reich et al., 2012). Follow-up letters and e-mails were sent and phone calls made during the next eight weeks. Of the 150 questionnaires returned, six responses were incomplete or were filled in during less than four minutes, which is the shortest possible time for completing the questionnaire according to the pilot study. The remaining 144 valid and complete questionnaires were used for the quantitative analysis, yielding a response rate of 20.57 %. Table 5 describes the characteristics of the sample.

Table 5 Characteristics of the respondents

<i>Characteristics of the respondents</i>	<i>Modus</i>	<i>Median</i>
How long have you worked as a PM (in years)?	10	9.5
Number of projects managed in the past 3 years	3	6
Number of finished projects with current employer	5	4

56.94 % of the respondents hold a project management certificate (Prince2, IPMA and Agile being the most frequent ones).

The respondents represented companies of different sizes (med = 101, mod = 50 employees) and industries and a variety of projects (in terms of project length, focus and size).

3 Results

Descriptive statistics for each variable can be found in Tables 6–8.

Table 6 Frequencies of occurrence of project knowledge management mechanisms

	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
INTERPERSONAL MEETING	41	32	35	20	16
STORYTELLING	96	23	20	1	4
PROJECT REVIEW	36	31	34	21	22
BRAINSTORMING	21	25	42	30	26
DEBRIEFING	37	34	38	21	14
ADHOC MEETING	4	14	39	46	41
LESSONS LEARNED	35	44	33	14	18
MEETING MINUTES	12	20	28	33	51
CASE WRITING	113	16	11	2	2
DAILY LOG	75	24	22	9	14

Table 7 Descriptive statistics of project knowledge sharing mechanisms

	<i>Min.</i>	<i>Median</i>	<i>Mean</i>	<i>Max.</i>
INTERPERSONAL MEETING	1.000	2.000	2.569	5.000
STORYTELLING	1.000	1.000	1.569	5.000
PROJECT REVIEW	1.000	3.000	2.736	5.000
BRAINSTORMING	1.000	3.000	3.104	5.000
DEBRIEFING	1.00	3.00	2.59	5.00
ADHOC MEETING	1.000	4.000	3.736	5.000
LESSONS LEARNED	1.000	2.000	2.556	5.000
MEETING MINUTES	1.000	4.000	3.632	5.000
CASE WRITING	1.000	1.000	1.361	5.000
DAILY LOG	1.000	1.000	2.049	5.000

Table 8 Descriptive statistics of INTENSITYSCORE, PROJSCORE and ENVISCORE

	<i>Min.</i>	<i>1st Qu.</i>	<i>Median</i>	<i>Mean</i>	<i>3rd Qu.</i>	<i>Max.</i>
INTENSITYSCORE = Intensity of using knowledge management mechanisms	12.0	21.0	25.5	25.9	30.0	50.0
PROJSCORE = project complexity	7.00	16.00	19.00	19.26	22.00	30.00
ENVISCORE = environmental uncertainty	4.00	10.00	12.00	12.15	14.00	20.00

3.1 Project manager's experience and tools used

At first, we focused on the correlation between the PM's experience and tools applied. With regard to the results, we also focused on correlations ranging from 0.15 to 0.2. Three of the four variables used for the measurement of the PM's experience show a correlation between greater experience and a higher degree of daily log use. Other tools whose degree of use is related to the PM's experience include case writing, post mortem meetings, ad hoc meetings, history files, and PM seminars. Project managers with the highest number of completed projects at the current employer probably use case writing more often. There is also a weak correlation ($r_s > 0.20$) between a higher number of managed projects and higher use of post mortem meetings.

The relationship between the INTENSITYSCORE variable (identifying the total intensity of using tools and techniques for the transfer of knowledge) and PM's experience (four variables) was subsequently examined. The results suggest that there is little relationship between these variables.

3.2 Project manager's certification and tools used

Another analysed area is the relationship between the PM's certification and tools used for knowledge transfer. If we generally look into the relationship between the intensity of using tools (INTENSITYSCORE) and the respective certifications, we can see a slightly positive correlation, except for the PMI certification, where the difference in the tool use is distinct. Details are in Table 9.

Table 9 Project manager's certification and tools used

	<i>PRINCE2 mean 0</i>	<i>PRINCE2 mean 1</i>	<i>Difference of means</i>
INTENSITYSCORE	25.72269	26.76	1.037311
	<i>IPMA mean 0</i>	<i>IPMA mean 1</i>	<i>Difference of means</i>
INTENSITYSCORE	25.69919	27.09524	1.396051
	<i>PMI mean 0</i>	<i>PMI mean 1</i>	<i>Difference of means</i>
INTENSITYSCORE	25.47445	34.28571	8.811262

If we focus on the use of the respective tools, managers with the PRINCE2 certification use daily logs and meeting minutes to a greater extent. IPMA certified managers also prefer meeting minutes but also reviews and debriefing. Project managers with the PMI certification use almost all knowledge sharing tools to a larger extent than the other two groups.

3.3 Project characteristics and tools used

As far as project characteristics are concerned, projects with longer duration make use of all the tools (positive correlation); the correlation coefficients, however, are low (very weak correlation, $r_s < 0.20$). Projects with larger teams more frequently use interpersonal meetings, ad hoc meetings, meeting minutes and daily logs.

3.4 External environment complexity and tools used

Another examined area was the complexity of the external environment, which was analysed as a whole (ENVISCORE) and individually. There is a positive correlation between the degree of overall complexity of the environment and the use of each knowledge sharing tool (weak correlation, $r_s = 0.33$); greater complexity probably leads to a higher use of the tools. If we consider the individual tools, a stronger relationship is apparent with storytelling, debriefing, and lessons learned (weak correlation, $r_s > 0.20$).

Higher customer dynamics is related to a greater use of lessons learned and meeting minutes (weak correlation, $r_s > 0.20$). Higher corporate dynamics then entails preference of interpersonal meetings, storytelling, brainstorming, debriefing, and lessons learned. A higher level of competition brings about a greater use of storytelling, daily log, and case writing.

Higher customer dynamics is related to taking meeting minutes more frequently; this is probably due to the customers' requirement for the documentation of negotiations or to the supplier protection in the case of potential changes in the customer entity.

3.4 Project complexity and tools used

The project complexity was examined as a whole (PROJSCORE) and also separately in the individual areas of the project complexity. There is a positive correlation between the overall complexity of the project and all the knowledge sharing tools (moderate correlation, $r_s = 0.40$); this suggests that higher project complexity most probably leads to a greater use of the tools. The following tools showed a positive correlation (weak correlation, $r_s > 0.20$): interpersonal meetings, brainstorming, debriefing, ad hoc meetings, lessons learned and meeting minutes.

There is a positive correlation between the project complexity (weak correlation, $r_s > 0.20$) and brainstorming, debriefing, ad hoc meetings, and lessons learned. A positive correlation is shown between the complexity of the project external environment and brainstorming and ad hoc meetings. Financial complexity of the project is related to brainstorming and debriefing; legal complexity is related to project reviews and lessons learned. Organisational complexity is positively related to interpersonal meetings, brainstorming and debriefing; the correlation is moderate ($r_s = 0.40$) with ad hoc meetings.

4 Discussion

Our first focus was the experience of a project manager. The results showed that the relationship between the PM's experience and degree of PKM tool use is positive, although not substantial. Earlier studies show that the PM's experience has an impact on knowledge sharing: Less experienced managers are afraid to share knowledge because they see the process as a threat to their future indispensability (Wiewiora et al., 2009). On the other hand, more experienced project managers have more confidence and tend to share their knowledge and experience, as shown by the above-mentioned study. It is possible that experienced managers use the PKM tools in a better and more elaborate way, albeit not significantly more frequently. This may be an explanation of the result of our study which proved a rather weak correlation between the PM's experience and

degree of the PKM tool use. According to the findings of the present study, higher experience of a project manager need not necessarily mean a higher degree of use of all the available tools and techniques but rather a careful selection of the time-tested ones. Case writing, in particular, is an interesting tool which is not part of the traditional project management methodologies and is often neglected; nevertheless, it apparently works as a highly effective method of knowledge transfer.

Project characteristics such as project duration and project team size are considered as relevant factors in project knowledge sharing. The present results show that it is the project team size rather than project duration that affect the use of PKM tools. In large projects, it is logical to utilise various types of meetings and also meeting minutes, which contributes to better informing the members of large teams.

As far as the complexity of the external environment is concerned, the results of our examination build on earlier studies which show that knowledge transfer in projects is affected by uncertainty (Mehta et al., 2014), which is a consequence of higher dynamics of the environment. The more complex the environment (containing greater uncertainty and dynamics), the higher the intensity of PKM tools used. The relationship between higher customer dynamics and meeting minutes seems logical, since the minutes often document an agreement on project changes reached during the meetings. Also knowledge sharing in the form of lessons learned is more frequent; it probably involves identification of various problems or risks connected with customers. In case the environment is more dynamic in the company, project managers tend to use more personal and ad hoc tools (storytelling, brainstorming and debriefing) and also use lessons learned more often. In case the level of competitiveness is higher, project managers tend to use more creative ways of knowledge sharing, such as storytelling and case writing.

The strongest correlation was proved between the use of PKM tools and project complexity. Earlier studies showed that certain project characteristics such as temporality, uniqueness, urgency, or limited time raise difficulties for the sharing of knowledge (Zhao et al., 2015; Abbasnejad et al., 2012). We extend these findings by showing that the more complex the project, the more often project managers use PKM tools, both oral and written. The correlation between organisational complexity of the project and use of personal meetings seems logical: more complex projects involve larger project teams and more stakeholders; enhanced transfer of knowledge is therefore essential. On the contrary, complexity in the legal area, involving more complex contracts and a larger number of project entities correlates with a greater use of written tools, project reviews and lessons learned. This testifies to a greater demand for documentation for the purposes of the legal aspects of the project.

5 Strengths and limitations

As we know, our study is the first to investigate the multiple factors that influence the use of techniques that support project knowledge sharing by project managers. Including different factors in the same study allows not only to assess the relevance of these factors, but also to compare their importance.

As our study is the first such comprehensive study on factors influencing project knowledge sharing techniques, we had to create new questionnaire for data collection. The advantage of our study is that the questionnaire we developed and piloted is available

for further research. The limitation is that we used method that have not yet been validated and for which there is no independent evidence of its reliability and validity.

We consider the strength of our study to be that it uses a homogeneous and well-described sample of project managers from one region of the Czech Republic who were approached through a respected institution (Regional Chamber of Commerce). However, our sample is also a limitation of the study. Further replications on other specific samples from other regions across various countries would be beneficial to generalise our results on the global population of project managers. Although Regional Chamber of Commerce contacted a representative sample of project managers operating in the selected region, the resulting sample might be affected by self-selection. For a clearer picture of the use of each technique, a different sampling procedure might be used in future research.

Our study was exploratory in nature and it performed a series of independent analyses on the same dataset. Therefore, it is possible that some significant results are false positives. Our study has shown which factors make sense to focus on in future investigation. However, these further investigations are needed for a clear conclusion regarding the significance of the different factors influencing the use of project know-how sharing techniques by project managers.

6 Conclusions

Knowledge transfer is one of the key factors influencing competitiveness of companies in this turbulent period. This is even more pronounced in project-based organisations, where relevant knowledge and information need to be available to subsequent projects (van Donk and Riezebos, 2005). The different nature of project management from day-to-day business of a company is often identified as a reason why knowledge sharing in projects is more complex and at the same time more important. According to Bresnen et al. (2003), it is the temporary nature and complex organisation of projects that complicates the transfer of knowledge across projects. The process of knowledge transfer is lacking natural learning mechanisms (Boh, 2007). Project work often leads to knowledge fragmentation (Kasvi et al., 2003).

The goal of this paper was to reveal interesting relationships between the use of project knowledge management tools and other project management variables through exploratory research. The results of our study offer possibilities for further research in a number of ways. As our study proved only weak correlation between the PM's experience and degree of the PKM tool use, questions remain to be answered why exactly this is and how differently (un)experienced managers use their PKM tools.

Some methodological limitations of our study also provide for the opportunity for more detailed examination of the relationship between the respective characteristics and application of project knowledge management tools. Also, some of our results make questions relating to assessing the efficiency of such tools in project knowledge management and interesting and important area for further research.

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