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THE EXPERT IS LEAVING—THE KNOWLEDGE IS LOST? DLR'S KNOWLEDGE MANAGEMENT SOLUTIONS FOR THE LEAVING EXPERT ISSUE

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Since four years the German Aerospace Centre (DLR, Deutsches Zentrum für Luft- und Raumfahrt) reorganizes its knowledge management processes. In the project "Establishing an integrated knowledge management system" (EIWis) critical knowledge gaps become identified. By asking the employees in a survey about knowledge management a main problem was clearly identified: the leaving expert issue. There are various situations why experts are leaving. In an academic environment like DLR, for instance, doctoral students leave after graduation. But leaving employees always leave with the knowledge they have achieved. Each case means a specific relationship between the expert and the organization, while the expert is leaving and after departure. This shows the necessity for different approaches for knowledge sharing. A comprehensive knowledge perspective can help to avoid problems when an expert is leaving, but cannot replace the engagement with the subject. Together with the human resources department EIWis developed a transfer process for leaving employees. After intensive testing three main components were chosen for the knowledge transfer at DLR: Expert Debriefing, Story Telling and the Computer-based Knowledge Transfer. In addition, a Lessons Learned research project at DLR debriefs project members about their experiences in multidisciplinary projects. The results indicate relevant circumstances and actions that support knowledge transfer through collaboration. An overview of the different approaches for knowledge transfer when experts are leaving will be given.
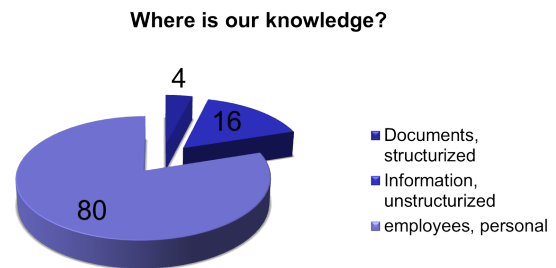
I. INTRODUCTION

In spite of all our modern technology like mobile devices, databases and computer networks, most of the knowledge of an organization is stored in people's heads. A research study of the Giga Information Group had the result that in organizations only 20% of knowledge was turned into written information and made accessible for anybody in the organization (Fig. I).

These facts won't bother many employees in their workaday life, but become critical for the organization when an expert is leaving. If there is no follower or the follower has not equivalent skills or time to work with the predecessor, a damage for the organization is obvious. This could mean the loss of information, knowledge and expertise. It may result in lost skills for the whole organization. Critical knowledge gaps will be the result, if no knowledge got transferred in advance. Any forgotten knowledge is a waste of time and money, which must be avoided. Besides, all employees need to be prevented

Where is our knowledge?

Giga Information Group KM Study 2002

Figure I: Organizational knowledge location [1].

from doing any redundant work that has already been done by someone else.

A short-term solution is to hire the leaving expert for a certain period again. But this is not always possible and often expensive.

To prevent disaster, organizations have to cope with the fact of leaving experts and to organize a knowledge transfer. More than that, they should understand how

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knowledge is transferred in their subdivisions, projects and directly between people. The people who are working together must be aware, that their knowledge and their products will be important for others in the future. The tacit knowledge has to be found and made explicit and usable for others.

With the EIWis project, DLR started to reorganize its knowledge management processes [2].

II. PROJECT EIWis

The project to establish an integrated knowledge management system at DLR (EIWis, Fig. II) was launched by a decision of the advisory board in April 2011, after a community of knowledge-management-interested employees wrote down many hints for developing and improving the knowledge processes at DLR into a pre-concept. Through a survey among all employees, seven actions were chosen to build up a knowledge management system:

- Knowledge sharing meetings
- The People's directory
- An Optimized search function
- The DLR.Wiki
- The Project Database
- The new introducing process for new employees
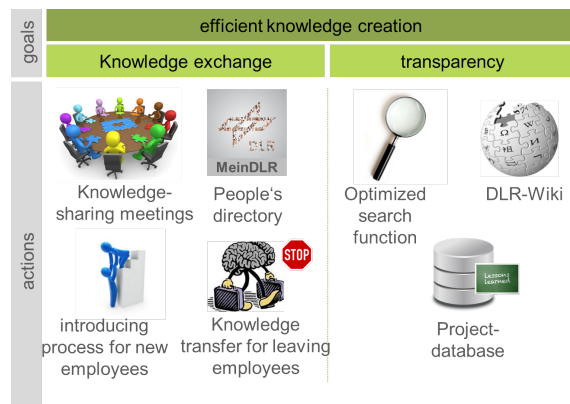- The Knowledge transfer for leaving employees

Figure II: EIWis concept.

The most recent EIWis action is the Project Database, which is currently being implemented. It is planned to finish EIWis by the end of 2015. The Knowledge Transfer for leaving employees will be described in the following abstract.

III. KNOWLEDGE TRANSFER FOR LEAVING EMPLOYEES

Leaving employees always leave with the knowledge they have achieved. Together with human resources EIWis developed a transfer process for leaving employees

who are willing to transfer their knowledge. Of course, if there are enough resources, the easiest way is to let the predecessor and the follower work together for a certain time. But then there will be mostly a transfer of tacit knowledge. Due to the fact, that very often the follower arrives too late for a personal knowledge exchange with the predecessor, we concentrated on ways to transfer the tacit knowledge into explicit knowledge.

The personality of the employee who is being debriefed, is an important fact. Therefore, the knowledge transfer is always individual. Some employees like to tell a lot from their own perspective and don't like a moderator who is frequently asking questions. Others like to have an interview, where a moderator can lead the direction of the talk. In special cases it may be even better if the employee is writing down everything on his own.

All approaches have the same goal: to find out the relevant knowledge to enhance existing projects and to help others in the future. Therefore, we try first to find out the highlights of a person's work life at DLR. This can be successful projects, tasks or events etc.

For each highlight, we identify important facts, e.g.:

- Goals
- Participants
- Agenda / sub-tasks
- Knowledge sources
- Necessary competencies (including social competencies)
- Success factors
- Best practices
- Barriers
- Lessons learned

III.I Expert Debriefing

The Expert Debriefing in our knowledge transfer is based on structured information. The goal is to open the field of a person's knowledge and get a good overview about the knowledge that will be relevant for the follower and the organization. Also the way of thinking is an important knowledge and should be transferred.

After a pre talk we draw a knowledge map (Fig. III) about all parts of the expert's work and the highlights. The first level of the job map is based on the work history, expertise, tasks and functions, personal network, storage location for digital data and and Lessons Learned of the expert.

After that we look at the job map and together with the expert we identify fields where to go deeper. Also we try to identify transfer tools beside the interview which can help to capture the knowledge better. Typical tools can be moderated transfer talks, social network diagrams, building document/ data storage libraries or podcasts.

Finally, we end with the reflection of the process. Expert and supervisor can reflect each part of the process and give hints to improve it.

Figure III: Debriefing Job Map.

III.II Computer Based Approach

An expert debriefing is normally dependent on the moderator, who costs time and money. If there is enough time and the leaving expert is willing to write down a work diary by himself, the computer based approach for knowledge transfer can be very helpful. However, the circumstances have to suit for this approach: There has to be an efficient, easy-to-use tool that helps to transfer the knowledge. The leaving expert has to be willing to use the tool, and colleagues need to know where they can find the knowledge. Besides, we found out that a minimum of two years before the expert is leaving is necessary to collect enough relevant knowledge for later. Because the leaving expert is mostly working on her own, self-discipline is necessary to keep the knowledge transfer ongoing.

We used our DLR.Wiki [2] as a tool for the computer based approach for knowledge transfer because the user rights can be defined for a group or division and, thus, the knowledge can selectively be made accessible. With good templates, the knowledge transfer is made as easy as possible. Sometimes the transfer process helps even the leaving expert, because with everything in a good order, the daily work can be made faster. E.g. the links to other documents can be found easier, if you have them on the right place. Day by day and week by week, the knowledge book gets bigger. In the end a good summary of the workplace for a follower or the colleagues will be the result, which we call knowledge book (Fig. IV). Every employee can open his own personal knowledge

book with a template and can start to write down his tacit knowledge, even if he is not regarded as an expert. The earlier people start to write down what they know, the better. It does not matter if they are leaving or not.
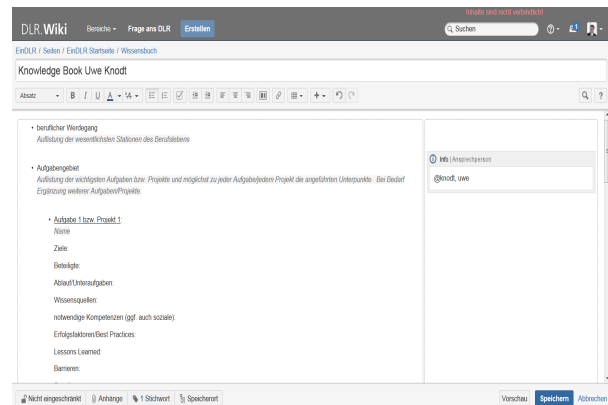

Figure IV: Knowledge Book.

However, the computer based approach did not work for us at all. Most common problem was that the knowledge transfer was not regarded as very important and every day problems were rated higher. Before the transfer process starts, it has to be found out if the expert is disciplined enough to fill the knowledge book constantly on his own and that colleagues and supervisors have a look at the knowledge book from time to time.

III.III Story Telling

Some people do not like interviews, debriefings or computer-based knowledge books. But often they like to share their knowledge on their own rules. Their preferred method to share their expertise often is to tell their stories, and the knowledge transfer is done by listening and writing down what is told.

Story Telling is a narrative approach, which means that the result is not clear and should be left open. The goal is to open dialog rooms, e.g. by the use of systematic question techniques and in that way to initiate a knowledge flow. Besides, there is always a focus on the personal reflection. The goal is not to have a complete documentation in the end.

What is the advantage? Through stories told by the experts, the knowledge that is hard to capture or to ask about becomes visible. Therefore questions have to be stated in a special technique to let the expert tell on his own but to direct the story telling into the right direction. In this manner, the tacit knowledge about relevant business processes can be filtered and made transferable. It is helpful to have consultants in the first knowledge transfers who know how to use the question techniques and to transfer the relevant knowledge.

IV. IMPLEMENTATION AND FIRST RESULTS

In a first step, the expert has to be identified by his supervisor for a knowledge transfer. Each supervisor can book knowledge transfer for his co-workers from our Human Resources (HR) department. As a product of our human resources department a process routine was created to describe the steps of the knowledge transfer. Each human resources developer is able to consult their customers about the knowledge transfer process and, if applicable, start the knowledge transfer according to the needs that have been identified. In the consulting phase, the HR developer can identify, if expert debriefing, story telling or even the computer based approach should be the right action. Our HR consulting partners for expert debriefing and story telling moderate the transfer actions.

We started the knowledge transfer in January 2015 and got many requests for it from the institutes. It is too early to state the results, but the feedback of the institutes who took part was very positive. For us it is clear, that the actions for knowledge transfer are effective and that they create value for DLR. We found a way to keep knowledge in the organization, even if experts are leaving.

In addition, we found out that the debriefing techniques are also useful for project debriefings. When a project is done, Lessons Learned and relevant findings have to be captured. Story Telling and Expert Debriefing were a good approach in several debriefing to get the relevant knowledge from a project.

V. KNOWLEDGE TRANSFER TROUGH COLLABORATION

V.I Lessons Learned Studies

Currently, we are piloting an extended lessons learned interview method for several interdisciplinary DLR projects with the aim to uncover patterns of collaboration among project members with different disciplinary backgrounds [3]. This study was motivated by project leaders who have observed communication to be often poor across disciplinary boundaries—their observation has been largely confirmed subsequently with the interview data. Here, we will summarize the lessons learned studies and take a new look with a focus on pathways of knowledge transfer.

Background

The German Aerospace Center, DLR, covers a large scope of engineering disciplines in the fields of space, aviation, and transportation. Thus, DLR projects often cover many disciplines, and teams are put together from members of several different institutes for the duration of the project. It is typical that team members are not collocated and are often involved part-time in several projects. This makes it particularly challenging to truly work in-terdisciplinary beyond just compiling the results from the different disciplines. We address this issue with an extended lessons learned study. We perform interviews concerning the nature of collaboration in distributed multidisciplinary projects at DLR. Interviews are conducted with members of twelve project teams, with a particular focus on four projects. The interviews cover (i) standard questions about the course of the project (i.e., debriefings); (ii) explicit discussion of the collaboration structure; and (iii) perceived satisfaction with the project work.

Method

The extended lessons learned studies are based on semi-structured interviews in which we ask participants about their experiences in interdisciplinary projects [3]. Semi-structured means that we use a questionnaire with a pre-defined set of questions, but the interviewer is free to change the sequence of and to ask additional questions, as it appears appropriate during an interview. We performed two rounds of extended Lessons Learned studies, Study 1 and Study 2. Compared to regular debriefings approaches that focus on the course of a project [4], the extensions include questions that particularly aim at collaboration and personal experiences. Some questions are designed to require scaled and tabular responses, examples for which are shown in Figure V. The questionnaire for the second study was improved based on the evaluation of the first study—core details and differences are shown in Table I.
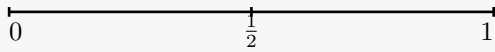
Participants

For data collection we complied with the German ethics guidelines for psychological research with human subjects [5], including obtaining informed consent from the interviewees. Identifying personal information is omitted from this report, for instance, participants and projects are, respectively, referred to by numbers and letters. In total 20 participants, several of whom reported on more than one projects, contributed twenty-six data sets about twelve projects A–L. We interviewed six participants about four projects A–D in Study 1 and additional 14 participants about eleven projects B–L in Study 2. The numbers of interview data per project and in sum ($\sum$) are shown in Table II for each study and in total.

Because this research is still in a piloting phase, it is important to note two facts about the data samples. Firstly, the data is obtained from two related but different Studies (Study 1 was necessary in order to improve the questionnaire for Study 2). Secondly, sample sizes per project are very low. For the data analysis we will combine statistical measurements with anecdotal evidence from the verbal report. At this stage, the data may provide mostly valuable hints for future investigations.

3.6 Plase rate the relvance of the following experiences for your contribution:

    (a) technical expertise

    (b) understanding of other disciplines

    (c) communication and social interaction

    (d) other: _____

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|----------------|----------------|
0                1/2              1
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3.7 What are the sources of your relevant qualifications or experiences [✓]?

source / qualification from question 3.6	(a)	(b)	(c)	(d)
university:				
advanced training:				
mentors:				
"on the job":				
teaching:				
other:				

Figure V: Examples of questions with non-verbal responses, "scale" and "table", as used in the most recent version of the questionnaire—shown are translations from German of question 3.6 and 3.7. Background shading is included to distinguish the questionnaire snapshot from the current text. Reproduced from [3] with permission from IOS Press.

Preliminary Data Analysis

Projects A through D were in focus of both Studies. The personal and team overall satisfaction with the course of the project was reported on a scale (similar to the example of question 3.6 in Fig. V). The satisfaction measures showed similar patterns for both Studies [3]. For simplicity, here the data from both interview series is combined and shown in Figure VI. Satisfaction rates increased from project A to C, from very low to very good. In comparison, Project D has an average satisfaction rate.

Familiarity

It is worth noting that A, B, and C are consecutive and about half of the respective project members participated in all three projects. Similarly to Project C, Project D also has preceding projects, trough which members know one aborter and are already familiar to a large extend with task and goals of the project. Familiarity, due to longer-

	Study 1	Study 2
Context:		

Context:

- project key factors
- personal involvement

- participant's background

Project Progress:

- preceding projects
- subsequent projects
- achievement of goals
- yes/no: events with impact

- scaled: jeopardy levels for events with impact

Collaboration:

- team satisfaction
- shared experiences
- required skills
- communication
- interdisciplinary level

- tabulated: interaction frequencies across disciplines
- tabulated: interaction frequencies across locations

Personal Experience:

- level of expertise
- core skills
- source of skills

- motivation sources
- tabulated: core skills versus their sources

Resume:

- what was good
- what was not good
- what was learned

Table I: Core topics of the interview Sections (underliend) for both Studies; For Study 2 only additions or changes are shown.

Project	A	B	C	D	E	F	G	H	I	J	K	L	$\sum$
Study 1	2	5	3	1	0	0	0	0	0	0	0	0	11
Study 2	0	2	1	3	1	1	1	1	2	1	1	1	15
Total	2	7	4	4	1	1	1	1	2	1	1	1	26

Table II: Distributions of interview data over projects and studies. Data from [3], reproduced with permission from IOS Press.

term shared experiences on similar projects, seems to be an important factor that might increase satisfaction with a project. Larger data-samples are needed to provide stronger support the above hypothesis about familiarity.

The pattern of satisfaction rates is also reflected in the verbal reports from the participants. For example, Project A (a kick-off of a novel multidisciplinary initiative) was
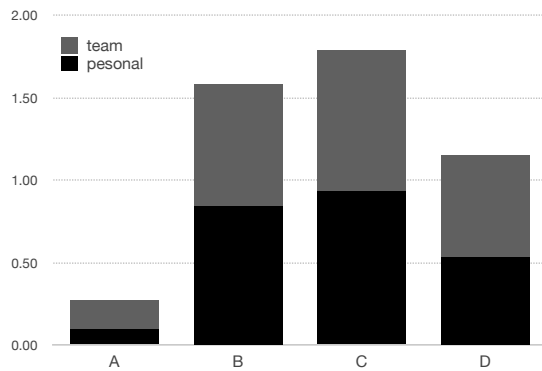
Figure VI: Accumulated—team plus personal—average satisfaction rates in projects A–D.

mentioned to be particularly unsatisfactory because the goals—the big picture, what this project is about—were not clear to the members. Not only the contents and methods become more familiar, but also people become to know one another by working together over the years (about eight years at the time of the interviews).

Motivation

Next to familiarity of goals and people, some explicit measures have been taken to increase the participants' motivation. Project managers report that in response to the poor satisfaction with kick-off projects (e.g. A) , they have taken the following actions prior to the subsequent ones (e.g. B and C):

Goal Alignment: prior to the project, the project managers traveled to the individual institutes to talk with potential project members and departmental directors in order to align the project task with the personal and departmental interests.

DLR-Wide Networking: the above mentioned meetings also served for networking and for advertising of the project goals.

Local Networking: double doubling of project meeting time: twice as many project meetings, each of which last twice as long; critically, also an evening in-between is included to socialize—project members get to know each other personally.

Hands-On Work Sessions: for instance design camps, where people concurrently work on specific tasks introduced for more recent projects (e.g. C).

Naturally, both hands-on work sessions and networking will contribute to increased familiarity both among project members and with tasks and goals. A similar argument is also made by Moerland, Nagel, and Becker [6]. The motivating actions and familiarity, which is based on a longterm collaboration, both have the potential to contribute to increased satisfaction. In support, it is

worth noting that most participants of Project D positively mention the newly introduced hands-on work sessions as contributing toward better understating of the overall project and of how ones' own discipline is linked to others. This experience of learning—knowledge transfer through concurrently working together—is explicitly valued as motivating. Both, challenging goals and learning from each-other is mentioned virtually anonymous as sources for motivations in Study 2 (motivation was inquired about in Study 1).

In future studies it would be interesting to evaluate learning from one another—knowledge transfer through collaboration—also with respect of the leaving expert issue: To what extend do more intense long-term collaborations and hands-on work sessions with the experts help to pass on their knowledge within the community of co-workers? The leaving expert issue and multidisciplinary collaboration are mutually linked at DLR. Although disciplinary boundaries are difficult to overcome, interdisciplinary is valued because it allows for learning; and learning is reported in the interviews a major factor for motivation, and it is the basis for knowledge transfer trough collaboration. And reversely, given DLR's distributed working environment, when an expert leaves, this is an issue not only for the expert's department but also for many collaborations where she has been involved.

Geographic Location

The interview data confirm another obvious factor: geographic separation needs to be taken into account with respect to interdisciplinary collaboration (and the resulting knowledge transfer). This is typically not the case in the literature because most studies on interdisciplinary collaboration consider teams which are collocated and which typically work together on a day-to-day basis [see 7, for discussion]. In contrast, DLR is a large research institution which employs almost 8 000 people distributed over 16 sites in Germany and four offices abroad. Note also that disciplinary orientations are not necessarily coherent with geographic locations, instead: (i) several institutes cover multiple disciplines; (ii) a fair number of DLR's institutes are situated at two or more locations (to be close to facilities or external partner organizations); (iii) departments on major DLR sites, where about 1 500 people work, are separated by long walkways, making it unlikely for employees to simply meet; and (iv) many projects, especially these funded by third-party, are in cooperation with universities or companies worldwide. In this setting, multidisciplinary collaboration naturally entails overcoming physical distance as well.

We did include questions about the role of physical distance only in Study 2, but the sample size is too small

(maximal 3 participants for Project C) and, thus, does not allow jet for further statistical analysis. It matters to understand how knowledge transfer through collaboration can be acquired within a distributed working environment because travel expenses are often a prohibitive factor for extracurricular meetings that don't serve the intermediate project goals.

Results from the Lessons Learned Studies

Overall, we could identify four main factors that affect collaboration and knowledge transfer:

Institutional Structure: As a large research institution, DLR supports large-scale multidisciplinary projects and can attract experts in the diverse disciplines—this is, respectively, reflected in enthusiasm to work on relevant tasks, and high rating of the expertise among colleagues;

Institutional Practice: Because experts are often involved in several projects with different priorities that are difficult to coordinate, delays occur in some of the projects. In the interviews, this is observed as frustration about having to ask and wait for deliverables;

Leadership: Both collaboration experience and perceived satisfaction correlate with the efforts of the project leaders to provide intrinsic motivation by aligning the project, personal, and departmental goals of the involved team members and their departments.

Familiarity and Continuity: When project members work together more frequently or over longer periods, then satisfaction with and effectiveness of their project team increase as well—teams progress from multi- to transdisciplinary approach. This is due to an improved routine with the multi-participatory process as reflected in the knowledge of whom to address which questions to and of how one's own work influences that of others.

These factors are not well documented in the literature, as most studies on collaboration have teams in focus, which are co-located and work together on a regular basis. Our study suggests that distributed teams have a different intrinsic dynamics. By understanding the underlying factors, we intent to develop best-practice strategies for distributed trans-disciplinary research teams.

V.II Outlook: How to Apply what we Learn from Projects?

The mere fact of people working together provides opportunities for knowledge transfer and, not surprisingly, for increased motivation. A direct conclusion from our extended lessons learned study is that increased work-related communication (when planned and performed in a meaningful way) is worth the investment which it requires. However, in practice, this investment is often seen by companies and organizations as a waste of resources because the outcomes of more communication are tacit and are not directly linked to the pursued project goals. It is therefore a challenge is to disseminate the idea that increased communication among experts is an investment that, on the long-run, pays off with (individual and institutional) returns. How can we increase the number of and better use these opportunities? We don't have an answer yet, but few strategies to consider:

Systematic Lessons Learned: Lessons learned sessions should be performed regularly in all projects. Critically, however, the lessons learned outcomes need to reenter the system and inform future projects—a process for this is currently being developed at DLR [8].

Project Database: A DLR-wide project database, which will be implemented within the DLR.Wiki, is currently in a piloting phase by EIWis (see Section II and [2] for details). Next to an overview of content and contact information about projects, it may contain meta-information like Lessons Learned. This would then serve to exchange of experiences across projects (e.g. to help others avoid a common pitfall situation or not to waste time to reinvent what has been previously done by oters).

Best Practices: From a DLR-wide project data base with Lessons Leaned data a collection of explicit "dos" and "don'ts" may be deuced—building the basis for explicit Best Practices guidelines for knowledge transfer and collaboration.

Facilities for Collaboration: DLR also supports Facilities for Collaboration: the Concurrent Engineering Facility [CEF, 9, 10] and the Integrated Design Lab [IDL, 11]. The Lessons Learned research parented here as well as experimental studies on visualization are specifically geared toward improving the collaborative environment IDL [8, 12].

VI. CONCLUSION

The majority of DLR's knowledge is located in the heads of people who work for DLR. Therefore it was important to establish a knowledge transfer, especially for leaving employees. Story Telling and Expert Debriefing were techniques that helped to capture the relevant knowledge from our experts. The techniques were rather successful and also requested for project debriefings. But not only the knowledge transfer of an expert when he is leaving is part of our solution. We have to understand where knowledge is transferred and how our organization can learn from the knowledge that is already existing. Next to explicit EIWis strategies how to maintain expert knowledge in the organization also after experts leave, the extended Lessons Leaned debriefings indicate that the mere collaboration of experts within interdisciplinary projects results in shared knowledge among a wider pool

of colleagues. However, this knowledge transfer is often not used to its full potential because the benefits are long-term and directly linked to project goals. One goal of the expert debriefings is move into focus how knowledge is captured and transferred within projects. Based on this, explicit strategies can be developed to systematically utilize knowledge transfer through collaboration.

Further studies need to also address the specific challenge of not just "preaching to the choir". Experts who contribute to the Knowledge Transfer activities or Lessons Leaned are typically converts, who are enthusiastic abut their disciplines. However, it is difficult to get any critical opinions because the respective persons are not interested to share.

The discussion in DLR about the knowledge management activities has led to more awareness about knowledge and its worth and will lead to futher measures to capture knowledge.

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