

Knowledge Maturing Activities and Practices Fostering Organisational Learning: Results of an Empirical Study

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Abstract. Knowledge work is performed in all occupations and across all industries. The level of similarity of knowledge work allows for designing supporting tools that can be widely used. In this paper an activity-based perspective towards knowledge work is taken. Based on findings from a previous ethnographically-informed study, we identified valuable activities to be supported in order to increase knowledge maturing inside companies. The goal of this paper is to contribute to which knowledge maturing activities are deemed important, so that they can be supported by IT services. Quantitative and qualitative data have been collected in 126 organisations of different size, sector and knowledge intensity. Important feedback and issues emerged and need to be managed in order to support success in the knowledge maturing activities that allow improvement of organisational learning through the dissemination and application of the most appropriate knowledge.

Keywords: empirical study, knowledge maturing activities, knowledge work

1 Introduction

The share of knowledge work [1] has risen continuously during recent decades [2] and knowledge work can be found in all occupations and industries with a level of similarity that is sufficient to allow the design of instruments to foster knowledge work independent of occupations or industries.

The systematic design of interventions aiming at increasing productivity of knowledge work [3] needs more information about how knowledge work is actually performed in real-world organisations. In clear opposition to the abundance of concepts, models, methods, tools and systems suggested for such interventions [4], many of

which have failed to achieve their goals [5], information on how knowledge work is actually performed is scarce. Blackler et al. [6] recommend to study knowledge work by focusing on work practices or activities focusing on interactions between humans and computers, frequently referred to in the context of knowledge and learning management [7, 8].

This paper takes on a practice perspective towards knowledge work. Additionally, instead of integrated systems for workplace learning or knowledge management that support a prescribed, comprehensive process of handling knowledge and learning in organisations in their entirety, we focus on loosely coupled arrangements of services¹ supporting selected activities which are well aligned with the context of the work environment, i.e. the “spirit” [10], of the digital artefacts and tools available in the work environment and adopted by a community of knowledge workers that are jointly engaged in knowledge handling activities in an organisation. In this paper, so-called knowledge maturing activities (KM activities) are defined. Furthermore, we aim to contribute to the knowledge in the field about which KM activities are deemed important so that they can be supported by IT services. We employ a broad empirical study involving 126 European organisations. Collected data is analysed with a mixed-method approach using quantitative and qualitative methods. Section 2 of the paper introduces the context in which the study was conducted and details the study design which was employed. Section 3 elaborates on the results, utilizing a portfolio approach on the one hand and evaluating contextual data on the other. Section 4 discusses limitations, before a summary on the paper is given in section 5.

2 Background to the Study

2.1 The Context: The MATURE Project

The study has been conducted within the context of the MATURE Integrating Project (<http://mature-ip.eu>), which is based on the concept of knowledge maturing [11], i.e., goal-oriented learning on a collective level. The project investigates how knowledge maturing takes place in companies, which barriers are encountered, and how socio-technical solutions overcome those barriers with a particular focus on bottom-up processes. The project is characterised by four strands: the empirical strand conducting different forms of studies, the conceptual-technical strand conceptualising knowledge maturing support and implementing tools, the integration strand developing a flexible infrastructure and enabling loosely coupled solutions, and the evaluation strand which consists of participatory design activities, formative and summative evaluation.

¹ A service is a building block of software systems that consists of contract, interface and implementation. It has a distinctive functional meaning, typically reflecting a high-level business concept covering data and business logic [9]. A service is an abstract resource that represents a capability of performing tasks that form a coherent functionality from the point of view of the provider’s entities and requester’s entities (www.w3.org/TR/ws-gloss/).

Knowledge maturing has been analysed in terms of identifying the different phases of knowledge development, specifically ‘expressing ideas’, ‘appropriating ideas’, ‘distributing in communities’, ‘formalising’, ‘ad-hoc training’ and ‘standardising’, which are described in the knowledge maturing (phase) model [12, 13]. Within the first year of the project, an ethnographically-informed study [14] was conducted to understand real-world maturing practices and activities as well as design studies that explored different approaches to support KM activities. Based on these findings, the project has collaboratively defined use cases that correspond to important KM activities.

2.2 Study Design

In contrary to the ethnographically-informed study which researched a small number of organisations, the aim was to broaden the scope of organisations that were investigated in order to get a varied picture of perceptions held in companies of different size, sector and knowledge intensity about the results of the former study.

Therefore, we decided to conduct telephone interviews throughout Europe. Contacts were gained using a mixed approach of purposeful sampling and cold-calling. We asked for interviewees who have had work experience of at least three years, have been employed in the organisation for at least one year and have had responsibility for, e.g., knowledge management, innovation management or personnel development. The interview guideline was partly structured and partly semi-structured and was designed to focus on three subject areas: the phases of the knowledge maturing model [12], KM activities and knowledge maturing indicators. With respect to the knowledge maturing model, information was sought on the perception of importance, support from organisational and ICT measures, tools and infrastructures, barriers and motivational factors involved as well as perception of success.

The knowledge maturing model provides a new² and distinct lens for studying phenomena of knowledge conversion. Consequently, the empirical studies conducted in MATURE are exploratory in nature. This means that the study aimed at hypotheses generation rather than testing, and combines quantitative with qualitative elements in a mixed-method approach, so that phenomena of knowledge maturing, specifically about phases, KM activities and indicators, are investigated in more detail. However, some initial assumptions about relationships between concepts were also studied.

Within our project, we define KM activities as individual or group activities that contribute to the goal-oriented development of knowledge within an organisation. Knowledge activities in general have their roots in the perspective of practice of knowledge work as described above. Practice is the source of coherence of a community due to mutual engagement, joint enterprise and shared repertoire [18]. Practices formed by individuals that are part of semi-permanent work groups are examples of how knowledge work can be framed as a social process [19]. Knowledge work is characterised by practices such as acquiring, creating, gathering, organising, packag-

² There have been a number of models and theories for describing, analysing and studying knowledge handling in organisations, e.g., Nonaka’s [15] SECI model, Wiig’s [16] model for situation handling from a knowledge perspective or Sveiby’s [17] knowledge conversions to create business value. However, none has an explicit focus on knowledge maturing.

ing, maintaining, systemising, communicating and applying knowledge [20-22], and by roles such as data gatherer, knowledge user and knowledge builder [23]. However, the practices proposed so far need to be detailed in order to offer starting points for information systems design. Schultze identifies informing practices in an ethnographic study of knowledge work in a large Fortune 500 manufacturing firm [24]: (1) ex-pressing, i.e. self-reflexive converting of individual knowledge and subjective insights into informational objects that are independent of knowledge workers, (2) monitoring, i.e. continuous non-focused scanning of the environment and the gathering of useful “just in case”-information, and (3) translating, i.e. creation of information by ferrying it across multiple realms and different contexts until a coherent meaning emerges, and later adds (4) networking, i.e. building relationships with people inside and outside the company that knowledge workers rely on [25]. In particular the work performed by [26], i.e. a series of 31 interviews with knowledge workers building on Schultze’s practices, was considered useful to inform our approach to design a list of KM activities that are deemed important to be supported by MATURE software and services.

These knowledge activities, gained from a review of literature, were merged with results from the previous ethnographically-informed study (i.e. codes) and use cases created for the project, and then were further refined [27]. This resulted in a list of twelve KM activities, which can occur in each phase of the knowledge maturing model.

The concepts ‘perceived importance’, ‘perceived support’ and ‘perceived success’ are investigated with respect to each KM activity. KM activities have been explained to interviewees as activities of individuals or groups of individuals that contribute to the development of knowledge, which can occur within one knowledge maturing phase, e.g., ‘distributing in communities’, or between two knowledge maturing phases, e.g., from ‘distributing in communities’ to ‘formalising’. Importance asks to what extent interviewees think that a KM activity is important for increasing knowledge maturity in the organisations they represent (question 12 of the interview guideline). Support refers to organisational or information and communication technological instruments that help individuals or groups of individuals perform an activity so that it contributes to the development of knowledge (question 13). Finally, success captures to what extent interviewees believe that a KM activity has been performed successfully in the organisations they represent (question 14). Each concept has been operationalised with the help of one statement per activity for which interviewees could mark to what extent they would agree to this statement on a 7-point Likert scale. We are well aware that the concepts of importance and, especially support and success would deserve a much more thorough investigation with the help of a number of variables that should be questioned for each of them, see e.g., [28, 29]. However, we are confident that the depth of these concepts has been explored in the course of the interviews by interviewer-interviewee dialogues that appropriated the concepts to the context of the organisations that the interviewees represent and that were documented on a per activity basis. Besides reflecting on each of the twelve proposed KM activities with respect to the three concepts, interviewees were also asked for additional ones. Moreover, comments of interviewees regarding the KM activities were collected.

3 Results

This paper focuses on evaluating data collected with respect to the three concepts described in the previous section. The following section 3.1 provides a quantitative analysis of the results. Additionally provided KM activities and comments from interviewees regarding existing KM activities are the basis for a qualitative analysis presented in section 3.2.

3.1 Knowledge Maturing Activities – Descriptives and Portfolios

In this section, the perceptions of interviewees are descriptively analysed and interesting facets of individual activities are highlighted. This detailed information is then further investigated with the help of portfolios opposing importance and support as well as importance and success of performance.

Importance, Support and Success of KM Activities. With respect to all three questions, a relatively high mean value of agreement can be observed. Looking at each question separately, the following aspects can be highlighted:

Perceived importance (question 12): According to the medians, at least 50% of respondents agreed or fully agreed that all of the twelve KM activities are important for increasing maturity of knowledge in their organisation (see table 1). The agreement to the importance of KM activities *'find relevant digital resources'*, *'reflect on and refine work practices or processes'*, *'find people with particular knowledge or expertise'* and *'communicate with people'* was even higher, as at least 50% of the respondents fully agreed. The KM activity with the highest standard deviation (2.15) is *'restrict access and protect digital resources'*. One reason for that is that 26.0% of respondents fully disagreed or disagreed with the statement that this activity is important for knowledge maturing in their organisation. The frequencies (see table 1) indicate that two different interpretations of this KM activity might exist which is analysed in more detail in section 3.2.

Perceived support (question 13): The agreement to the statement that the respective KM activity is supported in the respondents' organisations (see table 2) is not as high as the agreement to the importance of the respective KM activity (question 12). However, for ten out of twelve KM activities, according to the median at least 50% of interviewees agreed or fully agreed. With respect to the KM activity *'reorganise information at individual or organisational level'* 66.4% and with respect to *'assess, verify and rate information'* 69.9% of interviewees slightly agreed, agreed or fully agreed. Again, the most heterogeneous answers were given to the KM activity *'restrict access and protect digital resources'* (standard deviation is 1.81).

Perceived success of performance (question 14): Compared to the agreement to question 13 about support of KM activities, the level of agreement to the statement that the respective KM activity is performed successfully is lower (see table 3). However, more than 50% of interviewees (exact values after each activity) agreed or fully agreed that the KM activities *'familiarise oneself with new information'* (54.4%), *'share and release digital resources'* (51.2%), *'restrict access and protect digital*

resources' (61.0%), 'find people with particular knowledge or expertise' (52.4%) and 'communicate with people' (58.7%), are performed successfully in their organisation. With respect to the remaining seven out of twelve KM activities, a median of five indicates that at least 50% of respondents slightly agreed, agreed or fully agreed. It is worth mentioning that the KM activity 'share and release digital resources' has the highest standard deviation (1.67) closely followed by 'restrict access and protect digital resources' (1.63).

The descriptions above are also mirrored in figure 1 where the mean values of the level of agreement to the three questions for each KM activity are shown.

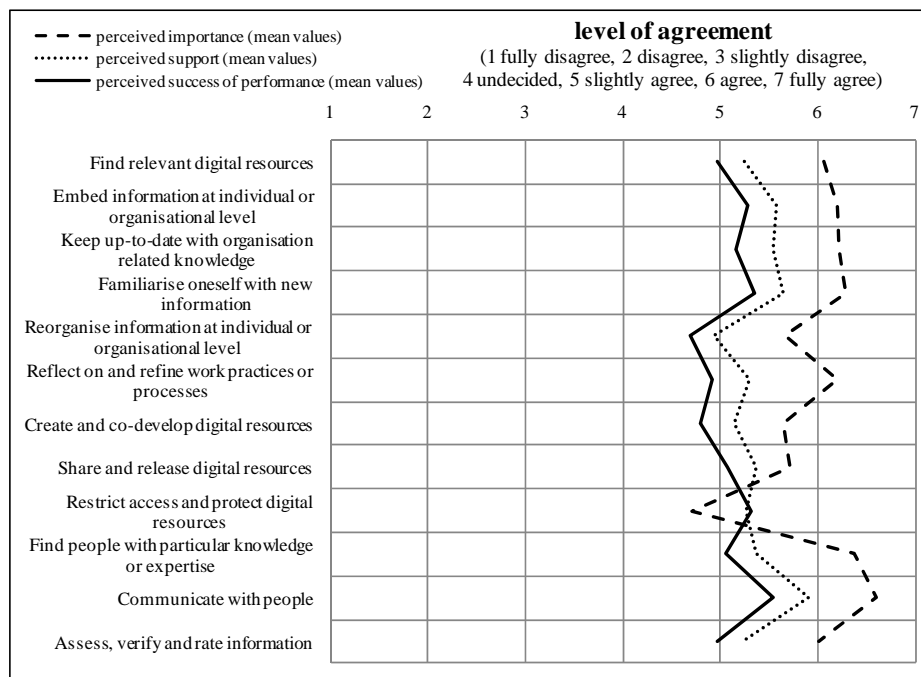


Figure 1: KM activities – level of agreement

For eleven KM activities, the mean values of given answers decrease from question 12 over 13 to 14. Hence, though these KM activities are perceived to be important, they are actually less well supported. This might result in a less successful performance. In case of the remaining KM activity 'restrict access and protect digital resources' the opposite is true: mean values increase from questions 12 over 13 to 14. For this KM activity, the perceived success of performance seems to be slightly higher than the perceived support and the perceived support seems to be higher than the perceived importance. We will investigate this further in section 3.2.

Portfolios. In order to support decisions in our project, it is of interest to identify KM activities that are, firstly, deemed important for increasing knowledge maturity, but perceived less supported and, secondly, deemed important, but perceived less successfully performed. In such cases, software or services could be (further) developed to

enhance the support of such activities aiming at a more successful performance in organisations. To perform this analysis, we employed the mean levels of agreement. In order to avoid influences of the absolute height of mean values, we decided to concentrate on the relative values (i.e. mean level of agreement to one KM activity relative to the mean levels of agreement to other KM activities). This has also the advantage of retaining information about the relative mean height of agreement to each concept with respect to a specific KM activity, instead of reducing it to one single difference score. Therefore, mean values for each of the questions 12, 13 and 14, are divided into quartiles, comprising three KM activities each. These are then contrasted. Applying this approach makes explicit which KM activities are deemed to be more important, and at the same time, less supported or successfully performed than others. For investigating and for presenting results of this area of interest, we decided to create and evaluate portfolios.

Each of the portfolios described in the following opposes two dimensions. According to the number of possible pair-wise combinations of perceived importance, support and success of performance, three portfolios could be created. Based on the assumption that software or services can support KM activities and hence might have a positive influence on the success of performance, we concentrate on the deemed importance of KM activities and relate it to the perceived support and success of performance.

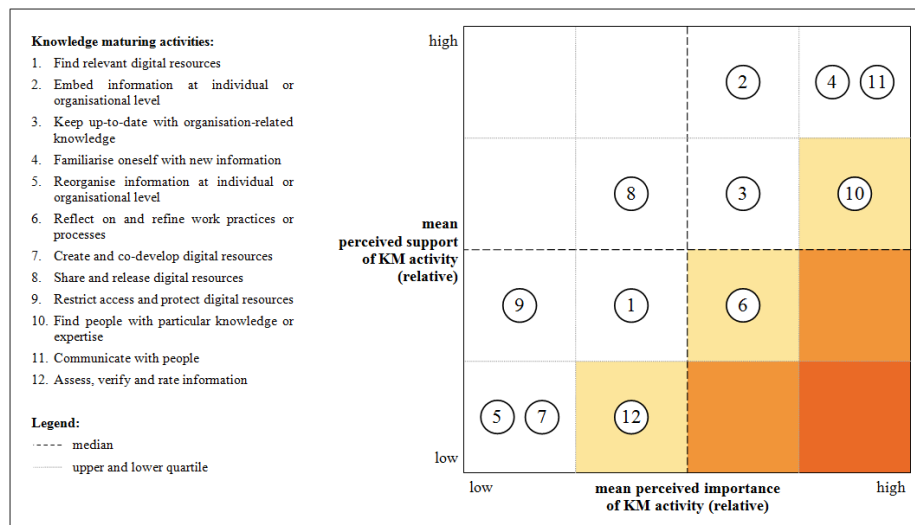


Figure 2: KM activities portfolio importance – support

The portfolio displayed in figure 2 depicts on its x-axis the mean values of perceived importance and on its y-axis the mean values of perceived support. As quartiles were used for placing KM activities within the portfolio, the mean values of both, perceived support and importance are arranged relatively to each other.

The higher the perceived importance and the lower the perceived support, the worthier it is to focus on this KM activity. Following this, the background of the portfolio shown in figure 2 is coloured in different shades to show the strategy of investing into

those activities that are in the lower right corner of the portfolio. The darker the background colour, the higher the importance and the higher the assumed lack of software or services that provide functionalities to support the KM activity.

Relatively to others, the KM activities *'4-familiarise oneself with new information'*, *'11-communicate with people'* and *'10-find people with particular knowledge or expertise'* are deemed most important for increasing knowledge maturity in respondent's organisations. The latter is less supported and hence, would be most interesting for the MATURE project. The KM activities *'2-embed information at individual or organisational level'*, *'3-keep up-to-date with organisation-related knowledge'* and *'6-reflect on and refine work practices or processes'* are deemed of secondary importance. The latter KM activity is deemed less supported, and additionally is the only one in this portfolio which belongs to both, the 50% of KM activities that are deemed more important and the 50% of KM activities that are deemed less supported than others. Hence, this KM activity would be of high interest for further consideration. With respect to perceived importance, the KM activities *'1-find relevant digital resources'*, *'8-share and release digital resources'* and *'12-assess, verify and rate information'* would fall into the third group. The latter of this group is less supported and would be a candidate to be facilitated with the help of software or services. The KM activities *'5-reorganise information at individual or organisational level'*, *'7-create and co-develop digital resources'* and *'9-restrict access and protect digital resources'* are part of the group that is deemed least important.

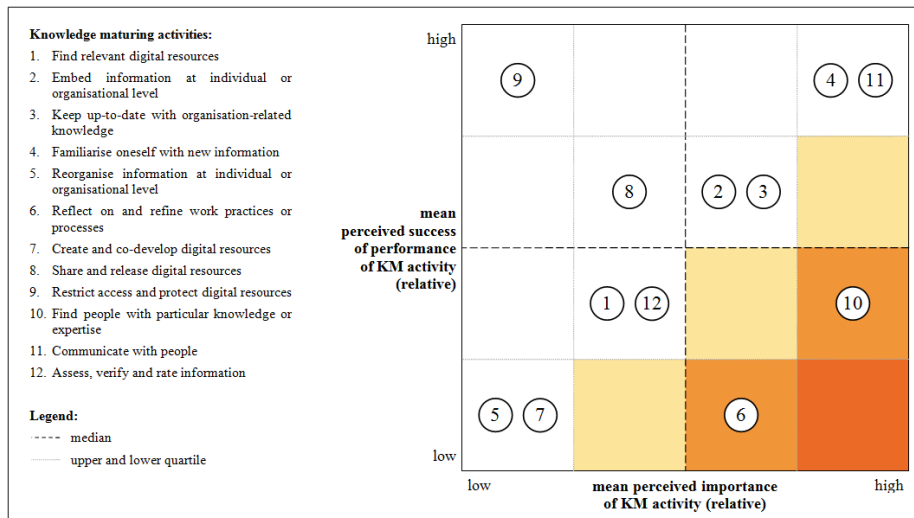


Figure 3: KM activities portfolio importance – success of performance

The portfolio depicted in figure 3 displays the mean values of perceived importance on its x-axis and the mean values of perceived success of performance on its y-axis. Those activities deemed important and at the same time perceived to be performed less successfully would be most interesting for further consideration. Again, this area of interest is coloured in different shades to show the norm strategy of investing into those activities that are in the lower right corner of the portfolio.

According to this portfolio ‘10-find people with particular knowledge or expertise’ and ‘6-reflect on and refine work practices or processes’ would be most interesting for the MATURE project. The former falls into the group of most important KM activities and, at the same time, is part of the 50% of KM activities that are less successfully performed. The latter is deemed to be one of the 50% of more important and, at the same time, is perceived to be one of the three less successfully performed KM activities.

In summary, a comparison of both portfolios (depicted in figure 2 and figure 3) shows that ‘6-reflect on and refine work practices or processes’ and ‘10-find people with particular knowledge or expertise’ would be most interesting to be supported by software or services. ‘12-Assess, verify and rate information’ could be considered as a third interesting KM activity, because it is one of the least supported and less successfully performed activities. Also ‘1-find relevant digital resources’, ‘5-reorganise information at individual or organisational level’ and ‘7-create and co-develop digital resources’ might be of interest. Although, in relation to others, these activities are deemed to be less important, their mean values calculated based on the Likert scale (6.06, 5.66 and 5.65) still indicate an agreement. Furthermore, compared to others, they fall into the group of less supported and less successfully performed KM activities.

3.2 Collected Evidences on Knowledge Maturing Activities

The KM activity ‘restrict access and protect digital resources’ – a double perspective: The most controversial KM activity is ‘restrict access and protect digital resources’, as shown in the previous section. An analysis of a total of 42 comments related to this activity has revealed that two types of answers can be distinguished: (a) statements whether and why the organisation restricts access and (b) statements about personal opinion whether restricting access is beneficial to knowledge maturing.

From an organisational perspective, a mixed picture emerged. Some organisations have very few restrictions (related to an open organisational culture), whilst others are giving high priority to restricting access. In some cases, this is due to the fact that organisations are required to protect the information (e.g., data related to their customers), for others this is part of protecting their own competitive advantage.

In fact, several organisations in high technological sectors have recognized the importance of the KM activity ‘restrict access and protect digital resources’. In those organisations, this activity is perceived as a normal practice to channel the knowledge through the correct users and to avoid dissipating it. It seems a common practice to improve the structured knowledge and to support the diffusion among the employees correctly. This activity guarantees the right classification of knowledge and secures the diffusion with the most appropriate policy. On the personal side three reasons why individuals considered restricting access as important emerged from the data:

- **Trust as a prerequisite for knowledge sharing and collaboration.** Two interviewees mentioned that they consider restricting access as a measure to create a protected space in which you can more freely exchange knowledge because they trust each other. “There are people who will share only in a limited way if they can trust that not everyone can see it.” The alternative they basically see is that knowl-

edge is kept personally: *“But you have to restrict access, I think that restricting access as a functionality of a tool is an important prerequisite for exchanging knowledge. So if you restrict access, it is also good for knowledge exchange, not with those who don't have access, but for those who have access. Otherwise you wouldn't share anything if you couldn't restrict it to certain persons”*. This is in line with the general comment that *“human nature of the individual is very important and needs to be taken into account”*.

- **Information channelling and avoidance of information overload.** The underlying assumption of this line of argumentation is that shared knowledge and information leads to a counterproductive overload situation: *“Knowledge is not something that has to be always distributed. With this activity the knowledge is channelled to the right users.”*
- **Data security and fear of competition.** While in many cases, data security and fear of losing competitive advantage was seen as a given necessity, in some cases the interviewees also shared the company's position that this is essential. In other cases, there were more critical statements that this obstructs knowledge maturing: *“It does not help knowledge maturing, I would clearly say. Has also reasons of data protection that not everyone has access to everything. Having to restrict it: would rather disagree”*.

Furthermore, interviewees also gave reasons against restricted access to resources (from the perspective of knowledge maturing). Overall, 14 comments suggest that restriction means obstructing people's access to knowledge which they view as a prerequisite for knowledge maturing to happen. Answers range from *“nonsense”* to critical reflection on their organisation's practice: *“The access rights are pretty strict, as extreme as personnel office not being able to see my drive, my drive cannot be seen by my colleagues, I find that unbelievable.”* Or: *“We are destroying knowledge in this area”*.

The KM activities ‘familiarise one-self with new information’ and ‘find relevant digital resources’: ‘Familiarise one-self with new information’ is a very important KM activity, and is also supported and realized with success (see section 3.1). When performing this activity the employees use internal knowledge and also external sources (e.g., participating webinar, searching information on internet or attending training course). However, internal initiatives to support the exchange of knowledge among employees also exist and allow familiarising with the organisation's knowledge. For example, an Italian ICT company has introduced a corporate training school in which employees are taught by colleagues. The aims are to share experiences about projects, to stimulate discussions and to exchange ideas. Thereby, knowledge and lessons learnt diffuse from a single team to a broad set of employees.

The lower support and success of the activity ‘find relevant digital resources’ is often related to a lack of a common access point to organisational knowledge which, instead, could be easily supported by introducing specific ICT systems. The problem is, perhaps, in the high amount of knowledge that has to be structured and inserted into a unique platform or in different (for scope) platforms linked together. However, some organisations have introduced ad-hoc systems to classify organisational knowledge. Proprietary platforms manage that knowledge and the search and access to the most relevant and needed resources.

Description of critical KM activities: *'Find people with particular knowledge or expertise'* is one of the activities carried out with less support and less success, but it is deemed to be of high importance. The interviewees perceive that it is important to find the most useful people for giving help for certain issues and also for special needs faced during their daily tasks. The ability to find the most adequate people, e.g., to assign activities to, becomes also increasingly important. Some initiatives are undertaken by the organisations, but they are not a widely diffused practice, and better results have to be achieved. Another example is reported by an aerospace company which has introduced a Competence Management Roadmap. It has developed a methodology and software to trace the employees' competences, to elaborate the state of each activity in order to highlight gaps in the needed competences, and to simulate and forecast the situation of the organisational activities when changes in the team are hypothesized.

The activity *'reflect on and refine work practices or processes'* comprises thinking about tasks and processes within the organisation, and aims at their improvement. The most adequate knowledge can be highlighted and be "stored" in the company processes to be widely distributed and used daily. This activity allows for effective knowledge distribution amongst employees and to mature the organisational knowledge, learning how to apply it in work practices and processes. To better support this activity, initiatives oriented to the business process management can be useful. An example is a company which has applied business process management to reflect on the existing processes, analysing and mapping them, and to refine those processes through the mitigation of gaps and low performance. This allows them to have accurate processes that incorporate the learnt organisational knowledge and to improve the organisational performance. Furthermore, in that company, to support the application of the refined processes, a system has been developed automating the new processes. All the actions are traced and the employees are led in the execution, always being informed about the process task being performed and being up-dated about errors and performance. Therefore, the right application of the refined processes with the business process management is assured, using the ICT system in which each task can be digitally executed and traced.

The KM activity *'assess verify and rate information'* allows the organisation to make available the right and correct information for the organisational activities. A mechanism to verify and validate the information can be very useful in order to improve the quality of diffused information and to allow only the right knowledge to mature. In some companies, digital workflows are available to share, verify and approve documents. An Italian company, for example, invented a digital workflow for product design information. The files are verified and shared with other employees after approval. This digital workflow supports the *'assess verify and rate information'* activity and allows employees to learn from and apply the most adequate knowledge, reducing time due to wrong information and related errors. Therefore, this activity provides a clear view about what information is correct to learn from, and allows the most valid knowledge to mature.

General considerations: If organisations had top management support for explicit policies and practices for, e.g., innovation management, performance improvement or knowledge management, conditions for supporting collaborative KM activities were favourable. On the other hand, where innovation and improvement practices either did

not have full top management support or were treated as (a series of) one-off events, then collaborative KM activities were also likely to be viewed in a similar fashion. The issue of how to cope with cases where expertise is distributed across organisations is an interesting challenge, as treating knowledge as something to be matured separately in single organisations could itself be problematic. Many organisations also saw movement towards more collaborative knowledge maturing processes as part of a 'bundle' of practices, inevitably bound up with the 'management of change' and significant shifts in the organisational culture.

Overall, it is clear that the stories told to us from a wide variety of organisations align with the view that the knowledge maturing model is one of a number of possible perspectives for engaging people in discussions about organisational change, learning and development. Further, some participants could see how collaborative knowledge maturing processes could be a key part of achieving a more fundamental transformation, where the quality of choice, information and commitment are improved in a move towards double-loop learning where broader questions about organisational goals are also addressed. Inter-organisational learning and knowledge development can be a particular challenge in this respect.

It is clear that innovation, learning and KM activities within and across organisations are essentially social processes and that both personal networks and cross-company networks need to pay attention to building relationships to support development, as well as focusing upon substantive issues. There is also a need to consider the interaction between formal and informal approaches to learning, skill development and knowledge creation as a particularly effective way forward, not only for enhancing personal professional development, but also as a means to improve organisational effectiveness.

Finally, there were some clearly differentiated answers related to the tension around external collaboration. Already identified as part of the ethnographically-informed study, knowledge and information exchange with external contacts in an individual's social network was a very essential part of everyday work (even to an unanticipated degree). Also, external sources have been seen by interviewees as essential for triggering change in an organisation. Organisations tend to be very cautious towards external collaboration, as they see the risk of losing competitive advantage, or need to ensure compliance to externally induced regulations for data protection. One balanced answer also indicated that you have to differentiate between different types of knowledge: *"Not all digital resources - I would here (and above) say all resources that influence the work process, the product, the organisational goals, here I would always say yes. If it is not influencing the work process, then it is stupid."*

4 Limitations

The topic of knowledge maturing is quite complex in general. This was known in advance as it is a distinct and new lens to look at the phenomena surrounding knowledge handling in organisations, and thus the concept certainly was new to all interviewees. This was also a primary reason why we decided to do interviews in the first place. Thus the interviewer-interviewee relationship and the interviewers' competence

in appropriating an understanding of knowledge maturing in the context of the organisation represented by the interviewee were crucial. We spent substantial effort in preparing precisely and clearly defined concepts, with further explanations and examples to ease the task for the interviewer. Moreover, the study coordinators offered intensive interviewer training and kept in close contact with interviewers in order to transfer lessons learned and help overcome barriers of understanding. When interviews are conducted by different interviewers, there may be differences in answers. However, we found no significant differences between cases with respect to the interviewer that had performed them.

Although the interview aimed at (parts of) organisations, the personal scope (responsibility, interests) of the interviewee may have had an influence on the interviewees' perceptions. We performed statistical tests and could exclude the personal background (e.g., technical background versus business or HR background) as a factor influencing answers.

As we conducted one interview per organisation, different interviewees within the same organisation might have given different answers. However, as we carefully selected interviewees who had a good command of the knowledge and learning management in their organisation, this problem could at least be alleviated.

Another impression which arose as the interviews were carried out was that interviewees in leadership positions (i.e. CEOs) tended to provide an optimistic vision of the company, rather than pointing out shortcomings. Nevertheless, this factor could also be excluded by statistical tests we conducted.

5 Discussion and Conclusion

On average, all KM activities were deemed important for increasing knowledge maturity in interviewees' organisations. For eleven out of twelve KM activities, perceived importance is significantly higher than perceived support and perceived support is significantly higher than perceived success of performance. Based on these results, portfolios contrasting importance/support and importance/success were created. It seems, that the KM activities '*reflect on and refine work practices or processes*' and '*find people with particular knowledge or expertise*' are most interesting. Both are deemed to be important, but were less supported and less successfully performed.

The interviewees attribute high importance to the KM activities, and in general, to the knowledge which is perceived as a strategic resource to improve the actual practices and obtain competitive advantages. If the importance of a KM activity is shown to be very high from the study results, it may emerge that more support can be attributed to that activity in order to reach better results. Several initiatives have to be undertaken, in particular to improve the most critical KM activities ('*reflect on and refine work practices or processes*', '*find people with particular knowledge or expertise*' and '*assess verify and rate information*'). For those activities, the importance is highly perceived but low support and lack of success are shown. When adequate support is given to a KM activity, performance is improved. Hence, organisations could support those KM activities through actions based, especially for the most critical

ones, on the level of perceived importance and on the level of the existing initiatives. Therefore, in MATURE, it is planned to further investigate and take up these results to provide services embedded in the MATURE system for improving support of KM activities. Hence, support and success of KM activities allow organisational learning to improve because the right knowledge is disseminated and employees are able to acquire content and information and to apply them in their work.

However, not in all organisations, knowledge management initiatives were widely available and thus, effective and broader support is needed. Several interviewees have affirmed that their organisations are starting to think of knowledge as a strategic resource. They are actually working to improve knowledge management and to diffuse a culture based on sharing of appropriate knowledge, in order to capture what exists in the organisation and to learn how to apply it within daily work practices, thus capitalizing on their own intangible assets and getting higher profits. Today many organisations work in value networks and share knowledge, risks, costs and tangible assets with external actors who require a better and broader focus on the KM activities involving these external actors. In fact, the establishment of consortiums or project collaborations permit the development of a network with other actors, thus increasing the maturing of the knowledge of a single company. Working together, the knowledge is mutually influenced, and thus the potential to mature knowledge could increase. The exchange of best practices and initiatives with other actors can allow individual organisations to learn from others and to improve their application of organisational knowledge, creating new linkages between internal and external knowledge.

References

1. Blackler, F., Knowledge, Knowledge Work and Organizations: An Overview and Interpretation. *Organization Studies*, 1995. 16(6): p. 1021-1046.
2. Wolff, E., The Growth of Information Workers. *Communications of the ACM*, 2005. 48(10): p. 37-42.
3. Drucker, P.F., The Age of Social Transformation. *The Atlantic Monthly*, 1994. 274(5): p. 53-80.
4. Alavi, M. and D.E. Leidner, Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. *MIS Quarterly*, 2001. 25(1): p. 101-136.
5. Bishop, J., et al., Ensuring the effectiveness of a knowledge management initiative. *Journal of Knowledge Management*, 2008. 12(4): p. 16-29.
6. Blackler, F., M. Reed, and A. Whitaker, Epilogue - An Agenda for Research. *Journal of Management Studies*, 1993. 30(6): p. 1017-1020.
7. Boer, N.-I., P.J. Baalen, and K. Kumar, An Activity Theory Approach for Studying the Situatedness of Knowledge Sharing. in 35th Annual Hawaii International Conference on System Sciences (HICS). 2002. Hilton Waikoloa Village, USA.
8. Clases, C. and T. Wehner, Steps Across the Border – Cooperation, Knowledge Production and Systems Design. *Computer Supported Cooperative Work*, 2002. 11: p. 39-54.
9. Krafzig, D., K. Banke, and D. Slama, *Enterprise SOA: Service-Oriented Architecture Best Practices*. 2005: Prentice Hall.
10. DeSanctis, G. and M.S. Poole, Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory. *Organization Science*, 1994. 5(2): p. 121-147.

11. Schmidt, A., Knowledge Maturing and the Continuity of Context as a Unifying Concept for Knowledge Management and E-Learning. in 5th International Conference on Knowledge Management (I-KNOW '05). 2005. Graz, Austria.
12. Maier, R. and A. Schmidt, Characterizing Knowledge Maturing: A Conceptual Model Integrating E-Learning and Knowledge Management. in 4th Conference of Professional Knowledge Management (WM07). 2007. Potsdam.
13. Kaschig, A., et al., D1.1 - Results of the Ethnographic Study and Conceptual Knowledge Maturing Model. 2009: Innsbruck.
14. Barnes, S.-A., et al., Knowledge Maturing at Workplaces of Knowledge Workers: Results of an Ethnographically Informed Study. in 9th International Conference on Knowledge Management (I-KNOW '09). 2009. Graz, Austria.
15. Nonaka, I., A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, 1994. 5(1): p. 14-37.
16. Wiig, K.M., A Knowledge Model for Situation-Handling. *Journal of Knowledge Management*, 2003. 7(5): p. 6-24.
17. Sveiby, K.-E., A Knowledge-Based Theory of the Firm to Guide in Strategy Formulation. *Journal of Intellectual Capital*, 2001. 2(4): p. 344-358.
18. Wenger, E., *Communities of Practice. Learning, Meaning, and Identity*. 1998, Cambridge: Cambridge University Press
19. Daskalaki, M. and H. Blair, Knowing as an Activity: Implications for the Film Industry and Semi-Permanent Work Groups. in *Proceedings of the 3rd Conference on Organizational Knowledge, Learning and Capabilities*. 2002. Athens.
20. Davenport, T.H., S.L. Jarvenpaa, and M.C. Beers, Improving Knowledge Work Processes. *Sloan Management Review*, 1996. 37(4): p. 53-65.
21. Kelloway, E.K. and J. Barling, Knowledge Work as organizational behavior. *International Journal of Management Reviews*, 2000. 2(3): p. 287-304.
22. Holsapple, C.W. and A.B. Whinston, *Knowledge-based Organizations*. The Information Society, 1987. 5(2): p. 77-90.
23. Snyder-Halpern, R., S. Corcoran-Perry, and S. Narayan, Developing Critical Practice Environments Supporting Knowledge Work of Nurses. *Computers in Nursing*, 2001. 19(1): p. 17-23.
24. Schultze, U., A confessional account of an ethnography about knowledge work. *MIS Quarterly*, 2000. 24(1): p. 3-41.
25. Schultze, U., On Knowledge Work, in *Handbook on Knowledge Management 1 - Knowledge Matters*, C.W. Holsapple, Editor. 2003, Springer: Berlin. p. 43-58.
26. Hädrich, T., Situation-oriented Provision of Knowledge Services, in *Information Systems*. 2007, University of Halle-Wittenberg: Halle(Saale), Germany.
27. Kaschig, A., et al., D1.2 - Results of the Representative Study and Refined Conceptual Knowledge Maturing Model. 2010.
28. DeLone, W.H. and E.R. McLean, Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research*, 1992. 3(1): p. 60-95.
29. DeLone, W.H. and E.R. McLean, The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. *Journal of Management Information Systems*, 2003. 19(4): p. 9-30.

Statistical Data

Table 1: Measures and frequencies for perceived importance

KM activity (perceived importance)	n	mean	median	std dev.	value on likert scale						
					1	2	3	4	5	6	7
1 Find relevant digital resources	125	6,06	7,0	1,40	3	3	4	2	14	35	64
2 Embed information at individual or organisational level	126	6,20	6,0	0,96	1		3	1	11	58	52
3 Keep up-to-date with organisation related knowledge	126	6,22	6,0	0,96			5	1	14	47	59
4 Familiarise oneself with new information	125	6,28	6,0	0,81			3		10	58	54
5 Reorganise information at individual or organisational level	125	5,66	6,0	1,33	1	3	7	11	19	48	36
6 Reflect on and refine work practices or processes	125	6,19	7,0	1,13	1	1	3	6	9	42	63
7 Create and co-develop digital resources	124	5,65	6,0	1,43	1	5	8	7	22	40	41
8 Share and release digital resources	124	5,72	6,0	1,61	6	4	4	4	15	45	46
9 Restrict access and protect digital resources	123	4,70	6,0	2,15	12	20	10	4	14	31	32
10 Find people with particular knowledge or expertise	126	6,37	7,0	0,92		2	1	1	9	45	68
11 Communicate with people	126	6,60	7,0	0,82	1		1	1	3	31	89
12 Assess, verify and rate information	125	6,00	6,0	1,01	1		1	9	15	58	41

Table 2: Measures and frequencies for perceived support

KM activity (perceived support)	n	mean	median	std dev.	value on likert scale						
					1	2	3	4	5	6	7
1 Find relevant digital resources	125	5,25	6,0	1,55	3	7	11	8	27	44	25
2 Embed information at individual or organisational level	126	5,57	6,0	1,16	1	2	6	6	33	56	22
3 Keep up-to-date with organisation related knowledge	126	5,54	6,0	1,27	1	4	8	4	28	58	23
4 Familiarise oneself with new information	125	5,65	6,0	1,13		3	5	5	34	51	27
5 Reorganise information at individual or organisational level	125	4,93	5,0	1,50	1	9	15	17	33	31	19
6 Reflect on and refine work practices or processes	125	5,30	6,0	1,50	3	6	11	4	32	45	24
7 Create and co-develop digital resources	124	5,14	6,0	1,57	2	9	13	9	27	41	23
8 Share and release digital resources	123	5,36	6,0	1,62	4	7	10	5	20	48	29
9 Restrict access and protect digital resources	123	5,25	6,0	1,81	5	13	5	11	12	43	34
10 Find people with particular knowledge or expertise	126	5,36	6,0	1,55	2	8	11	6	22	49	28
11 Communicate with people	126	5,90	6,0	1,33	2	3	4	6	16	46	49
12 Assess, verify and rate information	123	5,23	5,0	1,53	4	3	7	23	26	30	30

Table 3: Measures and frequencies for perceived success of performance

KM activity (perceived success of performance)	n	mean	median	std dev.	value on likert scale						
					1	2	3	4	5	6	7
1 Find relevant digital resources	125	4,96	5,0	1,59	2	9	18	11	28	37	20
2 Embed information at individual or organisational level	126	5,28	5,0	1,24	2	2	7	12	46	39	18
3 Keep up-to-date with organisation related knowledge	126	5,15	5,0	1,44	4	3	13	7	39	43	17
4 Familiarise oneself with new information	125	5,35	6,0	1,24	1	3	8	12	33	51	17
5 Reorganise information at individual or organisational level	125	4,70	5,0	1,51	1	11	17	22	36	21	17
6 Reflect on and refine work practices or processes	125	4,92	5,0	1,47	2	6	19	12	35	36	15
7 Create and co-develop digital resources	123	4,79	5,0	1,60	3	10	19	11	28	39	13
8 Share and release digital resources	123	5,07	6,0	1,67	2	9	19	9	21	36	27
9 Restrict access and protect digital resources	123	5,31	6,0	1,63	3	11	3	15	16	46	29
10 Find people with particular knowledge or expertise	126	5,06	6,0	1,58	1	8	22	8	21	45	21
11 Communicate with people	126	5,54	6,0	1,45	2	4	9	6	31	36	38
12 Assess, verify and rate information	123	4,97	5,0	1,44	5	2	8	26	35	30	17

Note: Missing data has been excluded pair-wise.