

KNOWLEDGE MANAGEMENT FOR THE DECOMMISSIONING OF NUCLEAR POWER PLANTS

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Abstract. This paper describes background, objectives and select conceptual components of knowledge management for the decommissioning of nuclear power plants. The concept focuses on the transfer of personal practice experience within and between nuclear power plants. The conceptual insights embrace aspects of knowledge content, structure, KM processes, organization, cooperation, culture, persuasion, leadership, technology, infrastructure, business impact and resilience. Key challenges are discussed, and related advice is provided for KM practitioners with similar endeavours in the field of nuclear power plant decommissioning.

BACKGROUND

The current energy policy of the German government requires the gradual decommissioning of nuclear power plants in Germany. E.ON, a major energy corporation operating eight nuclear power plants in Germany, is in the process of decommissioning and dismantling its first two nuclear power plants in Würgassen and Stade, illustrated in Figure 1. Both ventures are pilots for the future decommissioning of further plants with corresponding reactor types. To harness the technological challenges, organizational complexity and cultural sensitivities of decommissioning projects, the nuclear power division of E.ON has developed and implemented a knowledge management (KM) concept to effectively capture and transfer critical project experiences, best practice and lessons learned within and between decommissioning projects. The development of the KM concept was initiated in October 2002 on the basis of a quantitative business case. The operative concept was launched in March 2004.

This paper provides select insights and discusses key challenges of KM concept development and implementation and of the first months of KM operation. It provides related advice for KM practitioners with similar endeavours in the field of nuclear power plant decommissioning.

This paper does not provide an exhaustive description of E.ON's KM concept. To offer a balanced view of KM for the decommissioning of nuclear power plants, this paper draws in part on the authors' general practice experience beyond the scope of E.ON's KM activities.

KM OBJECTIVES

E.ON's KM concept for the decommissioning of nuclear power plants is targeting three objectives:

- To secure technical quality and safety standards during decommissioning projects.
- To minimize risk related to the duration and budget of decommissioning projects.
- To allow expeditious training and optimal use of project staff.

Minimization of budget-related risk deserves special attention. Efforts for the decommissioning of nuclear power plants, from the initial planning phases to the complete decontamination and dismantling of all of its components, are significant: costs amount to several hundred million Euros per plant. The time to completion of these tasks may take more

than 10 years. One reason for the high time and budget requirements is that much of the highly complex and sophisticated decommissioning process, ranging from legal to organizational, economic and technological aspects, is a novelty for the nuclear power plant staff hitherto in charge of operating the plant. Although much of the physical work can be outsourced to external consultants and service providers, the key know-how must be developed internally.

Once this know-how has been generated, much of it can be transferred to other nuclear power plants to be decommissioned. In fact, the inherent impact and transferability of the knowledge determines the ultimate amount of costs that can be saved, and the value that can be created in follow-on decommissioning projects.

With numerous nuclear power plant decommissioning projects scheduled in Germany, and with a double-digit percentage of each project subject to knowledge-based cost savings and value creation, the total benefit of nuclear knowledge management in this particular field becomes apparent.

KM REQUISITES

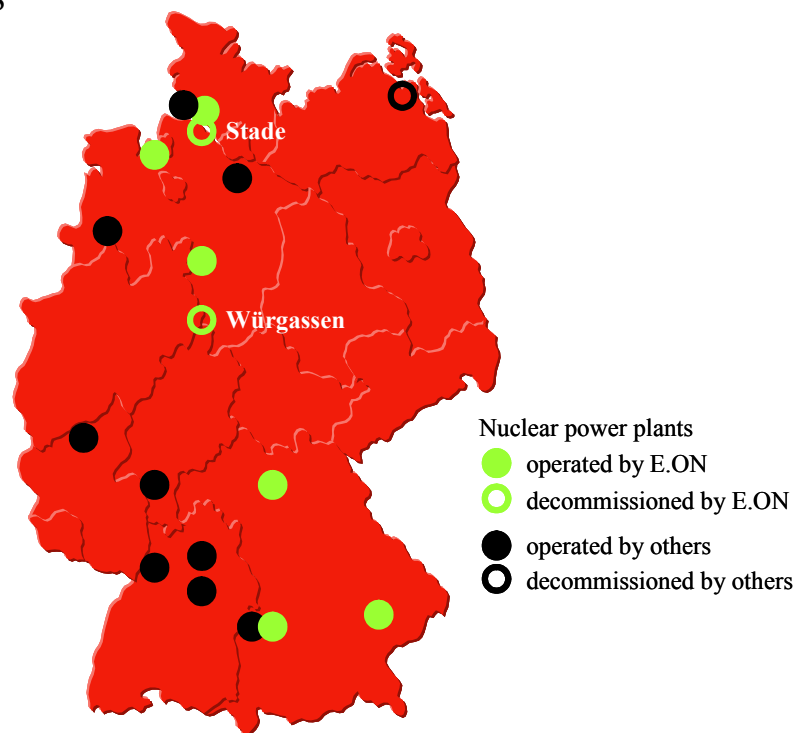


Figure 1: Selected major nuclear power plants in Germany

The following six sections outline conceptual aspects and related challenges of KM for the decommissioning of E.ON's nuclear power plants. These conceptual components are requisites, but certainly not guarantees, for the long-term success of KM on the basis of the objectives discussed above.

2.0. Content & Structure

Our preceding discussion of KM business objectives provided some insight on what type of decommissioning knowledge is to be distinctively managed. Such insight is rather important: a nuclear power plants decommissioning process produces an overwhelming flood of data, formal documents, technical reports, test statistics, etc. Yet, a crucial driver for the success of the decommissioning venture is the availability of personal practice experience, including distinctions of best practices, critical decisions, lessons learned, and approaches recommended in particular situations. This type of knowledge is an early ingredient of consolidated know-how and internal standards needed in the long run. Yet, it is not a natural by-product of the decommissioning process and its documentation.

A first conceptual step for KM is a clear definition of – and commitment to – what this personal practice experience is, and what it is not.

To further structure the wealth of experience in the context of nuclear power plant decommissioning, and to allow navigation and search, a knowledge structure should be developed. Figure 2 displays an excerpt of this knowledge structure currently used by E.ON, consisting of eleven knowledge fields, each having two to seven subfields. Note, that this knowledge structure need not correspond to a directory structure of an underlying document management system, as knowledge contributions could be attributed to several knowledge

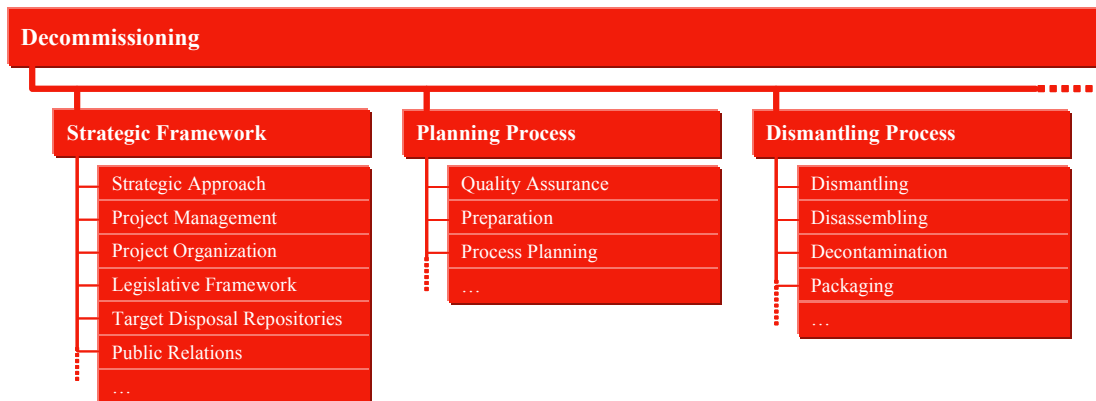


Figure 2: Excerpt of a knowledge structure

fields.

Deriving internal consensus on such knowledge structure is not a trivial task. To commit to a joint knowledge structure, and to its consistent use, the organization must first commit to a joint language that is free of double meanings, false interpretations and prevailing misunderstandings of a seemingly uniform, syndicated terminology.

While consensus on a knowledge structure can be typically obtained through systematic workshop discussions at working level, consensus on knowledge priorities typically cannot. Management decisions in line with a clear business focus are necessary to determine knowledge fields of high, medium and low importance within the knowledge structure thus introduced, reflecting that some knowledge fields bear more potential than others regarding the KM objectives listed in Section 2. Such distinction is necessary to allow targeted search and use of knowledge with respect to the underlying business objectives of KM.

Assigned knowledge fields and related priorities, knowledge origins, scope and validity claims are part of the meta data facilitating submission, navigation, search and retrieval of documented experience.

Three key challenges and related advice on content & structure:

- Be prepared for in-depth discussions on different interpretations of scientific and technical terminology when setting up the knowledge structure, especially when working with staff of different power plants. Don't suppress the technical discussions:
- fundamental terminological misunderstandings have to be cleared to provide a solid ground for KM.
- Be prepared for the same discussions when setting up a list of key words. In this case, however, keep key word lists to the absolute minimum by focusing on full-text search.
- Don't bring up the prioritization or even valuation of knowledge at working level, as there will be strong controversy with limited constructive results in sight. Knowledge prioritization is ultimately a management decision without much chance for consensus at working level.

2.1. Processes & Organization

After a closer specification of the required knowledge content and structure, processes are needed to capture, extract, prioritize, consolidate, transfer and disseminate this knowledge for further use throughout all decommissioning projects. Primary focus is placed on verbal transfer through personal conversations, meetings, events etc. Yellow page profiles facilitate the initial personal contact and ongoing networking with staff of other sites. To foster the networking with relation to the specific knowledge fields mentioned in the previous section, a center of competence (CoC) should be formed for each knowledge field. For the case of E.ON, eleven CoCs were formed.

To allow storage of key experiences over longer periods of time bridging the decommissioning of different nuclear power plants, thorough documentation is necessary. To handle documented experiences, three types of KM processes were designed and tied into the decommissioning process landscape, as outlined in Figure 3:

- Experience reports are generated locally through a structured on-site debriefing process. The experience reports are written once, and are not updated thereafter.
- CoC continuously screen the experience reports. Relevant experiences for the respective knowledge fields are extracted, prioritized and consolidated in the form of summaries on each one of the knowledge fields. These summaries are continuously kept up-to-date by the CoC through a central and possibly off-site process.
- Knowledge field summaries are used as streamlined input for follow-on decommissioning activities. Each summary may directly reference the original experience reports, which may then be used to check further details, if needed. This briefing process is tied into the decommissioning project and all its subprojects and tasks.

Considerable effort lies in the generation of experience reports, to be written after specific tasks throughout the decommission project are completed to capture the experiences made. This, however, is a one-time effort for each report, with fair effort distribution across the entire organization on-site. This also involves external service providers, which may receive a contractual clause asking them to submit an experience report after completion of their work. A questionnaire with all aspects to be covered in this report is supplemented, to avoid misunderstanding.

In contrast to experience reports, knowledge field summaries are always kept up-to-date, independent of site-specific particularities, and lie in the responsibility of the manager of the respective CoC. With eleven CoCs corresponding to the eleven knowledge fields, E.ON holds eleven summaries to be continuously updated. This volume is feasible considering the size of the organization, the target benefit of KM, and the resources allocated to KM activities.

In addition, however, local KM process support is necessary for the briefing and debriefing processes on site. Hence, one specially trained local knowledge manager per power plant site is typically necessary to ascertain the completeness and quality of local experience reports delivered. As specific KM-related functional qualifications are required, this task cannot be easily delegated to the decommissioning project management.

Local knowledge managers are complemented by a central knowledge manager who is in charge for overall conceptual issues and reports directly to the division management.

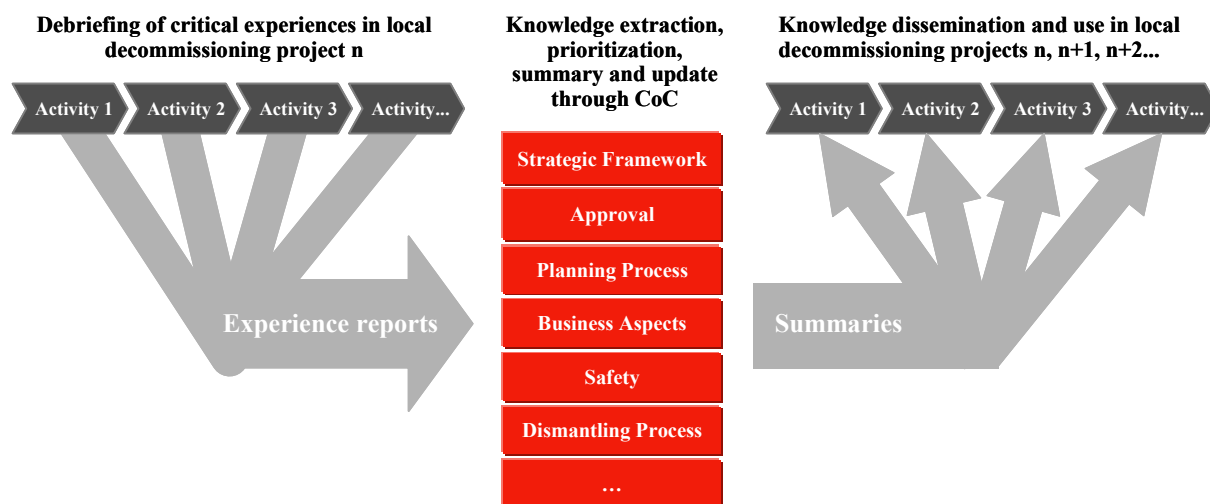


Figure 3: KM processes tied into the decommissioning process landscape

Three key challenges and related advice on processes & organization:

- Discuss the KM processes in detail with representatives of all sites involved, but limit the detail of KM workflow documentation. Demands regarding the depth of detail of new processes introduced in nuclear power plants are very high. Yet, KM processes are typically not as performance- and safety-relevant as technical processes in nuclear power plants, hence their documentation need not match the level of detail and rigor of technical process documentation.
- Be prepared for substantial discussions on additional resources needed for KM. There may be fundamentally different perceptions on how much work KM entails. Although KM may save a lot of resources at working level in the long run, in line with business objectives, it also consumes significant resources in the short run, particularly during launch.
- Knowledge managers must have high visibility, good standing and credibility within the organization, and must be well trained. KM is not a trivial task.

2.2. Cooperation & Culture

The previous section discussed organizational issues of KM from a very formal, structural perspective. Yet, another crucial requisite for KM success is the cultural shape of the organization with respect to KM. In fact, this requisite may even be a prerequisite for successful KM.

Cultural prerequisites take different facets. The first facet is trust of the individual project worker in her organization. Transferable and hence reusable practice experience on nuclear power plant decommissioning grants tremendous value to the decommissioning project staff. In a plant and project organization to be dissolved by the end of the successful decommissioning project, the benefit of knowledge debriefing may be significant for the

company as a whole, but does not become apparent to the individuals. Hence, KM must be complemented by clear signals of HR management regarding the further career perspectives of each crucial project member contributing to KM. In fact, a visible and credible personnel development program is necessary to effectively transfer critical knowledge within and between decommissioning projects.

A second cultural requisite with particular regard to critical (negative) experiences is fairness.

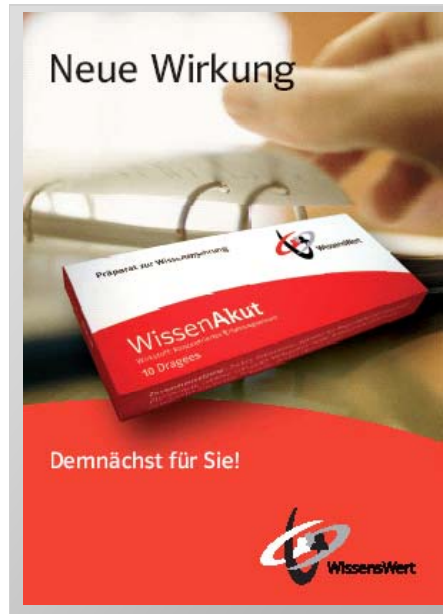


Figure 4: A poster promoting “knowledge pills”

With a KM concept in place, every member of a decommissioning project is still responsible for her actions, and faces consequences for mistakes. Yet, individuals must be able to pass on

their lessons learned without being penalized anew, neither directly by management, nor indirectly by the organization.

The third facet of the cultural KM requisites is freedom to communicate. The possibility to pass on personal, unfiltered practice experience to colleagues in other corporate sites without a lengthy screening process through the management hierarchy, reframing of point-of-views, reformulation of messages, etc. is essential for KM.

The fourth cultural requisites for KM is a strong understanding of KM benefits. A creative and visible communication campaign with well scheduled and targeted messages during the launch of KM activities proves to be useful to create both attention and understanding. Figure 4 displays a poster promoting “knowledge pills”, a gimmick to raise awareness for knowledge transfer within and between decommissioning projects.

Three key challenges and related advice on cooperation & culture:

- Culture is hard to shape through a KM concept. Announcements of a central knowledge manager promoting trust, fairness and freedom of communication may lack credibility if it is not complemented by observable facts at working level. In order to obtain observable facts, strong management commitment is required, and should be credibly signalled at working level.
- Cultural aspects are hard to shape all at once. Instead, observable cultural features should be addressed in select groups or key locations through sequential campaigns.

- Deriving the cultural requisites for effective KM takes time and requires transparency. A periodical cultural assessment, possibly as part of a sustainability concept discussed later in Section 3.6, may be of help in this regard.

2.3. Persuasion & Leadership

KM requisites of persuasion and leadership are tightly linked to aspects of cooperation and culture discussed in the previous section. Yet, it is recommended to highlight them in particular for their specific target audience at project and line management level rather than at working level.

There are two aspects of persuasion. Management must be persuaded that the potential long-term benefits of KM can and should be realized. Management must be able to persuade staff, in particular decommissioning project teams, that KM is beneficial. To persuade, words are not enough. Management must serve as a role model for KM:

- Communicate personal, critical experiences, and respectfully quote experiences of key experts during meetings and discussions.
- Actively approach key employees to discuss specific issues of KM, and explain the value of KM through success stories.

Leadership goes beyond persuasion. An important facet of leadership are the expectations set by management with regard to KM. If expectations are set through quantified targets, as is the case in many organizations, then a portion of these quantitative targets must be allocated to KM. Otherwise, KM will not play a crucial role in day-to-day business in the long run.

- Ask for specific experience reports, and honour good knowledge contributions in meetings and discussions.
- Sponsor and promote networks with employees of other sites, and reward related initiatives at working level.
- Provide time for KM-related activities: KM typically suffers from low priority, although it is oftentimes officially positioned as a top priority. Prioritize your expectations, explicitly indicating priorities 2 and 3 below the top priorities.

Expectations should be balanced in the sense that knowledge be delivered and used. This addresses in particular lessons learned, such as usefulness of dismantling tools, decontamination processes or true technical competencies of external service providers. A project manager learning a lesson although it was known and even documented, traceable and widely accessible, did not meet expectations. This should be clearly signalled for KM to remain credible.

Proactive documentation and transfer of critical experiences, best practice and lessons learned, exceed expectations. Hence, a special treat may be appropriate for particular contributions. Rewards could consist of concert tickets, a restaurant voucher or an invitation to another special event sponsored with a budget periodically allocated for each power plant site.

Three key challenges and related advice on persuasion & leadership:

- Be prepared that leadership requisites for KM are not in place in all areas of the organization. Use checklists to track commitment and related actions, such as the ones listed in this section.
- Use leaders of other organizations as external guest speakers to convey messages of persuasion and leadership at peer level.
- Obtain feedback from working level about the state and quality of persuasion.

2.4. Technology & Infrastructure

In contrast to the cultural and leadership aspects discussed in the previous sections, an IT solution is a much more tangible requisite for KM. This advantage should be explored wisely! In particular, a well designed mock-up of a target IT solution for a KM concept can help to

generate attention and interest for KM, to communicate its objectives and to obtain internal acceptance and support for a long way through a KM project.

Beyond an initial mock-up, the required media for effective KM have to be carefully specified before engaging an IT solution provider. The ideal set of media is typically a product of a discussion of what is needed and what can be provided. A corporate intranet with portal functions can provide a solid basis for a networked IT solution. Key functionalities are yellow pages and document management for navigation and search of experience reports and summaries, complemented by photo documentation and movie sequences. Further functions are news pages and a joint calendar of KM-related events. One possible extension is a discussion forum. E.ON chose a fairly slim and sober KM portal, illustrated in Figure 5, supporting the aforementioned functions.



Figure 5: A slim and sober IT solution

As nuclear power plant staff is technology-literate, a good IT solution will typically be appreciated. This does not mean that it is going to be used as a serious working instrument. Ownership for the solution is important. Representatives of all sites should be tied into the specification and testing of the IT solution, as it is part of generating attention and acceptance for KM.

Three key challenges and related advice on technology & infrastructure:

- Do not roll out a complex, exhaustive IT solution at once, but start with prioritized core functionalities: yellow pages and small-scale document submission and search. Then add more complex functionalities such as a discussion forum, tools for community building, topic subscription, project management, etc.
- Beware of investments in stand-alone media, e.g. local DMS, at power plant sites that are to be decommissioned. Rather, promote the network idea by expanding the functionalities of a corporate intranet.
- Engage a trusted IT service provider, and beware of new, untested solutions.

2.5. Impact & Resilience

Our discussion of KM objectives in Section 2 signalled a clear business expectation. Business impact is important for KM to be sustainable for any application: decommissioning of nuclear power plants is just one example. In this regard, a KM project should start with a solid

business case, or at least with a cost benefit assessment, based on a solid, validated, normative approach with a clear cash-flow projection.

Resilience of KM can be verified through transparency in three aspects:

- KM performance related to KM processes, the commitment of the organization, the cultural and leadership aspects and the functions and availability of the IT solution, can be verified periodically – every 3 to 6 months – through an anonymous questionnaire, displayed in Figure 6, to be completed by all staff involved in KM.
- KM efforts, in particular personnel-related expenses, and related budget commitments may be monitored through corresponding templates to be completed periodically by power plant or decommissioning project controllers.
- KM results in terms of reduced working time and budget risk can be tracked through a questionnaire for project and subproject managers with budget responsibility. For the tracking of quantitative results of KM, a proper and operable assessment approach is needed. This includes a clear understanding that tracked project cost savings through KM are *a priori* reflected in the project budget, and will not be subtracted after the project manager fills out this questionnaire.

Figure 6: An excerpt of a KM performance questionnaire

The quantitative results thus obtained may be consolidated in a KM scorecard to be reported to plant and division management by the central knowledge manager. The scorecard displays the current situation of the KM venture in line with the expectations set forth in the business case. This allows focused rewards for good KM performance, and targeted management interventions if KM activities go astray.

Three key challenges and related advice on impact & resilience:

- Carefully select the circle of people to actively involve in the development of a resilience concept. This is especially recommended with regard to KM results.

- Be prepared that the initial feedback on KM will result in red lights throughout your scorecard. Hence, start with low expectations, but raise them throughout the KM life cycle.
- Be prepared that expected benefits and committed resources for KM will be frequently questioned, especially when budget cuts are approaching. Hence, keep success stories on file and keep business case and scorecard up-to-date.

SUMMARY & DISCUSSION

In this paper, we outlined the background, objectives and conceptual components of KM for the decommissioning of nuclear power plants. Major components are:

- Briefing and debriefing processes tied into the decommissioning process landscape.
- CoCs for select knowledge fields, providing up-to-date summaries of experiences.
- Designated knowledge managers supporting KM on-site at working level.
- An intranet-based KM portal providing yellow page profiles, multimedia document management and other functions.
- Campaigns rooting KM in the corporate culture, and promoting persuasion and leadership.
- A KM scorecard supporting periodical reports of KM performance, efforts and results to plant and division management.

Insights gathered during KM concept development and during the first months of KM operation in Würgassen and Stade in particular stress the importance of organizational and cultural dimensions of KM beyond the necessary technological infrastructure:

- Visible resource and capacity commitment to KM by plant and division management.
- KM understood as an integral part of the decommissioning project leadership.
- Frequent reports of KM efforts and results to management to boost KM resilience.

The key question determining success or failure of KM, beyond persuasion, commitment and accountability, turns out to be skilful prioritization of tasks at working level. What priority should be assigned to KM in day-to-day business, given scarce resources during nuclear power plant decommissioning? The direct impact of a day's average KM contribution, such as passing on insights through a telephone call or writing several pages of a report, may be well below the decontamination or dismantling of half a ton of plant equipment. Given flexible operational planning with short time horizons, management decisions are not always in favor of KM. The cumulative signal and cultural consequences over a longer time horizon will thereby not allow to leverage business through KM.

Our recommendation for organizations interested in KM for nuclear power plant decommissioning would be to explore the potential benefits of KM and, if promising, to proceed with a small pilot project. This allows to monitor skilful management performance as a key ingredient for successful KM.