KNOWLEDGE MANAGEMENT AS AN ELEMENT IN REALIZING NUCLEAR TECHNOLOGY

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Abstract. A board spectrum of knowledge management (KM) tools and methods has been deployed yet, allowing the analysis of applications and success, and the identification of rules and challenges for further development: Acceptance by the staff favors 'localized' KM solutions that should be embedded in the business process complementary to quality management (QM) and project management (PM). Active KM involvement of experienced staff members and experts – e.g. by evaluation steps within KM procedures, as mentors for young employees, users of the tools and technical network participants – helps representing and transferring tacit knowledge. For future improvement they may form also the links in integrating the 'modular' KM landscape, bridging both the different business sectors and the phases of the plant life cycle. In regard to R&D for progress in nuclear technology, through this development KM will strengthen the basis contributing to identification and selection of the relevant issues.

1. Introduction

A company may be defined by its competences but it lives in realizing these competences in products. The technical knowledge needed in the business – here: in realizing nuclear technology – is usually taken a prerequisite in the company, as granted at a first glance. Understanding the role of knowledge management when applying this knowledge for our products, may optimize the business process, and in reversal will help to elucidate the needs and development requirements for KM methods and tools.

With this goal, the paper will outline the features of KM in the company first from more general observations, then it will analyse some examples deployed yet, and finally it will derive key aspects to be realized and some challenges faced for future KM systems.

2. The operational and the contextual dimension of KM in the business process

The analysis of KM 'in application' – focussing on knowledge with technical content mainly – may follow two dimensions:

When first considering the ***'operational' dimension***, one can start from the scope of the manufacturer's knowledge which covers the construction of plants, then accompanying its life cycle, and pursues the development of the technology for the future. A board spectrum of KM procedures and tools has been established yet for these different phases, from close product orientation to elements applied in 'support processes', as will be exemplified in sect. 3 below.

In cases of close KM integration in the business process, diversity over the different organizational sectors of the company has emerged: 'locally' optimized solutions are favoured by the specific conditions from the related technical field, by continuity and by ease of daily application. Accordingly the different 'local' solutions reflect also different but well adjusted positions in regard to KM parameters as the 'depth of knowledge accessible' – from specialized data to experience – and the 'sharing effect' of the KM application – some users to many units. Obviously many KM applications will be most efficient when developed under a clear limitation of these characteristics and do not cover all requests. 'Completeness' of the KM landscape can be analyzed from these parameters used as criteria.

On the other hand, ‘global’ KM tools are often preferred for integration in ‘global’ support processes (as human resource (HR) management).

The analysis of KM following a second, ***‘contextual’ dimension***, starts from the observation that knowledge is applied for business usually in the context of project management (PM) and quality management (QM). Both PM and QM are well established and organized under standards and guidelines. Both cover general – ‘management’ – aspects, using practices and tools often applicable in other industries as well, and may take profit from ‘best practices’ elsewhere. Regarding its general application, the same is true for KM, although there is still some delay in deployment.

Obviously successful projects require close interaction of the three management aspects; in very short form, *KM* helps to *devise*, *PM* helps to *act* and *QM* helps to *check* within a project, and none of them can replace one of the others. KM is not a stand-alone basis for the product; in contrary, PM and QM are focused more tightly to the realization of a product, relying on KM support as a ‘back office’ function – and in many cases they are ‘driving forces’ for KM deployment.

In this way, most of the aspects discussed usually for KM – as identification of knowledge gaps, acquisition of knowledge, its development, sharing, use, preservation and evaluation – are in part also tasks required for PM or QM. Interfaces between KM and QM are found e.g. when dealing with technical (input) data, when evaluating observations from plant operation, or when defining corrective actions in project realization. On the other hand there are interfaces between KM and PM, as in task-oriented organization of projects and related responsibilities, in competence profiles in human resources, and in appropriate tools and scope for project information systems. Of course there are also well-known links between PM and QM, as structuring the work by processes and related reviews, or methods for customer integration in acceptance.

Although not mentioned explicitly in some established PM guidelines, KM actions are obviously a prerequisite for optimized performance of PM processes – as ‘project scope definition’ and ‘verification’, or project HR processes as ‘staff acquisition’ and ‘team development’.

In regard to the QM regulations found in the ISO 9000 family of standards, KM has multiple while interacting roles: QM relies on the systematically organizing and describing the QM requirements, procedures and related results in the business process, i.e. it has to manage its knowledge consciously. An example is the ‘control of records’. Furthermore some KM steps are more closely linked to project work, e.g. in ensuring the ‘design and development input from previous similar designs’ (ISO9001, sect. 7.3.2 c) or the ‘records of results for corrective or preventive actions’ (sect. 8.5). Finally, the guidelines for performance improvements (ISO9004, sect 6.5) asks for KM as an action for “continual development of an organization’s knowledge, which is essential for making factual decisions and stimulation innovation”, and describe explicitly the different aspects for realisation in more detail.

Just from these few quotations it becomes clear that the deployment of a consolidated QM system will force the deployment of KM methods as well.

3. Examples for KM methods and tools deployed

The following examples of KM methods and tools deployed yet in the company for the different ‘operational phases’ may help to illustrate this context interaction as well as the operational benefit. Beside a document management system for technical and project support – implementing the company’s (and sometimes the customer’s) documentation guidelines –, these are:

Feedback procedure ('Lessons Learned') for new plant projects:

- capturing the experience gained during construction, including erection, commissioning and start-up, by formalized 'issue identification reports',
- integrating the evaluation of issues by a technical committee into the PM process of the current project,
- ensuring the transfer of improvements to future plant projects;

thus reducing erection time – and related capital cost – for next plants.

Making available standards and regulations in a systematic way:

- by a centralized information and update service,
- involving own experts in the external committees' work for the further development of standards and regulations.

Follow up nuclear event information globally:

- by collecting, comparing and assessing events systematically for technical proactive actions,
- sometimes as an input for corrections of internal quality guidelines;

thus identifying customer needs in advance also.

IT based KM tool used in nuclear maintenance services:

- supporting PM as a planning tool based on the related guidelines,
- ensuring complete and structured storage of service history and experience,
- making available technical data by a systematic data base solution;

resulting in plant service projects optimized in respect to technical reliability and duration.

Expert networks:

- leading the technological progress in our own core competences, while
- keeping high quality by 'distributed' evaluation of the new developments;

thus optimizing budget allocation and follow-up in R&D for development success.

Developing the staff responsively:

- defining consistent knowledge profiles for the employees from screening technical project needs,
- thereby optimizing the team structure of future projects,
- allocating the E&T activities for best benefit;

thus ensuring a well adjusted workforce – the main cost factor within the company.

Mentoring:

- deployed as an efficient instrument for transfer 'on-the-job' of relevant skills and experience – i.e. tacit knowledge,
- fostering alternative ways in solving project challenges by new people;

thus maintaining the knowledge of the company and facilitating the start-up phase for young employees.

External R&D co-operations:

- approach for extending knowledge by identifying alternative solutions,
- evaluation of the overall R&D progress in the nuclear field complementary to internal activities;

resulting in mutual benefit for the external institution and the company, keeping it on the edge of progress in a competitive environment.

4. Key aspects for KM development

The examples mentioned above were deployed successfully; others – not mentioned – were not. Thus the list can be used as a basis for outlining five key aspects for KM methods and tools, and criteria for future development and completion of a balanced KM landscape:

- *Allow for 'localized' tools and procedures.*

On has to live with 'smaller' solutions – not necessarily small. Development bottom-up of the KM method or tool makes easier the adjustment and acceptance, while a broader scope often compensates benefits for the user by increased complexity. Accepting this 'local' approach introduces a centrifugal component in KM that has to be balanced by the recommendation discussed next:

- *Ensure close coupling to the business process by intensifying interaction with QM and PM.*

This rule applies to the different KM approaches for projects in all phases of the plant life cycle. And as PM and QM are consolidated and well established activities both – as becomes visible for QM when referring to the fundamental ISO standards –, their interaction with KM will help to keep in line the different tools and methods.

- *Do not restrict KM activities to collection, but integrate evaluation and organize feedback.*

All examples given show that knowledge collection is only the half way for KM; neither the functionality not the contents of the KM approach can be optimized without closely coupled evaluation and feedback steps. Furthermore, these steps are the prerequisite for proactive actions – e.g. in service projects –, as one of the most beneficial goals of KM activities.

- *Take into account that tacit knowledge (or 'experience') has to be managed outside 'technical' KM tools.*

The situation of a business project is favourable for transfer of experience between people and should be used accordingly – no IT-based tool can take the place of that transfer. The focussed 'real' application of knowledge acquired by the newcomer from his mentor is the equivalent to the feedback requirement for the KM tools as mentioned above. And the close interaction of personal knowledge transfer with QM and HR aspects help to achieve a systematic integration with education & training actions.

- *Innovation deserves the input that is supplied by KM methods*

Innovation activities should comply with the strategic orientations of the company, but the experience collected during plant construction and life cycle will also help to derive and select the R&D objectives. This has to be complemented by linking internal and global progress of technology by networks of experts and external R&D co-operations.

5. Challenges

The development of KM oriented to specific business tasks has been proven successful. Nonetheless further improvement should especially focus to the reduction of barriers – without being detrimental to the approaches optimized 'locally'.

Remaining challenges to further KM development can be summarized as follows, indicating also the entry points for gradual solutions:

– *The different 'localized approaches' for the different technical fields should be integrated into a 'modular' KM landscape.*

As far as IT tools are concerned, the coupling of systems is – from a technical point – usually a task with a straight forward solution. An example is the joint collection of NDE observations and of operational input data for performing fluid induced corrosion analysis in piping. But linking of experience for the same technology in the different units in the company is more important: Sometimes this has been achieved by staff members with a broad background from a long career. Another appropriate approach is the set up of suitable networks, inherently a way of crossing borders. Examples of networks active in our business are 'welding and weld simulation', or 'radiology'. As a result in future, the constituents of the KM landscape in completion will be 'modular' tools – specific as far as needed –, used and thus interacting at an adjusted level by people in the related networks. Continuous extension of both the specific areas of information in the company and of personal expertise can be expected.

– *The interaction of these tools and procedures among the phases should be intensified*.

The extension of KM approaches within the company concerning a full life cycle view – i.e. over the 'phases' – can rely on the personal involvement of experts and their networks, similar as discussed for the 'localized' activities above. But when comparing the duration of plant life cycle and the duration of an expert's career, a careful mentoring and training program is required for maintaining competences for the technologies applied. This cannot be compensated alone by archiving electronically knowledge; implicit preconditions often are lost over time, which determine the value and applicability of these documents when used later.

Furthermore during a plant's life cycle the responsibilities will shift inevitably from the manufacturer to the utility, and this step limits the personal and IT based knowledge exchange and continuity. Even in an agreed co-operation – e.g. information on nuclear events – sometimes there will be limitations in the flow of detailed information due to confidentiality and competitive situation.

Finally, in regard to the phase of R&D for future nuclear technology, KM procedures must supply the relevant information from the other phases. A typical example is the long-term behavior of materials or components. But again, if external R&D co-operations are involved, KM cannot mitigate the non-symmetric situation when affecting core competences of the manufacturer by the information. Only a case by case decision might reduce the barrier.

– *The simultaneous use of internal sources and the KM tools in the public domain has to be fostered.*

The broad scope of services for knowledge access offered by the public organizations is indispensable – although often partly visible in the background only – for complementing the internal KM landscape in the company. Safety related IAEA publications as well as the fa mous TECDOC series are often consulted by the engineering teams. The systematic collection of bibliographic information offered by the INIS database is a task that can be realized by a public organization only; it has become an important source for studies prior to R&D activities in the company.

Generic ands non-commercial nuclear knowledge should be shared. But in a commercial company the results in nuclear technology in these categories are limited, and if results open for the public, they are published usually, and can finally be retrieved in public databases. KM improvements rely on the discussion of experts with the public organization on the contents selected and the data structures needed by the industrial engineer.

6. Conclusions

Construction of nuclear power plants, fuel supply, service, and the related R&D for progress in these fields constitute a highly complex business. The analysis of KM tools and methods deployed yet has shown that only the interaction of the different ‘modular’ KM elements – from IT supported tools to personal involvement of experts – will result in a KM landscape that come up to the broad expectations from the different nuclear technologies. ‘Local’ KM needs of the engineer should fit into the overall KM context for the plant life cycle, and should be complementary to QM and PM frames for his work.

According to this general KM structure, the further development of the KM landscape has to be balanced between self organization and conscious guidance: KM optimization for the business is a task for our engineers and for the management alike. The driving force stems from the continuous improvement of our processes that will result in a financial benefit of our business.