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A Nuclear Knowledge Management Course for University Master's Level Programmes

VIENNA, 2023

TRAINING COURSE SERIES 82

A NUCLEAR KNOWLEDGE MANAGEMENT COURSE FOR UNIVERSITY MASTER'S LEVEL PROGRAMMES

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TRAINING COURSE SERIES No. 82

A NUCLEAR KNOWLEDGE MANAGEMENT COURSE FOR UNIVERSITY MASTER'S LEVEL PROGRAMMES

INTERNATIONAL ATOMIC ENERGY AGENCY
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FOREWORD

The important role that the IAEA plays in assisting Member States in the preservation and enhancement of nuclear knowledge by facilitating international collaboration on nuclear education and training and knowledge management has been recognized by the General Conference in several resolutions. These resolutions consider nuclear education and training as a prerequisite for nuclear and radiological organizations to operate in a safe and efficient manner. The resolutions request that the IAEA assist Member States in their efforts to ensure sustainable nuclear education and training, in all aspects of nuclear science and technology for peaceful purposes, focusing on the following areas: developing policies and strategies in nuclear knowledge management, including the key issue of nuclear education with recognition of national and regional needs and expectations; fostering strong regional or interregional nuclear education networks; facilitating the harmonization of curricula in nuclear education and training programmes; promoting the awareness and use of nuclear research facilities and simulators as effective tools to enhance education and research and to maintain capability; and providing assist visits to address emergent problems and long term issues related to nuclear education. In this regard, the IAEA has organized meetings, training events and schools to promote the concept of nuclear knowledge management and increase the awareness of the subject among Member States.

Considering the importance of nuclear knowledge for power generation and non-power applications, it would be appropriate to include a course on nuclear knowledge management in university nuclear educational programmes. This publication provides a suggested curriculum for establishing a university master's level course on nuclear knowledge management.

The IAEA officers responsible for this publication were M.E. Urso and J.W. Roberts of the Division of Planning, Information and Knowledge Management.

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1. INTRODUCTION

1.1 BACKGROUND

Knowledge management has established itself as a key strategic approach for the management of intellectual assets in many successful organizations. Nuclear knowledge, nuclear facilities and the nuclear industry can be complex and multifaceted with a need for firm and sizable commitments over long timeframes. For organizations dealing with nuclear science and technology, knowledge management throughout these long timeframes can improve safety and efficiency, increase innovation and help preserve and enhance current knowledge.

Nuclear knowledge management (NKM) has acquired an increasing importance in the nuclear sector as a result of a number of challenges and trends:

- The accumulation of several decades of valuable nuclear knowledge in Member States with mature nuclear programmes has to be assessed and preserved for future use.
- In countries with mature nuclear programmes, there is a persistent need to recruit and retain workers to sustain the safe operation of existing facilities, their decommissioning and radioactive waste management programmes. Key issues are the replacement of workers who leave through retirement, or other forms of attrition, and attracting the younger generation;
- In countries with expanding nuclear programmes, skilled and trained workers are needed for the design, construction and operation of future nuclear installations. Capacity building through education and training and the transfer of knowledge from centres of knowledge to centres of growth are key issues.
- Non-power applications of nuclear technologies require a stable or growing base of nuclear knowledge and trained professionals for medical applications such as cancer treatment, or for food preservation and agriculture. This need is present in all Member States using any form of nuclear technology.
- Collaboration and the sharing of relevant knowledge can contribute to safety, efficiency and innovation. This can be achieved through the development of information technology (IT) tools, knowledge portals, databases of operating experience and communities of practice, but access to this information needs to be continually improved and expanded.
- Networking education and training with common curricula and harmonised qualifications can make nuclear education more attractive to students through the ability to take courses at other universities other than their host institute, facilitate the exchange of human resources and contribute to the development of educational quality benchmarks.

The IAEA Safety Standard GSR Part 2 on Leadership and Management for Safety [1] states that ‘The knowledge and the information of the organization shall be managed as a resource.’ Thus, given the importance of nuclear knowledge and its management for power generation and non-power applications, it is considered appropriate to include an introduction to the topic at university master’s level. A substantive curriculum is vital for a successful NKM course. While there is no international standard for the development of the content of such curricula, substantial consensus has been formed among educators in various organizations, including the IAEA, on what constitutes a high quality NKM curriculum.

Based on the above background, a university master’s level course on NKM is proposed as described in this publication.

1.2 OBJECTIVE

The objective of the publication is to support Member States, particularly universities, to establish a master's level course in nuclear knowledge management. The learning objective of the course is to understand how to establish a knowledge management culture and practice as a part of national capacity building policies and strategies, as well as an integral part of nuclear and radiological organizations' infrastructure.

1.3 SCOPE

The publication provides a suggested curriculum for the development of an NKM course for university master's level programmes, with introductory descriptions of eight modules to support the implementation of the course. The curriculum focuses on fundamental aspects of knowledge management, covering the following main topics:

- Knowledge concepts with an introduction to nuclear knowledge;
- Knowledge management history and development;
- Knowledge management for nuclear science and technology;
- Managing tacit and critical knowledge;
- Managing explicit knowledge and information;
- Organizational challenges and approaches for NKM;
- Implementing knowledge management in different nuclear organizations;
- NKM maturity assessment.

Further information and material to support the implementation of this course is available directly from the IAEA Nuclear Knowledge Management Section or for download from the IAEA website.

1.4 STRUCTURE

Section 2 provides an overview of the course, its target audience, the prerequisites for its organization and an introduction to the curriculum, its structure and the suggested duration of individual modules. The learning objectives and contents for each module of the curriculum are detailed in Section 3. Relevant publications and additional supporting material are also referenced for further reading.

2. DESCRIPTION OF THE COURSE

2.1 CONTRIBUTION TO NUCLEAR SCIENCE, TECHNOLOGY AND ENGINEERING EDUCATIONAL PROGRAMMES

The course on NKM outlined in this publication is proposed for inclusion in master's degree programmes in nuclear science, technology or engineering. The IAEA publication on Nuclear Engineering Education: A Competence-based Approach to Curricula Development [2] outlines the learning objectives, the learning outcomes and related competencies that are sought in nuclear engineering educational programmes. A complete core curriculum for such programmes should incorporate not only technical courses but also managerial courses on communication, team working, basic business, project management and knowledge management.

The expectations for master's level graduates are that they acquire the ability to not only analyse, summarize and evaluate the knowledge they have gained, but also be able to apply this knowledge. In particular, the specific competences that a master's graduate in nuclear engineering is expected to possess include:

- Project management skills for collaborative efforts with other team members, to assess the quality and efficiency of personnel and upgrade their performance;
- Organizational and managerial skills, including knowledge management, to optimize project outcomes with respect to safety, quality, reliability, economy, and the protection of the environment.

2.2 DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES

Upon completion of the NKM course it is expected that students will be able to critically appraise the nature of nuclear knowledge, its management and how this can contribute towards achieving the main NKM objectives of contributing to the safe operation of nuclear and radiological facilities, with improvements in economic and operational performance, facilitating innovations and ensuring the responsible use of sensitive knowledge.

By gaining these competencies, students are able to:

- Understand the meaning and importance of treating knowledge as an asset;
- Identify the potential benefits of applying knowledge management tools and techniques;
- Understand the approaches and practices to manage nuclear knowledge;
- Effectively utilize specialized information resources;
- Identify and apply appropriate knowledge management methods and tools in their future workplace.

2.3 TARGET AUDIENCE AND PREREQUISITES FOR THE COURSE

The course is intended for master's level students of nuclear science, technology and engineering, who are expected to have completed a bachelor's degree in science or engineering. Its content can also be modified or adapted to be used as a general basic course on knowledge management for other science or engineering programmes (e.g., general and specific engineering, physics, chemistry, medical physics, radiology and bio-sciences).

It is suggested to include the NKM curriculum in the second half of a master's programme, when a basic or intermediate level of nuclear knowledge has been acquired. At this point the students are able to comprehend the value of managing this knowledge as an asset.

The course can also be used as a basis for a training course on NKM (within continuous education) for managers and technical professionals working in nuclear and radiological organizations.

2.4 CURRICULUM

The curriculum of the proposed NKM course is structured in eight modules. The main topics and concepts addressed in each of the modules are detailed in Table 1.

TABLE 1. THE MAIN ELEMENTS OF THE NKM COURSE

Module No.	Module name	Main topics and concepts
1	Knowledge concepts with an introduction to nuclear knowledge	What is knowledge? Types of knowledge: — Tacit, explicit, implicit; — Data and information vs. knowledge; — Knowledge as a resource; — Intellectual capital; — Critical knowledge. Individual and organizational aspects of knowledge: — Knowledge workers; — Nuclear knowledge.
2	Knowledge management history and development	Knowledge management history and development; Knowledge management models; Main elements of knowledge management; Benefits of knowledge management; Knowledge management tools and techniques; Introduction to knowledge management strategies and implementation: — Project management; — Integration into management system; — Nuclear knowledge management.
3	Knowledge Management for nuclear science and technology	NKM specifics; Needs and challenges of knowledge management for nuclear science and technology; NKM objectives (safety, performance, economics, innovations, responsible use); Managing loss of knowledge and critical competencies; Risk and consequences of knowledge loss (explicit and tacit); NKM and safety culture; Elements of effective NKM systems; Performance indicators; Case studies.
4	Managing tacit knowledge	Human resource management and competence development; Knowledge prioritization; Techniques to identify, capture and transfer tacit knowledge: — Communities of practice, knowledge mapping; — Simulators, mentoring, interviews, on the job training, etc.; Identifying and managing critical knowledge; Knowledge loss risk assessment and management; Case studies.
5	Managing explicit knowledge and information	History of managing nuclear information; Methods and tools for managing explicit knowledge and ensuring its responsible use; Knowledge organization systems (ontologies, taxonomies, thesauri, etc.); Information preservation; Specialized nuclear related information resources.

TABLE 1. THE MAIN ELEMENTS OF THE NKM COURSE, cont.

Module No.	Module name	Main topics and concepts
6	NKM Organizational challenges and approaches	Linkage of knowledge management with business goals and safety; Linkage of knowledge management with the organizational and individual performance; Knowledge management policy and strategy development and implementation; — Roles and responsibilities; — Change management plan; — Stakeholders; — Timeframes; — Cross-cutting organizational impact; — Evaluation of the knowledge management effectiveness. Integration of NKM in organizational management systems: — Process oriented knowledge management. Organizational culture influence: — Facilitating organizational learning; — Building a knowledge sharing culture. Implementation of NKM projects and programmes.
7	Implementing NKM in specific organizations	Knowledge domains within organizations: common and different features; Specifics of each type of organization; Case studies: NKM in different nuclear and radiological organizations: — Nuclear power plants; — Research and development (R&D) organizations; — Universities; — Regulatory bodies; — Other users of nuclear and radiation technology.
8	NKM maturity assessment	Knowledge management maturity models; The IAEA NKM maturity model; Assessment, methodology, tools and implementation; Case study.

In Table 2, the suggested number of learning hours for each module is presented in terms of lectures, practical sessions and recommended self-study time. The core is the minimum time required for the course. Topics can be expanded, depending on the specific target audience.

TABLE 2. TIME ALLOCATION FOR THE COURSE IMPLEMENTATION (in hours)

Module No.	Lectures		Practical		Self-study
	Core	Optional	Core	Optional	
1	1	-	-	2	3
2	2	-	-	-	6
3	3	2	2	2	9
4	3	2	2	2	9
5	3	1	2	2	9
6	3	2	2	2	9
7	3	3	2	2	9
8	2	-	2	2	6
Total	20	10	12	14	60

For the practical sessions, a list of possible core and optional exercises, with the minimum time to be allocated for each of them, is presented below. The practical sessions can be adjusted for the particular audience, scope and available time with the minimum recommended hours extended accordingly (e.g., as suggested in Table 2).

List of practical sessions:

Module 1:

- Introduction to nuclear knowledge and knowledge concepts (optional session) — 1 hour;
- Differentiating between explicit and tacit knowledge (optional session) — 1 hour.

Module 2:

- None.

Module 3:

- Knowledge loss risk management 2 hours plus 2 optional hours.

Module 4:

- Concept map exercise – 2 hours;
- Methods for identifying, capturing, preserving, transferring and using tacit knowledge (optional session) — 2 hours.

Module 5:

- Development of a project proposal for information preservation in nuclear organization — 2 hours;
- Selection of IT tools for managing information (optional session) — 1-2 hours;
- The development of taxonomy for nuclear reactors (optional session) — 2 hours.

Module 6:

- Critical assessment of selected knowledge management topics — 2 hours;
- Organizational culture (optional session) — minimum of 2 hours.

Module 7:

- NKM for different organizations: matching main issues with appropriate tools — 2 hours;
- Development of a knowledge management portal (scenario A) (optional session) — minimum of 2 hours;
- Development of a university knowledge management portal (scenario B) (optional session) — minimum of 2 hours.

Module 8:

- Knowledge management maturity assessment for different types of nuclear organizations — 2 hours plus 2 optional hours.

3. DESCRIPTION OF THE MODULES

The proposed content of each of the eight modules is described below to provide guidance for the design of the NKM course.

3.1 MODULE 1: KNOWLEDGE CONCEPTS WITH AN INTRODUCTION TO NUCLEAR KNOWLEDGE

3.1.1 Learning objectives

After completing this module, the student should be able to:

- Define knowledge;
- Define and give examples of explicit, tacit and implicit knowledge;
- Relate data and information to knowledge;
- Explain how knowledge can be used as a resource;
- Explain individual, organizational and relational aspects of knowledge;
- Differentiate between organizational and individual learning;
- Define knowledge workers;
- Explain the relationship between knowledge and competence;
- Describe the specifics of nuclear knowledge.

3.1.2 Module content summary

This module introduces the basic concepts, terminology and definitions relevant to understanding knowledge, with emphasis on knowledge related to the nuclear industry. Various definitions are available but for the purpose of this course the following IAEA definition for knowledge is recommended:

'Knowledge is bodies of facts and principles accumulated over the course of time.' [3].

Similarly, the following IAEA definitions [3] for knowledge types can be used throughout the course:

- **Explicit**: Knowledge that is contained in, for example, documents, drawings, calculations, designs, databases, procedures and manuals.
- **Tacit**: Knowledge that is held in a person's mind and has typically not been captured or transferred in any form. Compared with explicit knowledge, tacit knowledge is more difficult to articulate or write down and so it tends to be shared between people through discussion, stories and personal interactions. It includes skills, experiences, insight, intuition and judgement.
- **Implicit**: Often an alternative term for tacit knowledge. However, a distinction can be made in that implicit knowledge, typically held in a person's mind or consciousness, can be written down and, therefore, is more easily shared than tacit.

An important issue is the relationship between knowledge and competence, as competence enables a person to act effectively in a job or situation. Competence indicates that someone has sufficient knowledge and skills to act in a wide variety of situations. The level of competence is expected to be aligned with the level of responsibility and may be developed through a combination of education, experience and training, with their contributions varying depending on the circumstance. Sometimes the term competency is also used in relation to a generic task or function (e.g., for nuclear or radiological facility manager jobs). The IAEA defines competence as 'the ability to put skills, knowledge and attitudes into practice in order to perform activities or a job in an effective and efficient manner within an occupation or job position to identified standards' [4].

Knowledge as a resource can be explored by examining how it provides value to an organization. Aspects related to organizational learning can be explained and the different ways of learning for organizations and individuals considered. Terms such as knowledge asset, intellectual capital and critical knowledge can be introduced. Critical knowledge is the most significant knowledge, its loss, failed preservation or inadequate implementation would directly and immediately challenge the safety or operational and commercial viability. It is important to include the process of managing intellectual capital related to knowledge management and the investment necessary to build nuclear knowledge intellectual capital. Individual and organizational learning can be discussed and contrasted, with their different learning methods compared.

Due to its complexity, nuclear knowledge can only be retained through significant financial commitment and government support as it is developed, shared and transferred over many generations. Over the full lifecycle of nuclear and radiological facilities a combination of personal skills and experience is needed to turn relevant information into useable knowledge over possibly very long timescales for the development of the facilities. Significant investments by governments or large organizations are necessary, as a large critical mass of basic nuclear science is needed to support its practical application.

3.2 MODULE 2: KNOWLEDGE MANAGEMENT HISTORY AND DEVELOPMENT

3.2.1 Learning objectives

After completing this module, the student should be able to:

- Define knowledge management;
- Provide a brief overview of the history and development of knowledge management;
- Describe the various knowledge management models;
- Explain the importance and benefits of knowledge management;
- Describe the main knowledge management tools and techniques;
- Describe various approaches to knowledge management;
- Discuss knowledge management strategy development and project management;
- Explain the specifics of nuclear knowledge and why its management is particularly important.

3.2.2 Module content summary

This module introduces the concept of knowledge management, initially by reviewing its history and development through to today's business focus. The importance of capturing and sharing knowledge in the business world is discussed, as well as why knowledge is an asset with value to organizations. Knowledge management benefits are outlined, with various approaches and implementation strategies analysed. The specific characteristics of nuclear knowledge are discussed with a special emphasis on knowledge management in the nuclear and radiological organizations and facilities.

Knowledge management has several different definitions with many recognized knowledge management experts having their own versions:

- "Knowledge management is a business philosophy. It is an emerging set of principles, processes, organizational structures and technology applications that help people share and leverage their knowledge to meet their business objectives"[1]…;
- "The purpose of knowledge management is to provide support for improved decision making and innovation throughout the organization. This is achieved through the effective

[1] http://www.gurteen.com/gurteen/gurteen.nsf/id/knowledge-management

management of human intuition and experience augmented by the provision of information, processes and technology together with training and mentoring programmes"[2].

The IAEA defines knowledge management as coordinated, integrated, systemic practices and activities, which enable and promote effective knowledge processes and ensure adequate knowledge assets as needed to achieve organizational goals. This definition is well suited for the purposes of this course.

Whatever definition is used, it is important to understand how knowledge management has evolved over many years to become a significant area of study with applications and impact over most aspects of business, research and development and academia.

During the 1980s knowledge started to be recognized as a key business asset, with articles on knowledge management beginning to appear in journals and books. In the 1990s organizations, which had previously considered only natural resources as assets, began to realize the importance of intellectual assets. Organizational cultures where knowledge was previously hoarded, started to develop a new approach of knowledge sharing. As a result, studies about how knowledge is acquired, used and shared became a subject to be understood.

It also became apparent how valuable people were to organizations, as they were creating and accumulating the knowledge. The value of people was instrumental in determining the success of the organizations. The focus then shifted on to creating procedures and a culture in which the knowledge of individuals and of the organization was shared.

Although organizations knew what knowledge was, they lacked the procedures to find out where it resided: who had the knowledge, how to nourish and manage it and how to change the work culture to support the establishment of knowledge networks. Technology was used to ease the codification, sharing, storage and delivery of knowledge. The challenge became how to develop successful knowledge management models.

For an organization to invest resources (time and money) in any programme, a return on the investment is generally expected. One of the first questions management often asks is, "what are the benefits?". This is a justified question but for programmes like knowledge management, it may be difficult to quantify the benefits. Separating the benefits of knowledge management from other programmes or processes, such as succession planning, training or human performance can be difficult. Sometimes benefits come from several connected programmes. If important knowledge is captured, preserved and transferred, there will be measurable benefits.

Executive leadership support is key to the success of any project or programme, including knowledge management. Other important elements to be considered in the development of strategies and in the implementation of knowledge management projects include:

(1) Knowledge management policy and strategy:

- Written policies for implementing a knowledge management strategy;
- Integration into the management system;
- Communication strategy;
- Identification of responsibilities;
- Personal involvement of managers.

[2] https://info-architecture.blogspot.com/2009/11/what-is-knowledge-management.html

(2) Human resource processes for knowledge management:

— A comprehensive workforce planning methodology;
— Succession planning;
— Risk assessment for critical knowledge loss;
— Employee development plans for knowledge management;
— Job profiles, competency mapping or equivalent to assess and monitor skills/competencies;
— A supportive training and learning environment.

(3) Training and competence development for knowledge management:

— Mentoring and coaching;
— A systematic approach to training;
— Simulator use;
— E-learning and continuous education;
— Refresher training;
— Human performance improvement.

(4) Methods, procedures and documentation processes for improving knowledge management:

— Learning from operating experience;
— Work control methods;
— Error prevention;
— Document control and configuration procedures;
— Corrective action programmes;
— Benchmarking.

(5) Information Technology (IT) solutions for knowledge management:

— Knowledge databases;
— Content and document management systems;
— Skills and competencies databases;
— Data collection, processing and storage.

(6) Approaches for the capture and transfer of knowledge:

— Development of taxonomies;
— A process for critical knowledge identification;
— Processes for knowledge harvesting;
— Concept mapping;
— Communities of practice;
— Mentoring and coaching;
— Diffusion, transfer and utilization of captured knowledge.

(7) Organizational culture to support knowledge management:

— A culture that promotes knowledge sharing;
— A no blame environment for the reporting of incidents and events and the sharing of lessons learned;
— Sharing knowledge methods and tools;
— Leadership and commitment.

(8) Internal and external collaboration for knowledge management:

- Collaboration with other units of the organization;
- Collaboration with other organizations;
- Joint projects;
- Lessons learned.

Several of these elements are discussed in more detail in the following modules. Knowledge management programmes are not intended to replace other programmes and processes, such as human resource development or training and information technology, but rather to enhance their overall effectiveness.

In the nuclear industry, several major characteristics that influence knowledge management can be identified. Nuclear facilities have a long lifecycle of construction, operation and decommissioning, with a long-term accumulation of knowledge. This nuclear knowledge is retained, transferred and used over long periods of time, typically greater than 100 years. Significant investments by governments and organizations are needed for the development of the necessary nuclear knowledge base needed to support practical applications in the nuclear industry. The responsibility for maintaining this knowledge base cannot solely be the responsibility of private industry where the focus is short-term and business driven. A large critical mass of basic nuclear knowledge is needed to support practical applications across the entire nuclear industry.

Gaps in nuclear competencies have emerged in the management of large projects, new build and vendor performance. For decommissioning and waste management, knowledgeable and skilled workers are needed for many decades. Future nuclear knowledge and competencies are necessary to support new applications in medicine and agriculture as well as nuclear programmes (power and non-power) in embarking countries. Knowledge retention and transfer to the new nuclear workforce are ongoing concerns, it is therefore very important to maintain and expand knowledge management programmes for the nuclear industry to successfully meet the current and future challenges.

3.3 MODULE 3: KNOWLEDGE MANAGEMENT FOR NUCLEAR SCIENCE AND TECHNOLOGY

3.3.1 Learning objectives

After completing this module, the student should be able to:

- Interpret the meaning of nuclear knowledge;
- Describe the needs and challenges of knowledge management for nuclear science and technology;
- Identify the nuclear stakeholders and explain their role in NKM;
- Explain the elements of an effective NKM system;
- Understand the NKM differences in countries at different stages of nuclear programme deployment and maturity;
- Be familiar with the NKM objectives envisioned by the IAEA and apply this understanding to the needs of organizations;
- Be familiar with the IAEA approach to address the potential loss of knowledge and skills in nuclear organizations;
- Understand the link between knowledge management and safety culture.

3.3.2 Module content summary

The module presents the main drivers for applying knowledge management in nuclear organizations, along with the basic approaches for its implementation. The meaning of nuclear knowledge and elements of an effective knowledge management system are explained, as well as the role of nuclear stakeholders

in knowledge management implementation. The module also describes the relationship between knowledge management and safety culture.

Information and knowledge are continually created, lessons learned and new practices adopted and improved throughout the different phases of a nuclear facility's lifecycle. The challenge is how to identify, organize, capture and easily disseminate the knowledge created within these phases. Good knowledge management can offer significant business value and have a considerable impact on nuclear safety and cost savings by creating a dynamic learning organization that:

- Minimizes the impact of worker mobility and attrition;
- Maintains high levels of information integrity;
- Reduces costs through the availability of knowledge that enhances quality collaboration and minimizes the impact on work schedules caused by reworking and repeatable errors.

For nuclear technology development, a continuous, consistent and well-managed human resource development programme is a prerequisite, with training in nuclear related skills and education in nuclear relevant subjects. This will ensure a continual supply of the required skills and knowledge to establish and maintain the workforce.

Increasing interest in the development of knowledge management programmes in Member States underlines a growing recognition that measures need to be implemented to avert knowledge loss. Knowledge loss is an on-going threat in countries with mature nuclear programmes due to the ageing workforce and sometimes inadequate knowledge transfer processes. Loss of knowledge may also occur in developing countries if the number of employment opportunities is declining.

Member States have a significant responsibility to ensure that advanced nuclear science and engineering education and research programmes are in place. A coordinated approach to education, training and outreach is necessary to demonstrate a commitment to this important industry sector and to support the next generation of nuclear and radiological professionals. Without skilled and experienced professionals, there is a risk that significant gaps will develop in the nuclear knowledge base. This may lead to critical errors in technical decisions that impact safety, it may result in the need to recreate knowledge at very high costs, or it may prevent the creation of new knowledge.

NKM issues and priorities are often unique to the circumstances of individual Member States and their nuclear industry and radiological organizations. They may determine the main focus of the NKM programme, which could be directed towards knowledge creation, identification, sharing, transfer, protection, validation, storage, dissemination, preservation or utilization.

The nuclear and radiological industries operate within an organizational culture that recognizes the value of nuclear knowledge based on people with their expertise and experience, organizational processes and technology. Each is to be considered within the context of the organizational culture, with effective NKM focusing on strengthening and aligning the knowledge base of these three knowledge aspects. Knowledge management policies and practices can help create a supportive organizational culture that recognizes the value of nuclear knowledge and promotes effective knowledge processes.

The creation, dissemination, sharing, transfer and application of nuclear knowledge can only be achieved by people who have the appropriate skills, experience, attitude and motivation. Work methods and practices are controlled through processes which ensure that activities are undertaken in an orderly and consistent way, including the effective control of knowledge. In a highly regulated environment, such as that governing organizations that deal with nuclear and radiological technologies, clear directives, governance and oversight are essential to preserve safety, control risk and ensure efficiency. Methodological know-how is embedded in processes and procedures and in the training programmes that support them. Technology is used to apply or access the knowledge to achieve a specific purpose or function. Information systems technology is a key enabler to support knowledge processes.

Nuclear organizations need to develop and implement an NKM strategy that provides a framework for establishing principles, policy, priorities and plans to apply knowledge management practices in the workplace. Clearly defined objectives will help establish the role of knowledge management in the nuclear organization.

In addition, the integration of knowledge management into the overall organizational management system is fundamental and its implementation may involve the application of any of a wide range of knowledge management practices to enhance and support traditional business functions and goals such as human resource management, training, planning, operations, maintenance, projects, innovation, performance and risk management, information management, process management, organizational learning and IT support.

When presenting and discussing nuclear knowledge management, it is important to highlight the knowledge-based nature and the elements of knowledge management in the general approach to building nuclear safety culture. NKM issues that affect or can undermine a safety culture are:

- The quality of communications between the staff and senior management;
- The attitude of senior management towards safety culture;
- Degradation of knowledge related to site-specific jobs;
- An aging workforce and decline in job applications from the younger generation;
- Insufficient funds within some sectors to provide job security and therefore knowledge preservation;
- An imbalance between the government, regulatory and operational sectors created by salary disparity;
- Ageing technology and equipment and the need for maintenance and upgrades;
- Lack of the appropriate competence for new projects and facilities;
- The need for knowledge transfer and experience sharing.

NKM and nuclear safety culture have a functional relationship based on the common overall objective to maintain safety and efficiency in nuclear and radiological facilities and to keep organizational and individual competencies and attitudes focused on the overriding priority of safety.

Decisions are based on the best knowledge and information available. Good NKM is therefore a critical enabler for safety, security, environmental and financial management. Once in place, it is fundamental that NKM is continuously sustained and further strengthened, so that, with appropriate support from the executive level, it becomes a robust component of the working environment and an organizational routine.

3.4 MODULE 4: MANAGING TACIT KNOWLEDGE

3.4.1 Learning objectives

After completing this module, the student should be able to:

- Describe the characteristics of tacit knowledge;
- Discuss the relationships of managing tacit knowledge with human resource management and competency development;
- Describe knowledge prioritization;
- Define critical knowledge and how it can be identified;
- Conduct a risk assessment to determine the potential for loss of critical knowledge caused by the loss of experienced workers;
- Identify appropriate techniques to identify, capture and transfer tacit knowledge.

3.4.2 Module content summary

This module describes the importance of tacit knowledge and how it can be managed and preserved within an organization for current and future nuclear and radiological applications. As the characteristics of tacit knowledge are explored, techniques for prioritizing and identifying critical knowledge are also described. The relationship between managing tacit knowledge, human resource management and competency management are reviewed.

Tacit knowledge is undocumented knowledge, considered to reside in the mind of the holder. Emphasis is therefore placed on using appropriate tools and techniques to capture, retain and transfer this knowledge. As noted in previous modules, it is very important to provide evidence that professionals are fully qualified and competent for their job. Adequate tools and strategies (job evaluation, competency inventories/profiles, etc.) are needed to establish the core competencies for specific tasks or positions. Tacit knowledge is a major contributor to competence.

Tacit knowledge can be very difficult to identify or describe even by the expert holder. It may involve knowledge of important work history, predictive ability, problem solving, intuition, etc. It is often easier to use an example of tacit knowledge for discussion purposes. For instance, a prominent case of tacit knowledge is that of an employee who can predict the impending failure of a component based on vibration, noise, smell or a variety of seemingly unrelated data and information. It takes time and experience to gain such tacit knowledge and it is very difficult to identify, capture, retain and use.

One way to describe tacit knowledge is through the following categories:

- **Know what** or **know that** –a body of knowledge embodied at some level by people, but also accessible in codified written form. This is the kind of knowledge you might acquire in formal learning, as recorded on a curriculum vitae.
- **Know who** – the knowledge that includes individuals' personal networks, contact databases and directories of experts. Systems can provide ways to structure information and access people's expertise which is a priority for any knowledge management programme.
- **Know how** – the knowledge that is about getting things done, there are two main elements, the processes, formal and informal, by which things get done and the unique expertise of individuals, their personal skills and capabilities.
- **Know when** – the knowledge of performing the right actions at the right time.
- **Know where** – the knowledge that is connected with a location.
- **Know why** – the knowledge or vision of a situation as a whole. This could be the value system that exists within an organization. For example, it is important for organizations to be able to communicate what they stand for to all stakeholders with clear business goals expressed and demonstrated to staff.

When attempting to capture knowledge from experts, it is important to acknowledge that the most valuable knowledge is often in their heads (tacit knowledge), but they may find it difficult to describe it or share it. Many experts do not communicate or share knowledge easily and tacit knowledge can be even more difficult for them to describe. Normally, only a part of an expert's knowledge is critical to the organization, it is therefore important to communicate to the expert clearly and precisely the information that needs to be shared.

While emphasis is given to tacit knowledge and its elicitation and preservation, not all knowledge in an organization needs to be identified and captured. An important first step is to identify the critical knowledge and those individuals who possess it.

In many organizations, only a small number of staff, sometimes less than 1%, actually possess critical knowledge. The process of identifying the critical knowledge through knowledge prioritization is focussed on the unique or critical skills and knowledge possessed by an employee. This process is usually carried out by managers as part of a knowledge loss risk assessment and critical positions are

categorized by a position risk factor, which reflects their vulnerability to loss. The risk assessment process allows an organization to focus time and effort on the truly critical knowledge by knowing what it is and who has it.

Very often, during the process of identifying critical knowledge, a positive outcome may be to find that critical resources are fewer than envisaged or that mitigation measures can easily be put in place, enabling process streamlining and economic savings. These results help to modify operational processes and considerably reduce the risks from the loss of critical knowledge in the future.

In this module it is important to explain the importance and characterization of critical knowledge and the numerous techniques utilized to conduct knowledge loss risk assessments, as well as ways to identify, capture and transfer tacit knowledge, such as mentoring, communities of practice, mind mapping, elicitation, etc. Before applying any capture techniques, identification of the different types of knowledge (historical knowledge, predictive ability, trouble shooting, etc.) ensures that appropriate and effective knowledge capture tools are applied.

3.5 MODULE 5: MANAGING EXPLICIT KNOWLEDGE AND INFORMATION

3.5.1 Learning objectives

After completing this module, the student should be able to:

- Summarize the history of nuclear information management;
- Understand the main principles and value of the International Nuclear Information System (INIS);
- Use the main INIS products: the INIS Database and the INIS Thesaurus;
- Understand the main practical steps in organizing activities for information management;
- Apply the knowledge gained towards practical applications for the preservation of concrete types of nuclear information;
- Evaluate and select the knowledge organization methodology to organize collections of concrete information;
- Select and apply the relevant knowledge organization methodology to describe a particular knowledge or subject domain;
- Develop a partial taxonomy based on the nuclear thesaurus for selected nuclear subjects;
- Use internet nuclear information resources efficiently.

3.5.2 Module content summary

This module provides the basis for managing nuclear information, spanning from a short history of information management through to an introduction of contemporary specialized nuclear information tools and resources, as detailed below:

- Information and explicit knowledge management;
- A brief history of nuclear information management;
- The INIS information system;
- The main elements of information management;
- International standards on digital preservation;
- Knowledge organization systems;
- International nuclear information resources.

This module describes the main types and sources of nuclear information and the most critical phases of information management. Various types of knowledge organization systems are introduced and their features explained.

The focus of information management is the ability of organizations to capture, manage, preserve, store and deliver the right information, to the right people, at the right time. A good organizational structure manages this information throughout the information lifecycle, regardless of its source or format (data, paper documents, electronic documents, audio, video, etc.) to ensure its delivery through multiple channels.

Nuclear research started at the beginning of the twentieth century and at the same time nuclear scientists began collecting, handling and sharing nuclear information. The immense potential of nuclear knowledge applications for human development was widely recognized, along with the need to carefully manage nuclear knowledge to harness its benefits and prevent its use for destructive purposes. The establishment of the International Atomic Energy Agency (IAEA) in 1957 constituted the first step by the international community to manage nuclear knowledge and information. The first division established in the IAEA was the Division of Scientific and Technical Information with their main goal to foster the exchange of scientific and technical information on the peaceful uses of atomic energy. In 1968 the United States of America and the Soviet Union made a proposal to develop the International Nuclear Information System (INIS) at the IAEA. The new system had to be based on international cooperation with the main contributors being the IAEA and INIS National Centres. INIS is the information system that covers the literature published worldwide on the peaceful uses of nuclear sciences and technology, it covers a wide domain of knowledge that reflects the knowledge domains of the IAEA.

The scope and aspects of the preservation of nuclear information are very wide and difficult to address in extensive detail in this short module. Digital technology offers distinctive advantages for institutions with extensive collections of information resources. Information content can be delivered directly to the reader without human intervention. It is now possible to replicate almost any type of traditional research material with digital technologies, so that reference to the original materials for most, if not all, purposes is now unnecessary.

The power of full text searching and sophisticated cross-collection indexing provides the opportunity to make new uses of traditional research resources but the corresponding investments for digitization and digital preservation can be significant.

The main goals of information preservation are to:

- Select the most valuable information to convey to future generations;
- Ensure that it remains readable, accessible and understandable;
- Manage technological change so that these objectives are met.

Usually, any process of information preservation consists of several important steps:

- Select and capture the information;
- Describe the information by assigning metadata;
- Select appropriate reliable storage and store the information;
- Provide access to information with corresponding restrictions, if necessary;
- Maintain information in a readable, accessible and understandable form and ensure its longevity.

Many organizations have developed their own procedures and practices for managing digital information.

Knowledge organization systems are very important for NKM activities. Structuring plans and information, meeting notes and ideas, all entail the development of knowledge organization systems. There are several approaches for organizing information and knowledge, the simplest forms are lists and catalogues, more complex examples are taxonomies and thesauri.

The selection of a knowledge organization system strongly depends on the scope and complexity of the knowledge management project. Some successful examples of knowledge organization systems developed in the IAEA include the INIS thesaurus, the IAEA Fast Reactor Knowledge Organization System (FR-KOS), the Radiation Safety Information Management System (RASIMS), the Database on Discharges of Radionuclides to the Atmosphere and Aquatic Environment (DIRATA), the Nuclear Security Information Portal (NUSEC) and the Unified System for Information Exchange in Incidents and Emergencies (USIE).

To accommodate changes in information technology, regular reviews of this module by teachers will be required to identify any modifications and updates to the content.

3.6 MODULE 6: NUCLEAR KNOWLEDGE MANAGEMENT ORGANIZATIONAL CHALLENGES AND APPROACHES

3.6.1 Learning objectives

After completing this module, the student should be able to:

- Explain the linkage between knowledge management, business goals, organizational performance, safety and safety culture, as well as the related benefits that can derive from applying NKM;
- Explain how organizational competence influences performance and the achievement of organizational objectives;
- Understand and explain the Fraunhofer reference model for knowledge management;
- Explain the principal knowledge attributes, approaches and main requirements for developing and implementing a policy and strategy for NKM;
- Be familiar with the IAEA safety standards on the management system for facilities and activities;
- Explain the meaning of the IAEA integrated management approach;
- Understand the meaning of the process-oriented knowledge management approach;
- Understand and explain the role of organizational culture in NKM;
- Explain the specifics of nuclear organizational culture and the basics of safety culture;
- Understand and explain knowledge sharing cultures, their importance, promotion and components;
- Understand the necessity of having a balance between sharing and protecting nuclear information and knowledge;
- Understand the role of leadership in implementing knowledge management, motivating people and building a knowledge sharing culture;
- Understand the role of IT in changing organizational culture;
- Illustrate the main steps in setting up, implementing and assessing NKM projects.

3.6.2 Module content summary

This module covers the possible organizational challenges of NKM:

- The wide spectrum of problems associated with the integration of NKM in an organizational management system;
- The relationship between NKM and corporative culture and how to build and maintain a knowledge sharing culture;
- How to set up, implement and assess NKM projects.

Other optional aspects than can be included are case studies on the requirements and accountability for critical knowledge retention and the development of a strategy for knowledge preservation.

Nuclear organizations adapt to respond to the changing expectations of industry, regulatory bodies, external stakeholders and the society at large. By employing integrated management systems, they can work effectively and efficiently to comply with local and national requirements.

The basis for the safe operation of a nuclear or radiological facility is technical competence supported by a well-integrated and established performance management system and a good organizational culture in which important aspects of safety, health, environmental protection, reliability, quality assurance and economic concerns are all addressed. Like other organizations, nuclear organizations need to find new ways of being smarter by taking advantage of the experience and knowledge of their people, innovations and new technologies, to continually improve organizational performance, effectiveness and safety. This type of continuous improvement at a systemic, organizational level is addressed by many of the performance excellence models used in different types of organizations around the world.

Individual organizations have different business and safety goals, they may therefore have different drivers for applying knowledge management efforts to address their essential issues.

The following list itemizes some of the possible benefits of applying knowledge management:

- Reduction of costs and safety issues through knowledge management procedures, which helps to avoid the repetition of errors;
- Faster identification and response to problems by employing the most knowledgeable experts through the adoption of an experience/knowledge-based employee directory;
- Broader knowledge across the organization of the early warning signs of potential trouble, using practices, such as regular team debriefs and knowledge exchange;
- Consistent use of the best practices in problem-resolution techniques across the organization through activities such as after-action reviews and knowledge sharing sessions;
- Corrective actions delivered more swiftly through greater support and use of problem reporting documentation (whether at the process level or as part of on-site maintenance and monitoring);
- Better knowledge capture and dissemination practices through the adoption of document management solutions;
- More comprehensive and robust ageing management programmes in the knowledge base through a systematic capture of critical knowledge throughout each stage of the life of a facility from design to decommissioning;
- Reduced costs from process improvements based on increased participation of employees and a strong collaboration on innovation and improvement opportunities;
- Better and faster trained employees through the support of process experts in refining process documentation and training materials;
- Lowered costs though reduced dependence on external training programmes, by employing internal coaching networks and communities of practice;
- Reduced downtime for maintenance through better planning and documentation.

For each type of organization, it is useful to understand the specific organizational competencies needed for successful and efficient operation. Several factors can contribute to this and some of the more basic elements include human, organizational and technical capital. It is important to understand that knowledge management practices contribute directly to the effectiveness and efficiency of an organization in its daily operations and its future successful performance, in addition to safety.

The Fraunhofer model [5] is significant due to the focus it brings to adding value to business processes with safety requirements being a principal feature for nuclear and radiological facilities and organizations. ‘The model is a three-layer schema that depicts the relationships between value-adding business processes, four knowledge management core processes and six design fields of knowledge management’ [5].

With good knowledge management, organizations generate value from their intellectual and knowledge-based assets. The tone and level of expectations set by the leaders and senior managers of organizations are vitally important for its success as they will drive both the implementation and the results. The success of any NKM programme strongly depends on the buy-in and support of senior managers who are responsible for setting the organization's objectives and priorities. Their values, priorities and leadership and the example that they set, help to establish and reinforce expectations and to create an organizational culture that values, and is supportive of, effective knowledge processes. Effective knowledge management programmes are reflected in the organization's values, behaviour and aspirations and become part of the organization's business culture, thus the NKM programme becomes part of the organizational culture. As knowledge management initiatives are undertaken or enhanced, it is imperative that the expectations and the drivers are clearly communicated throughout the organization.

A knowledge management programme can be successfully pursued if there is a clear strategy and the benefits are clear to the country or organization. As with any large project, a good NKM programme starts with the development of a strategy and a set of underpinning objectives. The first step in setting an NKM strategy is to define the problem that is to be addressed. To accomplish this, an assessment of the current nuclear knowledge in the organization is conducted. The key questions that may apply include the following:

— On a scale from minimal to adequate NKM, where is the position of the organization?
— Is there a risk of losing critical knowledge due to attrition (e.g., retirement from the aging workforce)?
— How can decision making and collaboration be improved?
— How can the current human resources be developed to improve performance and bridge the knowledge gap to address challenges and maintain a competitive edge?

Developing a knowledge management strategy provides a unique opportunity to gain a greater understanding of the way a nuclear organization operates and the inherent challenges. By focusing on identifying the needs and issues of the staff, activities and initiatives can be recommended that will have a clear and measurable impact upon the organization. Supplementing this bottom-up approach with a strategic focus ensures that the knowledge management initiative is aligned with broader organizational directions.

Taking this approach to the development of a knowledge management strategy allows limited resources to be targeted to the key needs within the organization, delivering the greatest business benefits while positioning the organization for long-term growth and stability, regardless of its development status.

A knowledge management strategy is a dedicated instrument used by business owners and their management team to plan, implement and control management actions concerning business relevant knowledge. The strategy identifies which knowledge areas have an impact on the business, the strength of the impact and the deficits that characterize each knowledge area in terms of proficiency, codification and diffusion. It also determines the management's possible responses.

The culture of an organization is extremely important for knowledge management; if it is not based on qualities such as trust and openness, then knowledge management initiatives are unlikely to succeed. A knowledge-sharing culture is essential because of the importance of intellectual capital to organizations and the need for effective knowledge management practices. In many organizations, a lack of collaborative teamwork, as well as the information explosion result in many people possessing only pieces of the solution, with nobody knowing it all. Therefore, cultures which inhibit knowledge-sharing constitute a significant barrier to creating and leveraging knowledge assets.

The typical elements necessary for establishing, implementing and assessing knowledge management projects can also be described in this module. These encompass the selection of the project, identification of project prerequisites, implementation aspects including a typical methodology and factors which are

critical to the success of the project, the relationship between knowledge management programmes and projects, along with assessment techniques. This module also provides general guidelines to develop knowledge management projects. Specific projects, however, need to be based on the type of organization and ultimately on its individual attributes and context.

The design of a knowledge management project starts by considering the steps that are generally applicable to all organizations and for which selected approaches among those mentioned above can be used. Subsequently, the project definition considers solutions related to challenges that are specific to different types of organizations, e.g., nuclear power plants (NPPs), radioactive waste management organizations, R&D institutions, radiotherapy and medical organizations, technical support organizations, regulatory bodies and academic organizations. For some of these organizations, knowledge management elements that are of particular importance are emphasized and discussed in Module 7.

Thereafter the module can address knowledge management project governance, which relates to the need for consistent management, the implementation of cohesive policies, the establishment of appropriate methods and tools and the provision of means for the empowerment of a given area of responsibility.

A project specific plan can be developed, which describes the project's aims and objectives together with a timed plan of tasks and details of resource requirements. The project is implemented as an internal change initiative, requiring buy-in and support from senior management. The exact details of the plan vary from project to project but need to reflect the benefits sought and the knowledge management tools and methodologies to be used. Many initiatives at this stage involve the initial development of a pilot project, i.e., a project with limited scope used to test the tools and methodologies before commencing full roll out.

The success of a knowledge management project depends on many factors, including an adequate strategy and policy, the support from senior management, job security, education and training, a knowledge sharing culture, IT infrastructure, dedicated resources, project management, human resource management, knowledge management tools, a network of experts, reward and recognitions, audits and measurement and graded implementation through knowledge management pilot projects.

3.7 MODULE 7: IMPLEMENTING KNOWLEDGE MANAGEMENT IN SPECIFIC ORGANIZATIONS

3.7.1 Learning objectives

After completing this module, the student should be able to:

- Understand and explain the different types of nuclear and radiological organizations;
- Explain NKM complexity and its scope for different organizations;
- Understand and explain the specifics of knowledge management for different organizations;
- Explain and illustrate cross-cutting issues;
- Explain the differences of the knowledge management objectives for various organizations, e.g., NPPs, regulatory bodies, R&D and education institutions;
- Understand the common organizational and functional issues in different organizations;
- Explain why the facilitation of knowledge sharing via collaboration and communities of practice is crucial for R&D organizations;
- Understand the importance of controlling intellectual properties;
- Understand and explain the role of R&D organizations in education related to nuclear and radiological science and technologies;
- Be able to select appropriate knowledge management methods and tools according to the specific challenges.

3.7.2 Module content summary

This module addresses issues related to the implementation of knowledge management in different nuclear and radiological organizations:

— The meaning of the terms nuclear and radiological organizations and the common and different features, critical success factors and knowledge management approaches for each type of organization;
— The specifics of implementing knowledge management in nuclear power operating organizations covering a wide spectrum of problems associated with the lifecycle of an NPP, performance and safety;
— The specifics of managing knowledge in R&D organizations which are knowledge-based organizations with their main products being new knowledge, intellectual properties and innovation;
— How universities manage knowledge and why increasing the efficiency of their knowledge management processes is important;
— The mission of regulatory bodies and how knowledge management can improve their regulation of all relevant stakeholders.

Nuclear knowledge is held by a variety of stakeholders, government ministries, nuclear utilities, public and private businesses, R&D organizations, regulatory agencies and academic institutions. Specific nuclear knowledge challenges may vary for the individual stakeholders. Some common challenges include:

— An aging workforce;
— Loss of established competencies due to uncoordinated strategic planning;
— The need to attract new technical talent;
— The expanding demand for qualified professionals;
— The imbalance of nuclear knowledge between countries with different degrees of development and implementation of nuclear and radiological technologies.

For any NKM programme, regardless of the type of organizations, there are common elements to be considered, clear policies and strategies, a proper organizational culture, human resource planning, training, knowledge processes and technical solutions, as addressed in previous modules.

However, specific organizational objectives and scopes may require a different focus and approach with respect to knowledge management. For instance, for certain organizations such as those engaged in R&D, intellectual capital is a central asset and the management of intellectual property becomes a core part of knowledge management policies.

Drawing a differentiation between the types of organizations according to their characteristics is instrumental in defining the scope and objectives of the knowledge to be managed. Some examples are considered below:

— Nuclear power plants (operational risk management);
  - Ensure safe operations and improve business efficiency;
— Research and development and technical support organizations (business improvement);
  - Improve methods and technologies;
— Regulatory bodies (social responsibility);
  - Ensure efficient regulation for the whole lifecycle of licenced nuclear and radiological facilities;
— Radioactive waste (social responsibility);
  - Ensure safety transport, processing, disposal and environmental protection;
— Education and training (business improvement);
  - Improve the methods and environments for education and training.

When considering NKM across different countries and organizations, differences may emerge in the level of maturity of the knowledge management programmes, notably between countries with a long-established nuclear programme and countries preparing for, or planning to establish, a new programme.

While the state of NKM in organizations residing in countries with mature nuclear programmes might not always be very advanced, NKM concepts and notions are generally well established. In countries with less developed nuclear programmes, there may be a lack of awareness about the principles and benefits of NKM and, consequently, a lower level of implementation. Transferring experience from countries and organizations with more mature knowledge management programmes to those with lower degrees of knowledge management awareness and implementation is a high priority for the IAEA.

In relation to knowledge management maturity levels, the differences in organization types affects the speed of the programme implementation. This can be further discussed in Module 8.

3.8 MODULE 8: KNOWLEDGE MANAGEMENT MATURITY ASSESSMENT

3.8.1 Learning objectives

After completing this module, the student should be able to:

- Understand and explain the importance of measuring the effectiveness of organizational knowledge management activities;
- Be familiar with the most applied methods of knowledge management maturity assessment;
- Understand the main elements and phases of knowledge management maturity assessment;
- Understand and explain the IAEA methodology of knowledge management maturity self-assessment;
- Understand the main criteria of the IAEA self-assessment specific to different types of organizations, e.g., regulatory bodies, Technical Support Organizations (TSOs), NPPs, R&D organizations and universities;
- Demonstrate in practice the IAEA tools of knowledge management maturity self-assessment.

3.8.2 Module content summary

This module provides an overview of the knowledge management assessment models and describes the methodology of the knowledge management maturity self-assessment, which was developed by the IAEA for different types of organizations, NPPs, regulatory bodies TSOs, R&D organizations, nuclear decommissioning organizations, nuclear waste management organizations, education providers and other nuclear organizations, agencies or bodies.

It is emphasized that the philosophy and principles of knowledge management are valid for almost all nuclear and radiation technologies, while the degree of emphasis and structured applicability may vary for specific cases. [6]

Knowledge management systems can be tailored for different types of organizations depending on the specific issues they face. Different approaches and techniques can present different levels of efficiency and effectiveness. Establishing benchmarks to assess how effective an organization is in managing its knowledge assets is a challenging task. The main goal of a knowledge management assessment is to develop a vision of where organizations need to be in terms of knowledge management and therefore to determine the areas for further improvement.

Assessment tools specific to individual organization types have been developed, which cater for a detailed evaluation of the knowledge management maturity level through guided self-assessment. Utilizing this methodology, aspects important to the specific organization may be analysed in depth. The results of this assessment may provide support for decisions and actions to be taken to further develop NKM and reach a desired level of implementation.

The majority of developed methods and models for the analysis and (self-) assessment of knowledge management maturity are based on the following elements:

- Attributes grouped by category;
- A simple assessment scale to measure each category;
- Questions facilitating dialogue and discussions with and among staff.

The main steps of a knowledge management maturity assessment are:

- Assess the current status of the organization or organizational unit for each maturity model area. The internal team (possibly with experts' assistance) evaluates where their organization or organizational unit stands in each area of the maturity model.
- Develop a vision of the knowledge management goals for each part of the organization or organizational unit. Discuss whether maturity levels are acceptable or need improvement. Envisage the future knowledge management maturity level to be achieved. The knowledge management strategy of the organization is considered during the creation phase of the future vision of the knowledge management system.
- Visualize the results. One of the most effective ways to stimulate discussion and make it productive is to visually present the results of phases 1 and 2 above. Various techniques can be used. The IAEA tools use a radar diagram presentation where results of both phases can be presented together.
- Define gaps and select areas for improvement. Based on the results envisioned and the emerging gaps between the current and desired status, the evaluation team can make a preliminary prioritization of areas for improvement. This phase is very important and determines where to focus resources.
- Repeat the exercise periodically to monitor progress. The assessment technique can be used as a tool for measuring progress by repeating this exercise periodically (e.g., every 6–10 months) and comparing the results of subsequent assessment runs.

Several knowledge management maturity models are available, including:

- EFQM Model;
- Collinson & Parcell's knowledge management self-assessment model;
- Siemens AG KMMM;
- TATA Consulting 5iKM3 Model;
- IAEA knowledge management maturity self-assessment method;
- InfoSys knowledge management maturity model;
- European Model of Knowledge Management Assessment;
- David Skyrme Model;
- TKCI KMmm.

The IAEA knowledge management maturity (KMM) model is based upon self-assessments conducted by staff members and aimed at identifying the current level of knowledge management maturity and necessary improvements.

In particular, the IAEA KMM self-assessment model includes:

- Evaluation of existing knowledge management practices;
- Determining which areas need improvement;
- Feedback on the adequacy of improvements;
- Informed decision making that is assisted through the knowledge management systems (at all levels);
- Alignment of the knowledge management objectives with the organization's strategy;
- Communication of management goals or priorities;
- Promotion and motivation of employees' desired behaviours (e.g., knowledge sharing);

— Stimulation of learning and innovation.

The IAEA assessment tool consists of eight organizational or functional categories, as listed below:

— Policy and strategy for knowledge management;
— Human resource processes for knowledge management;
— Training and competence development for knowledge management;
— Methods, procedures & documentation processes for improving knowledge management;
— Technical solutions for knowledge management;
— Approaches for the capture/transfer of knowledge;
— Organizational culture to support knowledge management;
— Internal/external collaboration for knowledge management.

The IAEA models of knowledge management maturity assessment and corresponding tools have been successfully used in many nuclear organizations in different countries and over many years have proved their value, effectiveness and usefulness.

4. CONCLUSIONS

In conclusion:

- The ideal core curriculum of nuclear science, technology and engineering master's level programmes includes not only technical courses but also managerial courses on communication, team working, business operation, project management and knowledge management;
- The NKM course suggested in this publication is aimed at developing specific competences on organizational and managerial decision tools offered by knowledge management systems, to achieve optimum organizational outcomes with respect to safety, quality, reliability and overall performance;
- Lecturers and teachers are recommended to emphasize the benefits of knowledge management and its impact on work at different levels, organizational and individual. On the individual level, knowledge management focuses on improvements of personal productivity for knowledge workers in their working environments. While the focus is the individual, the goal of knowledge management at the individual or personnel level is to enable better operation within the formal structure of organizations and within work groups. The emphasis of knowledge management on the individual level may also help students to better manage their own resources during university courses and their master's dissertation;
- The proposed course emphasizes the link between knowledge management and safety, as nuclear and radiation safety is based on knowledge and experience. A successfully implemented knowledge management programme ensures comprehensive integration of critical safety-related and knowledge-based practices into organizational routines. Managing organizational knowledge through establishing a skilled, competent workforce and an environment conducive to sharing knowledge and good practices, is key to creating and maintaining a safety culture;
- The course can be tailored to the specific university programmes and requirements, with regards to credits and hours of study;
- Lectures provide a guide on the subject matter and set out the foundations upon which students build their knowledge. Practical sessions help students to consolidate and apply knowledge presented in the lectures, introducing specific methods and procedures, developing technical skills, promoting teamwork and communication skills and increasing motivation. A combination of lectures and practical sessions is therefore strongly recommended;
- Universities and Member State training institutes can also consider the modules for use in training courses for continued education. This approach could provide important NKM training to professionals dealing with nuclear and radiological technologies;
- Educators implementing this NKM course may gain further support either directly from the IAEA or within the existing regional partnerships and networks for nuclear education, i.e.:
    - The Asian Network for Education in Nuclear Technology (ANENT);
    - The African Network for Education in Nuclear Science and Technology (AFRA-NEST);
    - The Latin American Network for Education in Nuclear Technology (LANENT);
    - The Regional Network for Education and Training in Nuclear Technology (STAR-NET).

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ABBREVIATIONS

DIRATA	Database on Discharges of Radionuclides to the Atmosphere and Aquatic Environment
FR-KOS	Fast Reactor Knowledge Organization System
IAEA	International Atomic Energy Agency
INIS	International Nuclear Information System
IT	Information technology
KM	Knowledge management
KMM	Knowledge management maturity
NKM	Nuclear knowledge management
NPP	Nuclear power plant
NUSEC	Nuclear Security Information Portal
RASIMS	Radiation Safety Information Management System
R&D	Research and development
USIE	Unified System for Information Exchange in Incidents and Emergencies

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