Digital Nuclear Leadership for Safety and Security - Towards Effective Regulatory Control

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ABSTRACT

The revaluation of information technologies nowadays encourages the reliance on Digital Leadership within the business environment using innovative solutions and digital technologies. National Regulators for safety, security and safeguard face huge challenges to meet this specific mandate and establish an optimized regulatory practice for nuclear and radiation facilities and activities. Digital leadership plays a big role to highlight the areas of the interface, identify opportunities, enhance organization culture, and encourage risk-informed decisions. This work introduces the Integrated Tool for Leadership and Knowledge Management for Safety and Security (ITLKMSS). It is tailed with specific requirements to create an automated infrastructure with five modules; Knowledge Management portal, Human Resource Development, and Training Centre, Sarcoma-Plus, Staff Information Database, and the e-Learning Portal. The tool is developed and tested In-house for a planned scenario to measure its effectiveness. Results support the national efforts for digitalization and help to guarantee sustainability of the regulatory framework with effective performance in a challenging context.

1- INTRODUCTION

New Built projects are growing all-over the world; many countries choose to go nuclear. But those mega projects need basic foundation of legal, regulatory, human, financial, knowledge, technological, and administration to achieve success. Each key organization of the project; NEPIO, Operator, Regulator, has specific role, framework, and organization structure. So, the need to develop are up-to-date Management System (MS) that suites their mandates, harmonizes the flow of work and promotes healthy organizational culture is given a big attention.

The nuclear industry relies on clear Quality Assurance (QA) and Quality Control (QC) programs to prevent failures of System, Structure, and Component (SSCs) and assure nuclear safety. All products and services shall achieve a high degree of integrity and reliability based on strict requirements and standards. Poor operation or performance could lead to a disaster and extend from generation to generation. Operating experience feedback from the fifties highlights the importance of QA and QC. The quality concept, as a part of safety, is basic and old. It was introduced by standardization entities such as the American Society of Mechanical Engineers (ASME), the British Standards

Institute (BSI), and the Deutsches Institut für Normung (DIN) to prevent industrial accidents. Then it was later adopted for Nuclear Power Plants (NPPs) projects. The quality management system standards series (ISO 9000) evolved since the 1970s based on BS 5750 that establish QA requirements for general products and services. New management systems standards consider QA and QC as a part of the processes needed to achieve the organization's outcomes [1] [2]. The Quality Assurance for Nuclear Power Plants: A Code of Practice2 was the first IAEA document covering this area (Series 50-C-QA,), which it evolved to the safety guide 50-C/SG-Q that incorporates all revised QA previous documents in the form of 14 criteria; Q1-Q14.

The Management System for Facilities and Activities (IAEA GS-R-3) was evolved to another document namely the Leadership and Management for Safety (GSR Part 2) [3], which gives an overview of management systems of nuclear and radiological facilities and activities. As a result, it could be stated that quality in the nuclear industry is crucial element and has a long history starting with Quality Control, Quality Assurance evolving to the Leadership and Management for Safety and Security, with the priority being to safety. Fig.1 shows the evolution of the IAEA Safety Standard related to the quality requirements.

FIG. (1): Evolution of the IAEA approach to quality, leadership, and management

In general, according to the GSR part2 requirements, the key principles are to establish and sustain Leadership for Safety in organizations that govern nuclear facilities and activities. Besides, Management for Safety and Security has to be achieved by a strong safety and security culture; and an effective integrated management system. Quality, as a part of a management system, required common elements such as policy, processes, procedures, and instructions that affect people, technology, and the organization.

2- REGULATORY ENVIRONMENT CONTEXT

The regulatory body is one of the key players in the nuclear industry, and it is the role of the government to establish a strong and independent legal and regulatory framework with defined responsibilities and authorities to protect human, property and environment from the risks of exposure to ionizing radiation. The scope of responsibilities of regulators can vary from country to another depending on the size of the national programs. Some regulators control the Safety, Security, Safeguard activities for all nuclear and radiological facilities and activities on the national level. This requires stable infrastructure that supports technical understanding of the requirements and expectations of each element together with the defined area of interface.

2.1 Leadership for Safety and Security

Safety and security are key responsibilities on the national level, but they have consequences on the international level in case of an accident or event. This requires an integrated approach to build a proactive management system with human and organizational harmonization capabilities to achieve the 3S' regulatory

outcomes effectively. Leaders are responsible for strategic planning and thinking approaches, making the best use of resources, fostering a culture that encourages open dialogue and team learning, and for encouraging and rewarding risk-taking, learning, and knowledge sharing. Leadership deals with the process of decision making taking into consideration the organization's values, objectives, mandates, knowledge sources and assets, prioritization, and resource allocation. The basic foundation of leadership is the ability to build strong safety and security culture that considers the organizational complexity and the dynamics of the human, technology, and organizational interactions [4] [5]. The assessment of an organization's culture requires a methodology that uses a combination of tools in the form of surveys, interviews, and others.

2.2 Knowledge Management (KM)

Knowledge is embedded in various forms with the safety, security, and safeguard and must be sufficiently built up and maintained systemically. KM focuses on raising the staff competencies, sharing the right information to facilitate the decision making and enhance the regulatory performance. Its role is to achieve fast and easy access to all types of information and data for all the staff. It covers long-term accumulation of knowledge, in a wide area of science and engineering that considers that sharing and transfer among generations is essential. Leaders build knowledge management program to address critical knowledge in the form of an added value that supports the decision making with the required wisdom and maintain public trust. The organization needs to manage the knowledge through measurements and assessment activities that

measure, map, quantify, and report the organization knowledge seeking for continuous improvement of the organization performance and intellectual capital [6]. Knowledge assessment is a critical issue that challenges all nuclear organizations, and developing tools to assist this process is an undergoing activity.

3- DIGITAL LEADERSHIP

The fast and dynamic IT technologies and data analytics, are changing the ways to perform work, hence the business processes, and models of organisations will need to be tailored and adjusted. Big data is one of the newest technologies that have been designed to utilize information assets and support the decision-making process in the organization [7] [8]. But the technology still faces a number of challenges that could limit its use in the nuclear industry. On the top of those challenges is the cyber security, and organization process complexity. Digital leadership is a critical issue for organizations around the world in both developed and emerging economies, and in all industries. But it requires six foundational building blocks: a different kind of business strategy, business models, humanized digital workplace, organization platform integration, corporate IT function, and a different kind of people mindset and skill set, as shown in Fig. 2.

FIG. (2): Digital Leadership Concept

Digital leadership can be described on two levels: on the individual level; where a particular skill set of a designer that allows pushing the frontiers of design being a digital leader by example; and on the organizational level, where a particular skill set of a person to advance game-changing technologies in a design team or organization is a digital leader by a team effort. In general, digital leaders are concerned moderators, bridge builders, and network organizers, rather than as classical

top-down managers. Digitalization and digital leadership are foundations of digital leadership, where organization capabilities for digital leadership can be developed. The main characteristics of digital leadership are identified:

- Recognising that digitalization is not always about projects, but also for transforming people and working landscape.
- Developing digital skills across the organisation is not the responsibility of a separate department.
- Integrating digital processes and technologies to serve and shape organization strategies.
- Providing leaders with adequate resources to test digital technology and create the routine working way.
- Starting all programmes and projects with client needs and do appropriate research, to cover responsibilities, teams, actions, deliverables and feedbacks.
- Inspiring teams and boards about the benefits of digital transformation with tangible proof of concept, even if the successful experiments are small in scale.

4- INTEGRATED TOOL FOR LEADERSHIP AND KNOWLEDGE MANAGEMENT FOR SAFETY AND SECURITY (ITLKMSS)

The **ITLKMSS** scope covers planning activities, managing day to day work, assessment and audits, preservation of knowledge and capacity building. Fig, 3 shows the starting window of the program with user authentication (user name and password), to manage the control of access of each employee according to his scope of work.

FIG. (3): ITLKMSS Starting Window

4.1. Development Methodology

The tool represents an organizational platform which is based on the visual basic language (VB 6.0) that may represent an acceptable solution. The Visual Basic provides a convenient method for building user interfaces. This software uses a set of Microsoft access data bases, unique and essential to fit all the required data for the management within organization. It covers processes and activities within the organization and deals with an easy of use graphical user the interface. It makes benefits of the advantages of visual basic 6.0 to link with excel VBA (SARCoN). Fig. 4 shows the flowchart of the program development process. Five design bases were identified; multi user management, integrity, user friendly, intelligent and secure. The layers of the software and securing its related databases, are built in the design and the code, consequently no user can access the data of another user as each of them has its own password. In case of incomplete data entry and dealing with databases through deleting or modification, a warning message appears. The link between the software and SARCon-Plus was done with a path location using "Shell" function supported by visual basic.
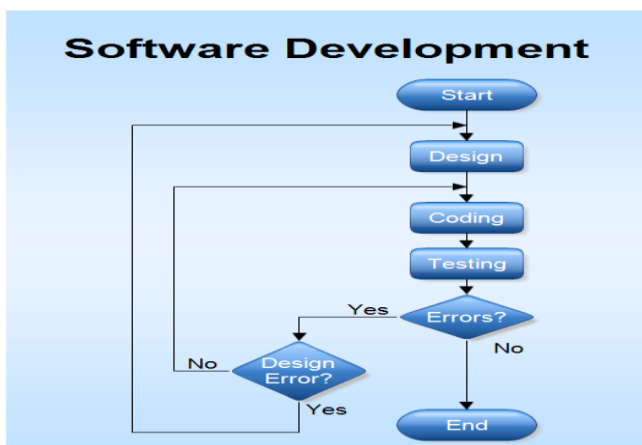

FIG. (4): Flowchart of the ITLKMSS operation

4.2. ITLKMSS Taxonomy

ITLKMSS represents the electronic management system of the organization; it is a comprehensive system that helps running a wheel of operation for all regulatory processes. It breaks the organizational barriers by sharing data across all employees and departments to capture tacit and explicit knowledge within the organization. It also provides interested parties with dynamic links to facilitate communication and optimize the return value of the service provided specially the authorization process. ITLKMSS has an intelligent mechanism that supports the performance evaluation of the employees and management system processes. It the empowers department to personalize interactions through automated workflows. It has five modules that work in a harmonized way to assure the process operation and meet the organization needs and expectations. Each module has a specific objective that represents a pillar of the management system. Fig.5 shows the five modules.

4.2.1 SARCoN-Plus

It is an updated version of the IAEA-developed Systematic Assessment of Regulatory Competence Needs (SARCoN) methodology and software, but with a wider scope of competencies to cover the Knowledge, Skills, and Attitude (KSA) related to nuclear safety, radiation safety, nuclear security, nuclear safeguard, and emergency preparedness. It deals with the limitation of the tool to enhance its use by regulatory bodies with a wider scope of responsibilities than nuclear safety. It is based on the four-quadrant model shown in Fig 6. but with an integrated questionnaire in each quadrant to widen the training needs assessment. The tool supports the use of Systematic Approach of Training (SAT) to develop competencies; [10] efficiently based on the training needs, gap analysis, competencies assessment, which helps workforce planning, qualification, training, and recruitment.
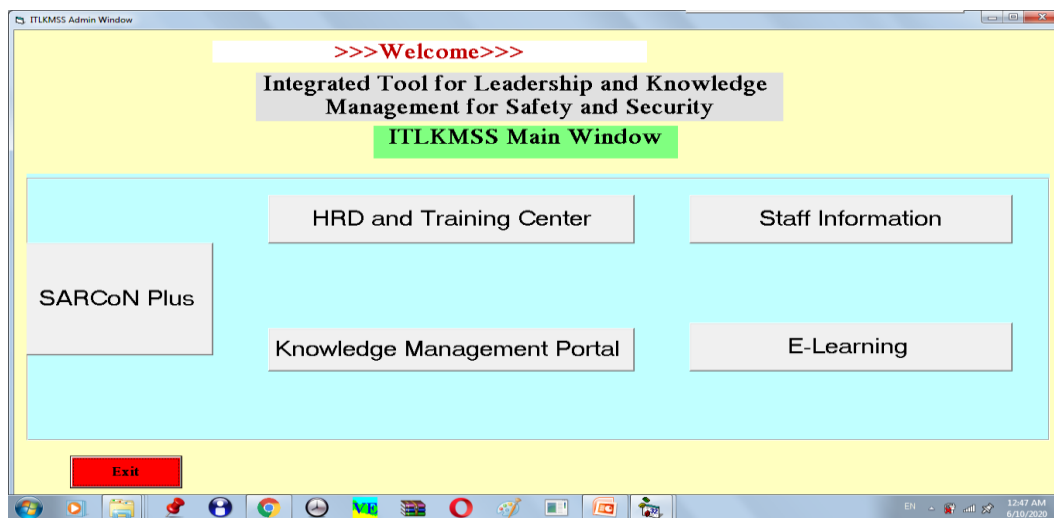

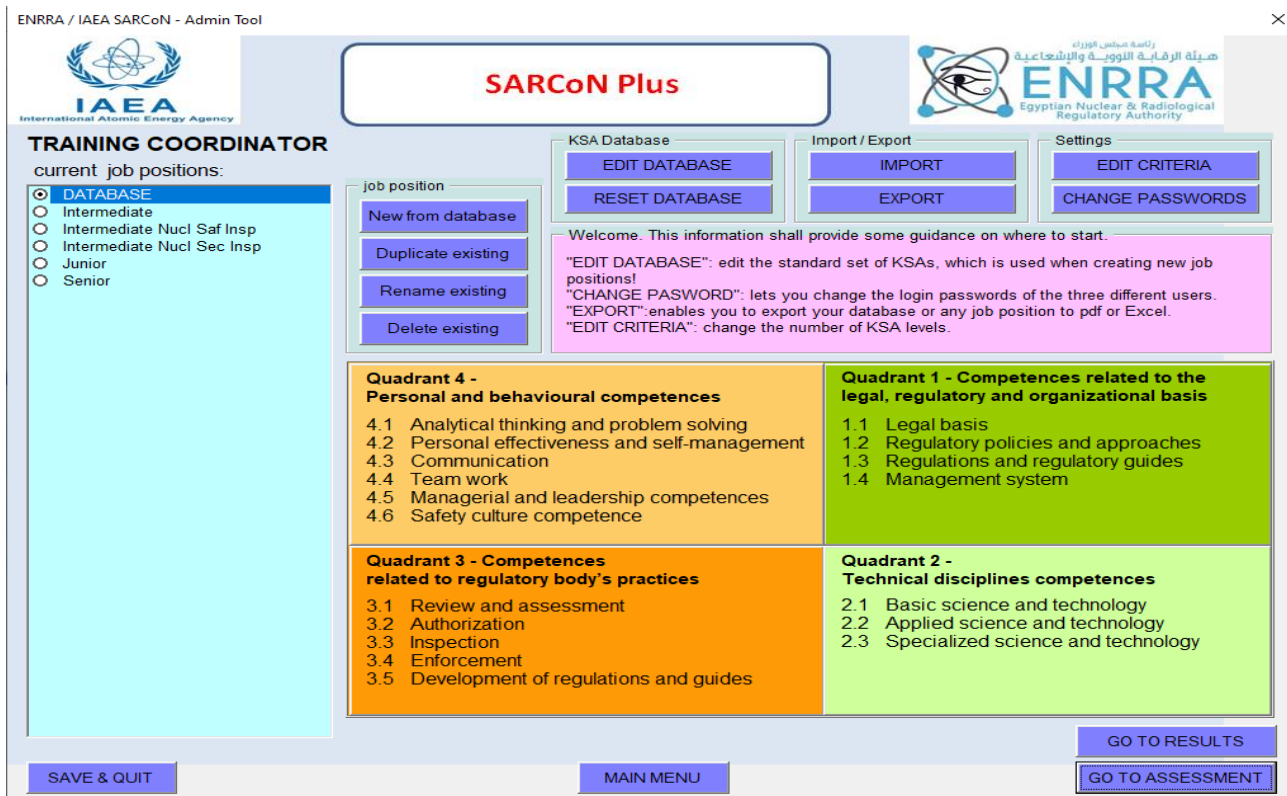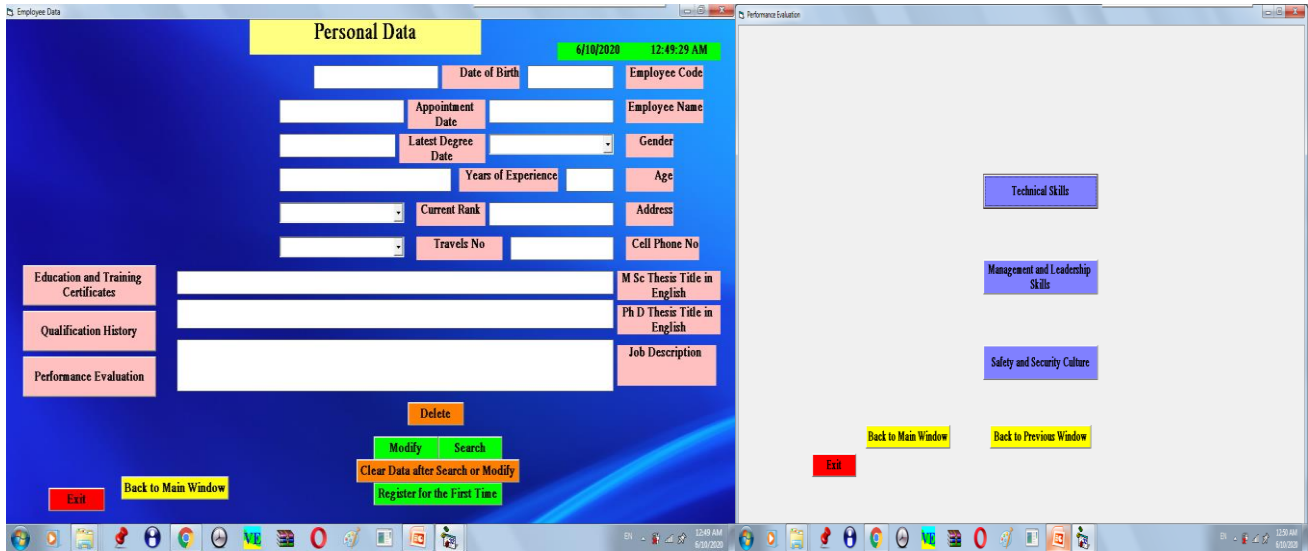**FIG. (5): ITLKMSS operation main modules**

FIG. (6): SARCoN-Plus for safety, Security, and safeguard competencies needs assessment

4.2.2 Staff Information Database

This module acts as a repository for all the information of the employee, which is needed by managers and decision-makers, to evaluate and enhance the overall HR performance. It includes the personal information of each employee, his job description, and education and training certificates, as shown in Fig.7. It also includes a history of the employee qualification in the form of reports produced based on the results of SARCoN-Plus. Also, icon is also needed for each employee performance evaluation that links to all his assessment reports. Three types of evaluation are executed periodically by his direct manager, HR manager and Quality manager: on his technical, Management, and Leadership Skills, and Safety/ Security Culture. That assessment report reflects the employee capacity building progress and the level of improvement in his qualification to meet his identified targets. Fig.7.b shows the records of the employee that can be retrieved either by his name or ID. Databases are developed by connecting Microsoft access 2007 that has and visual basic 6.0. The visual basic 6.0 supports access databases which have the extension "mdb". There are two ways of dealing with databases, one depends on data entry using text boxes while the other depends on data grid entry.

4.2.3 Human Resource Development and Training Centre (HRD & TC)

The HRD is an important element that helps in managing employee engagement, recognizing and rewarding individuals or teams, ensuring effective teamwork, both internal to the organization and also with suppliers and contractors, provide positive coaching, sharing organizational values, ethics and standards, and provide effective career development for a nuclear worker life cycle. The SAT is recognized by interested parties as one of the best models for training in the regulatory body. Many HR factors are considered as workforce planning, knowledge management, and individual and team development. The HRD & TC has a list of In-house and external events, by clicking on any event you can recall all the related stored information. The icon of Event Planning has all needed temples to plan an event as coordinator (technical officer) or as an administrator, who is responsible for all logistics and administration issues (attendance sheets, certificates, list of participants,...). After the training, the trainee has to fill the training feedback report, as shown in Fig.8. Feedback reports are collected in a database that could be restored to identify opportunities for improving the annual training program based on an employee evaluation. In general, the effectiveness of the overall training program is assessed through the training committees and assessment at each level of training.

(a)   (b)

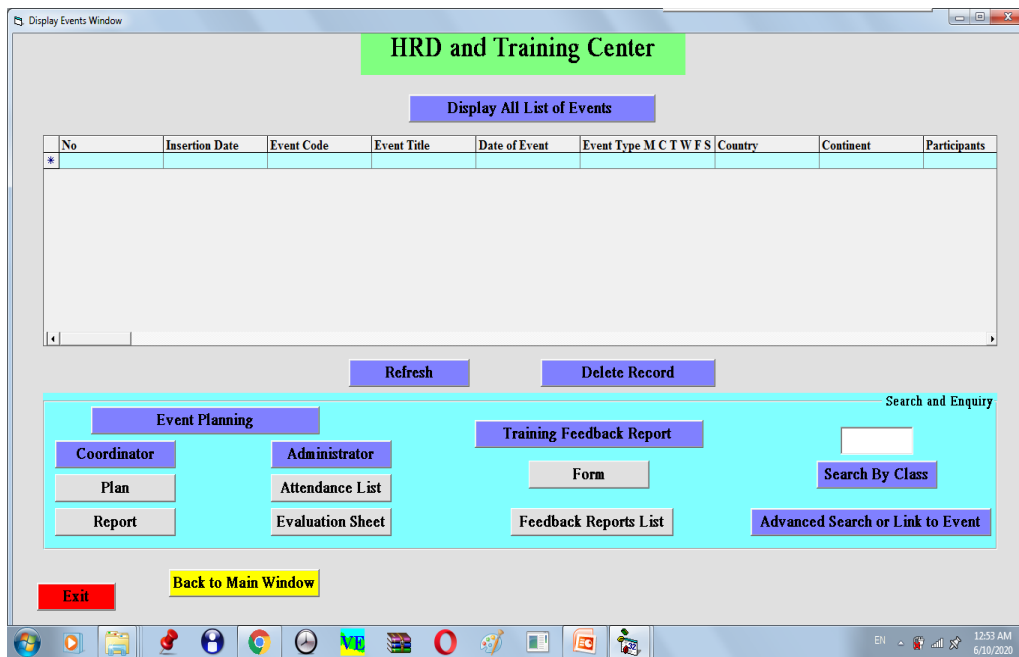**FIG. (7): Staff Information Database (a) Personal Data   (b) Employee Performance Reports**

FIG. (8): Human Resource Development and Training Centre

4.2.4 Knowledge Management portal

It deals with the various information and gained wisdom in different forms from all regulatory practices safety, security, or safeguard to support and/or enable the KM process. It supports the collaboration and codification of KM in the entire organization and promotes the efficient and effective capture of both tacit and explicit knowledge [11]. The key elements of modules are shown in Fig. 9 related to Integrated Management System where you have access to the organization's policies strategies, manuals, processes,

procedures, and forms. The second icon is for the legal and regulatory framework that includes regulations, guides, standards, and codes as a basic part of NKM. The third part is for the core regulatory practices review and assessment, licensing, inspection, and enforcement where you can access reports, issued licenses and permits, applications, and documents. The fourth module is for communication with interested parties, where the public can access the latest news and reports, and send their opinions. Also, another module is for the organization assessments either self-assessment by

department or internal audits or assessments by the third party as the IAEA missions [12].

4.2.5 e-Learning Portal

It includes a search engine that could facilitate the employee's effort to reach the correct information. It has basic search or advanced one by Topic, Journals, Conferences, and Authors. It also has e-learning store the user can find any required document of any type (Word, Pdf) which is related to this item. As shown in Fig.10, the process of basic searching in the database is based on the name or certain code, while the advanced searching depends on making the benefit of the filters built-in Microsoft Access.
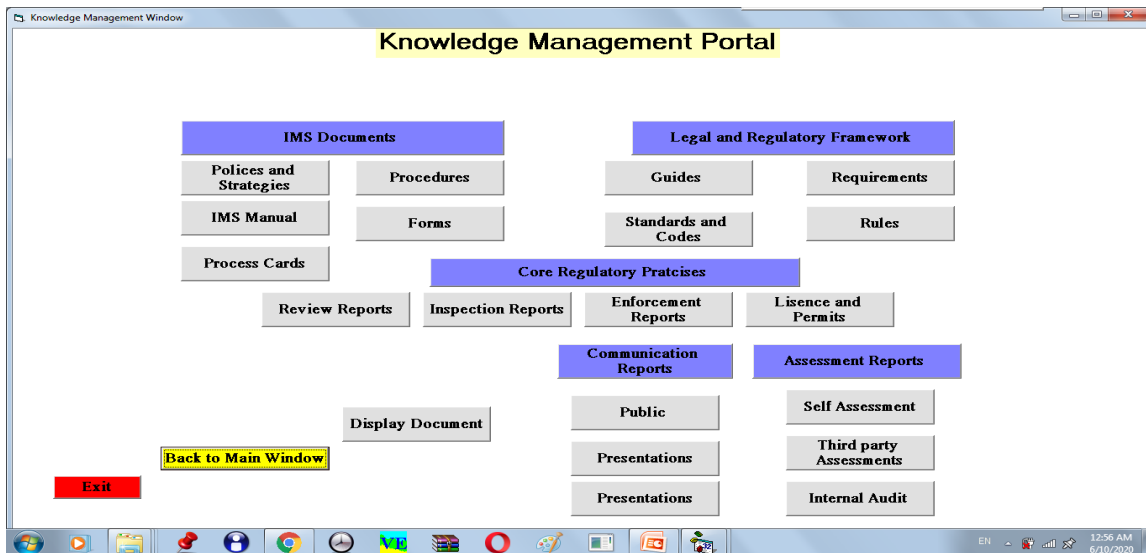

FIG. (9): Knowledge Management Portal
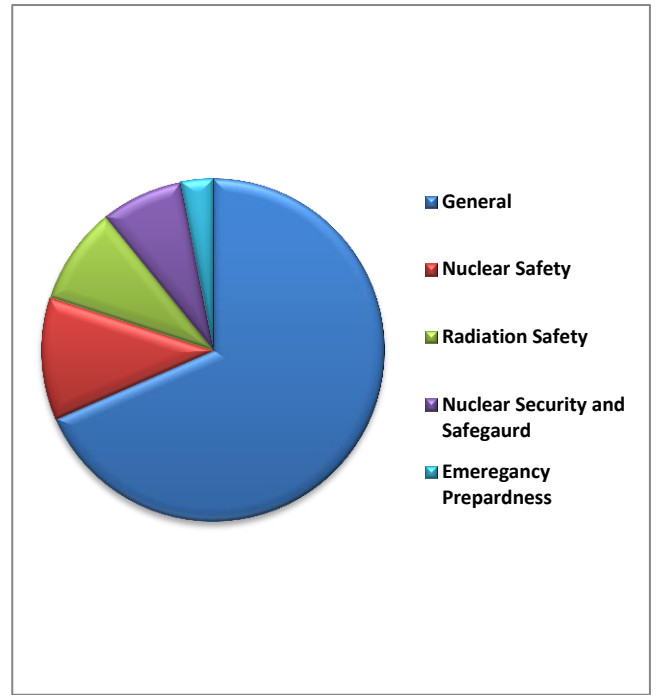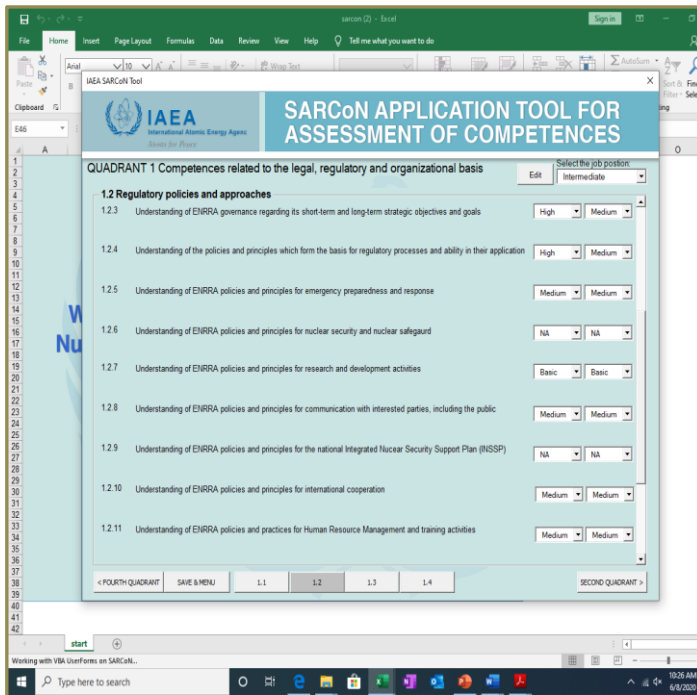

FIG. (10): e- Learning portal

5- ITLKMSS PERFORMANCE TEST

To test the ITLKMSS tool performance, a test was executed based on a developed scenario for two inspection officers, one is specialized in nuclear safety and the other is specialized in nuclear security. The SARCON-Plus was run based on the integrated questionnaire shown in fig.11.a for safety, security, and safeguards. Fig.11.b shows the percentage of each area within the questionnaire, It is very clear that the common competencies "General" is the dominant and the specific one is related to different regulatory areas that could represent only the third of all needed competencies for

the organization which support the integration and optimization of resources.

(a)

(b)

FIG. (11): Regulatory Competence needs assessment   a)SARCoN-Plus Sheet   b) Percentage by regulatory area
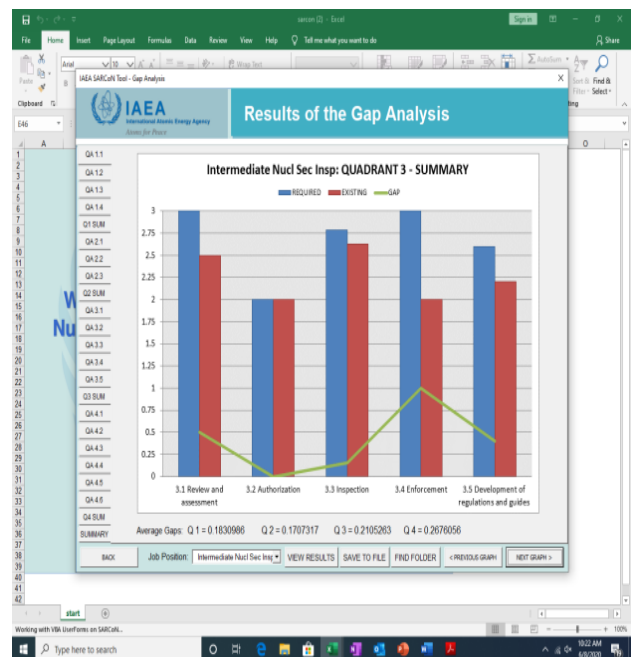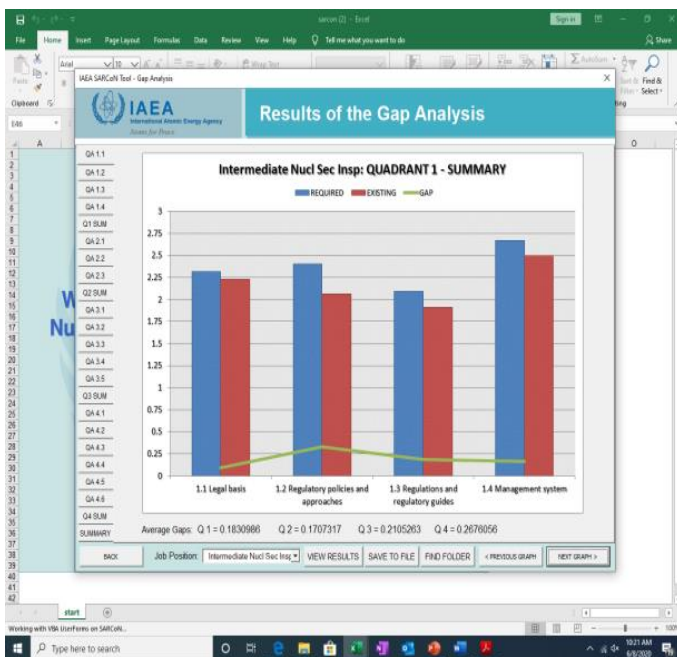

FIG (12): Results for the competencies gap analysis of Q1&Q3 for Nuclear Security Inspectors

SARCoN- Plus run for two intermediate inspectors, but one is in the department of nuclear safety and the second is for nuclear security. Both have the same basic KSA's needed for inspections, but with certain gaps related to the individuals. Figure 12 shows the competencies gap analysis of the nuclear security inspector, related to the competencies of legal, regulatory and organizational and to regulatory practices. The most relevant gap was related to the enforcement competencies, which could require a training on commensurate enforcement actions (such as requests for

corrective actions, verbal or written notifications, penalties or legal actions).
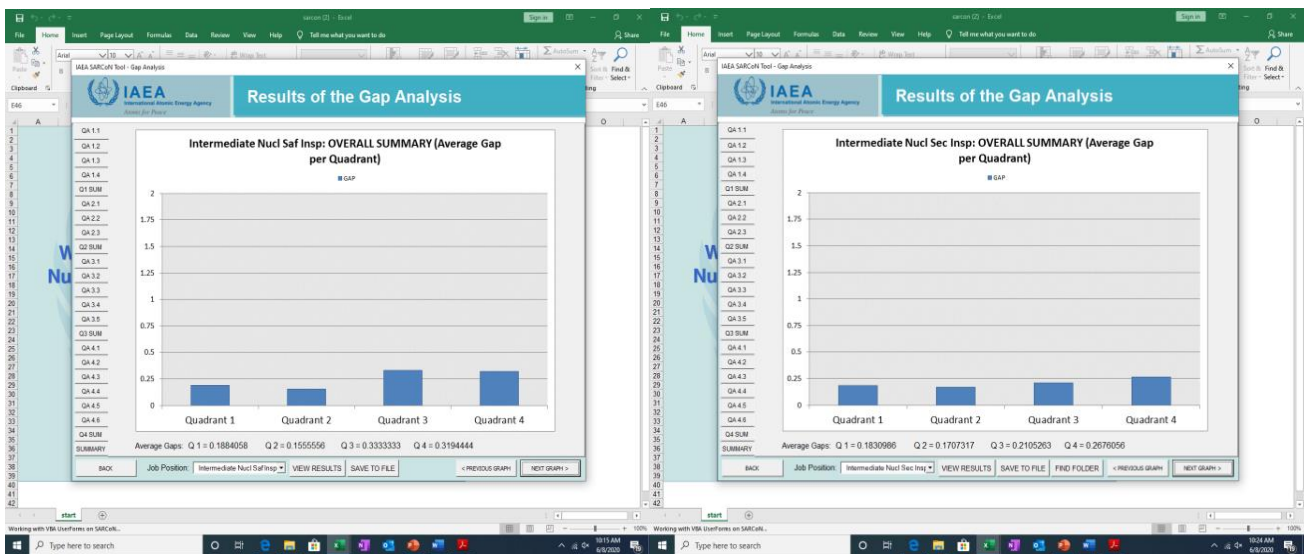

FIG (13): Comparative results of Gap Analysis of the safety and security Culture

Fig. 13 shows a trend within the organization that the competencies' related to safety and security culture and that needed for leadership have an identified gap within both departments, which means raising the need for the organization to plan a training program or develop a comprehensive project to enhance related skills. As a result, ITLKMSS allows the regulatory organization to create a workflow, and resource planning that enables regulatory services to be done smoothly in a systematic way, and also ensuring the use of integrated simple IT operations. More work could be done to enhance the second version of ITKMSS to cover full automation of all regulatory and administrative processes and be a more friendly electronic visualized workflow.

CONCLUSION

Digitalization is an opportunity for the nuclear industry, and specifically for regulatory bodies with a wide scope of responsibility covering nuclear safety, security, and safeguards. Digital leadership represents more than an electronic version of the traditional paper processes of the management system, but it is an exceptional performance driver. It is expected to improve efficiency, the effectiveness of the regulatory on the national and international levels. The developed version of ITLKMSS shows that it is a reliable tool that helps the organization, harmonize processes, optimize human and financial resources, and achieve excellence in its regulatory work performance. More updated features could be added in future that includes; advanced graphical interface for performance analysis. Customization to allow fixable changes to the modules

to meet the user needs. This improves the user interface to facilitate its use and enhance its security level.

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