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## NEW SKILLS AND QUALIFICATIONS REQUIRED BY THE CURRENT APPROACHES IN THE SOFTWARE DEVELOPMENT INDUSTRY

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***Abstract:** The organizations that are able to adapt quickly to changes are most competitive in a fast-changing business and industrial environment. In the software development industry, developing new skills for employees, that sustain the strategic objectives, is part of the solution for convincing all customers that the company is able to comply with new industry approaches. In the present paper, interviews, brainstorming sessions and workshops were used during two years period, to develop the conceptual framework for a new occupation – software development technical expert auditor (SDTEA). The results are based on ISO 19011:2018, ISO 9001:2015 and ISO 27001:2013 and can be used by the Integrated Management System Manager as a best practice example within a software development company, on one hand. On the other hand, the findings are useful for the specialists in the process of developing new trainings and a new occupational standard.*

***Key words:** quality, information security, auditor competencies, communication skills*

### 1. INTRODUCTION

In a fast-changing business and industrial environment, the organizations that are able to adapt quickly to changes are most competitive. The new challenges in the software development industry consist in applying the EU General Data Protection Regulation (GDPR) requirements in all software product development since May 2018.

In this context, a software development company must convince all customers of being able to comply with the GDPR, on one hand, and on the other hand, a Software Project Manager must be able to ensure the quality and information security within the project.

Involving project managers in auditing software development processes brings added value to the audit process and implicitly to the organization. As Henry Ford said, it is not important to find apologies but to look for solutions.

An organization's ability to find creative solutions in a fast-changing external environment depends on its management's ability to engage people to adopt a different

behavior and a new way of doing things. From a leadership and innovation standpoint, "improvement is fundamentally only about doing two things"[1]:

- Designing and implementing the new service, product, process, technology etc.;
- Engagement of the people so that they willingly embrace the change – by adopting, using, enjoying, accepting, doing the new thing.
- A great team leader has to be expert in [1]:
- Creating the vision and driving its team towards it;
- Encouraging ideas from others;
- Building on ideas, at times borrowing ideas or approaches to solving problems;
- Sharing ideas;
- Supporting, motivating and guiding its teams to succeed.

A Software Project Manager is a real leader for the team and helps others to succeed. An auditor who is also a leader finds always

solutions to complicated problems and has the ability to implement them.

The paper outlines the idea of a new qualification – software development technical expert auditor (SDTEA) – and the need for a new occupational standard in Romania. The concept presented in this paper was tested for more than two years in a Romanian software development organization.

## **2. BACKGROUND**

### **2.1 A new approach through ISO 9001:2015**

For a sustainable success, the focus of the company's management should shift from "Product Quality" to "Integrated Management System Quality".

An efficient integrated management system is a warranty for the company's ability to meet the needs and expectations of the customers and of other relevant interested parties, in the long term.

In order to insure quality, the company needs to define its strategic planning based on the identification of the company's context [2] taking into consideration that starting with 2018, companies will be audited, evaluated and recertified based on ISO 9001:2015 standard.

This standard brings a series of new elements compared to its previous edition, from which we can mention the following:

- The explicit introduction of risk based approach [3];
- The elimination of terms such as procedures and documents and the focus on processes management, in order to meet the planned results. Nevertheless, "some documents (in the form of procedures, work instructions, check-lists and so on) are likely to be needed in order to ensure that the processes are effectively managed, but the extent of that documentation and the associated records will depend on the particular context of the organization" [4].

### **2.2 ISO 9001:2015 requirements for Software Project managers**

Regarding the design, development and implementation processes of software products, and not only, Clause 8 of ISO 9001:2015 standard ("Operation") is directly related to Clause 7 of ISO 9001:2008 standard and aims: [5]:

- The operational planning and control;
- The identification of the market's needs and customer interaction;
- Customer communication;
- The operational planning process;
- The development, production and delivery of goods and services;
- The non-compliant goods and services.

In the software development industry, a project manager needs to take into consideration all these aspects regarding the operational processes' quality.

The monitoring, measuring and evaluation of the operational processes' performances and of the developed projects is done through periodical internal auditing which should involve, next to the quality and information security experts, a technical expert – a person within the company, who offers the audit team the specific technical expertise or knowledge.

## **3. AUDITING MANAGEMENT SYSTEMS**

For all specialists, except quality ones, "audit" means, first of all, financial audit or public internal audit [6], and this statement is backed up by the fact that some authors focused their attention on types of risk in the financial audit and their evaluation [7] or on internal audit within public and economic entities [8]. At first glance, financial audit, internal public audit and quality audit have very few in common. Never the less, there are similarities related to the audit principles.

Management systems' audit is the main tool used to ensure the company's success, management systems' auditing being governed by ISO 19011:2018 standard, which offers guidance related to auditing principles, audit programs' management, management systems' audit development and auditors' skills.

The standard identifies:

- 1st party auditing – internal auditing;

- 2nd party auditing – external provider auditing; certification and/or accreditation auditing;
- 3rd party auditing – other external interested party auditing; legal, regulatory and similar auditing.

### 3.1 Auditing principles

Clause 4 of ISO 19011:2018 standard describes management systems' auditing principles, which focus on aspects such as [6, 9]:

- Integrity;
- Fair presentation (the obligation of reporting the situation being audited in a truthful and exact manner);
- Due professional care (the ability to perform reasonable appreciation in all auditing situations);
- Confidentiality (the obligation of being discrete in handling and protecting information accessed during audit);
- Independence (the ability of maintaining an objective thinking throughout the entire auditing process);
- Evidence-based approach (the ability of gathering verifiable evidence in order to form reliable audit conclusions);
- Risk-based approach (the ability to significantly influence the audits' planning, development and reporting, as to make sure that audits focus on the aspects relevant for the auditing process and for meeting the objectives of the audit program).

This last auditing principle is a novelty brought by the ISO 19011:2018 standard as opposed to its previous edition from 2011 and it is in agreement with the ISO 9001:2015 requirements.

### 3.2 Auditors' competencies and evaluation

Information regarding auditors' competencies and evaluation can be found in Clause 7 of ISO 19011:2018, which stipulates that "competence should be evaluated regularly through a process that considers personal behavior and the ability to apply the knowledge and skills gained through education, work

experience, auditor training and audit experience" [9].

In order to determine the auditor's competencies, the standard separates them into three competence categories:

- General competencies;
- Personal behavior;
- Knowledge and skills:
  - General competencies of auditors;
  - Generic knowledge and skills of management system auditors;
  - Discipline and sector-specific competence of auditors;
  - Generic competence of an audit team leader;
  - Knowledge and skills for auditing multiple disciplines.

In order to evaluate auditors the standard suggests two categories of criteria [9]:

- Qualitative criteria (such as having demonstrated desired behavior, knowledge or the performance of the skills in training or in the workplace) and
- Quantitative criteria (such as the years of work experience and education, number of audits conducted, hours of audit training).

### 3.3 Auditors' communication abilities

The auditors' communication abilities ensure the practical application of audit specific methods, both for activities that are performed at the location of the auditee (on-side activities) and for activities that are performed at any place other than the location of the auditee, regardless of the distance (remote activities) [9]:

- Conducting interviews;
- Completing checklists and questionnaires with auditee's participation;
- Conducting document review with auditee' participation;
- Conducting document review (e.g. records, data analysis);
- Observation of the work performed;
- Conducting on-site visit;
- Completing checklists;
- Sampling.

Related to the communication abilities throughout the auditing process, the Romanian occupational standard for quality auditor – code COR 214130 – stipulates [10]:

- Consistent and efficient communication abilities in difficult situations;
- Information gathering and communication techniques specific to the auditing process;
- Team management abilities and work in the audit team.

More detailed, in difficult communication situations, the auditor needs to be an emotionally intelligent person, who can prove good knowledge, good understanding and management of its own and also of the others emotions.

The members of an audit team can take into consideration the following recommendations [11]:

- Approaching an information strategy by asking questions and active listening – clarification by use of paraphrasing and open questions;
- Avoiding contradictions regarding what happened;
- The existence of identity related feelings and questions and their legitimacy by understanding the thoughts, ideas and feelings expressed;
- Expressive articulation of what we think, feel or desire in a clear non-defensive manner, by expressing preferences and by personal accountability.

## **4. REQUIREMENTS FOR SOFTWARE PROJECT MANAGERS**

### **4.1 Auditors' competencies and evaluation**

The requirements regarding information security are defined by ISO 27001:2013 standard, which describes a process for systematically managing information risks [12]. The standard's structure is similar to that of ISO 9001:2015, which allows them to be easily integrated.

The implementation of ISO 27001:2013 standard in the software development industry is essential for ensuring the security of the

information managed in the design, development and implementation of the software products.

Information security protects information from a wide range of threats. It provides and maintains the following aspects [13]:

- Confidentiality: ensuring that information is accessible only to authorized persons;
- Integrity: preserving the accuracy and completeness of the information as well as the processing methods;
- Availability: ensuring that authorized users have access to information and the associated resources when needed.

According to ISO 27001:2013, information security is achieved by implementing an appropriate set of policies, practices, procedures, organizational structures and software functions. These elements are implemented to ensure the achievement of specific security objectives. The main sources used to identify the organization's security requirements are:

- Risk assessment: identifies threats to resources, assesses vulnerability to these threats and their probability of occurrence, and estimates their potential impact;
- Existing legislation that the organization must respect;
- Security analysis: specific set of principles, objectives and requirements for information processing, that the organization develops to support its activities.

### **4.2 Quality and communication skills**

Regarding the Software Project Manager abilities in quality and communication areas, the Romanian occupational standard for the project manager stipulates [14]:

- Quality requirements identification;
- The establishment of planning, tracking and quality control procedures;
- Project results quality evaluation;
- Identification and establishment of communication requirements within the project;

- Ensuring communication with all parties interested in the project;
- Offering a system for monitoring and reporting the project's progress.

A study performed in India, on 350 respondents from different software companies, drew the main causes for conflict occurrence in software projects implementation. Out of these we mention [15]:

- The lack of confidence between the Software Project Manager and the team;
- The lack of adequate communication, defined in the project, with all interested parties;
- The lack of support on behalf of the company's management throughout the implementation of the project;
- Unforeseeable requirements on behalf of the customers, causing conflicts related to time management and costs, initially agreed upon;
- The lack of coordination between on-side and offshore teams in completing project goals on time;
- The lack of clearly mentioning the Software Project Manager's role, when he has to play multiple roles inside the team.

The same study also pointed out the importance of communication abilities and emotional competencies both for the Software Project Manager and for the members of the project team. These have a major impact on understanding the feedback received from the customers and on getting all necessary approvals on time.

Another study conducted by ESI International, the leader in project management training, defines the 10 main qualities that describe an efficient project manager [16]:

- Vision – empowering people to experience their vision and offering them “opportunities to create their own vision, to explore what the vision will mean to their jobs and lives, and to envision their future as part of the vision for the organization”;
- Communication – efficient and effective, about “goals, responsibility, performance, expectations and

feedback”; the project leader uses communication to link the team to the larger organization; he/she uses also the ability to negotiate and persuade in order to ensure the success of the team and project; “a project manager should spend 90 per cent of their time communicating”;

- Integrity – the project manager's actions set an example for the team members; he/she imposes the standard regarding the ethical behavior to which both project manager and the team-members adapt.
- Enthusiasm/ passion – adopting a positive attitude to determine the other team members to follow him/her;
- Empathy/ compassion – developing a personal relationship with the team-members, as a tool for better results; he/she must understand that “there is life outside the workplace and that people are not machines without emotions”;
- Competence – leadership abilities, not only technical abilities, and a portfolio of successful projects.
- Delegation – the ability to recognize the team-members' skills and expertise and to assign or delegate the tasks accordingly. He/she demonstrates trust in others by how much he/she supervises and controls the team-work, how much he/she delegates and how much he/she allows people to participate; “individuals who are unable to trust other people often fail as leaders”.
- Composure – maintaining the cool when things do not go as expected; in such cases, the problems are seen as opportunities;
- Teambuilding – providing “the substance that holds the team together, in common purpose, towards the right objective”; he/ she must keep the sense of team spirit alive despite the problems occurred during the project's implementation;

- Problem solving – solving any or all problems, by involving the team-members in problem solving.

## 5. RESEARCH PURPOSE AND METHODOLOGY

### 5.1 New audit requirements in the context of EU GDPR

In order to comply with the new requirements of the EU GDPR the companies working in the software development industry need to ensure a permanent communication with the customer throughout the entire software development process, through the Integrated Management System Responsible and the Software Project Manager.

In the current context, a Software Project Manager may be involved in the audit team as a technical expert or technical observer, both in:

- internal audits (1st party auditing) and
- external audits (external provider auditing, legal/ regulatory auditing etc.).

The Integrated Management System Responsible must very well define and manage the level of involvement of the Software Development Managers in the auditing process, in order to obtain the audit evidence and to conclude the audit process.

Having as a starting point the requirements of ISO 19011:2018, this paper draws the conceptual framework regarding the training and evaluation of the Software Development Technical Expert internal Auditors (SDTEA). As Figure 1 shows, the auditor’s specific competencies are completed by the trinomial:

- Software project management competencies;
- Quality competencies (ISO 9001:2015, clause 8);
- Information security competencies (ISO/IEC 27001:2013).

This paper predicts that the software project manager’s motivation to get involved in the auditing process can be increased by training him to become SDTEA and by making it possible through this new responsibility to get

to know details about other projects in which his other colleagues are involved in.

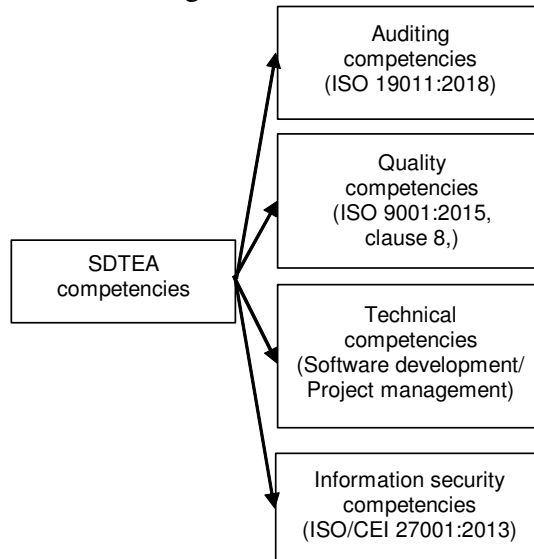


Fig.1: SDTEA competencies categories

### 5.2 Research objectives and methodology

This research’s main objectives were:

- The identification of SDTEA specific competencies (having as a starting point the categories of competencies presented in Figure 1);
- Creating the conceptual framework for training and evaluating SDTEA

The methodology for defining the conceptual framework for training and evaluation of the new suggested occupation – SDTEA – is presented in Figure 2.

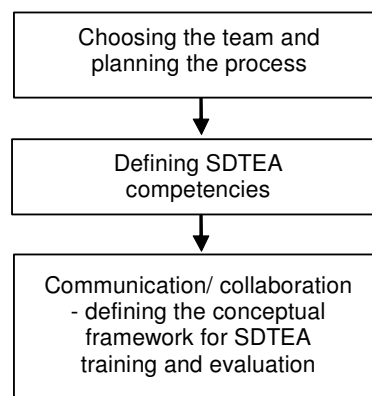


Fig.2: The methodology for defining the conceptual framework for training and evaluation of SDTEA

Step 1. Choosing the team and planning the process – the research team was conducted by the integrated management system Responsible

and it was composed of the expert representatives in: quality, information security, software development and project management. During the first meeting, the process was planned (desired results, time, resources, methods etc.).

Step 2. Defining SDTEA competencies – specific requirements have been defined for each field

Step 3. Communication/ collaboration for defining the conceptual framework for SDTEA training and evaluation.

The methods used during the mentioned process were interviews, brainstorming sessions and workshops.

## 6 FINDINDGS AND RESULTS

This new paragraph presents the main results of the research process, which define the conceptual framework of the training and evaluation process of candidates for the SDTEA position.

### 6.1 Requirements for Technical Expert Auditor

For a Software Project Manager expert or technical observer in the audit team to become Technical Expert Auditor, he needs to:

- Know the applicable procedures of the integrated management system (ex. production related, customer relationship related, security policy related, etc.) – corresponding to ISO 9001:2015, ISO/ IEC 27001:2013 and ISO 19011:2018.
- Prove its involvement in the projects that he manages.
- Have a minimum of 3 years work experience in project management up to the date he joined the audit team.
- Have a minimum of the projects managed up to the date he joined the audit team.
- Have managed both software development projects and quality assurance projects.
- Take part in at least 10 audits as a technical observer; out of those 10

participations in 5 of them he should have asked questions and verified records so as to prove that he can perform an audit.

- During each participation, it is mandatory that he takes notes and forward them to the Integrated Management System Responsible, the chief auditor of the auditing team that he is part of and /or to the entire audit team.

The following aspect, regarding confidentiality, has to be taken into account: the Software Project Manager who candidates for Technical Expert Auditor must sign a confidentiality agreement at the first audit he takes part in.

### 6.2 SDTEA candidates' evaluation criteria

For a Software Project Manager expert/ technical observer in the audit team to become SDTEA, he needs to:

- Participate in 10 audits as a technical observer in the audit team.
- Have experience in the projects and know the production processes inside the company (ISO standardization).
- Have audit notes (notes taken during the audit and handed over to the Leader of the auditing programme).
- Be involved by asking question during the audit.
- Have the necessary qualities that allow him to act according to the auditing principles described in Clause 4 of ISO 19011:2018:
  - integrity;
  - fair presentation;
  - due professional care;
  - confidentiality;
  - independence;
  - evidence-based approach;
  - risk-based approach.
- Have a professional behavior while fulfilling the audit activity (Clause 7.2.2 of ISO 19011:2018).

### 6.3 SDTEA evaluation methodology

Aspects related to the evaluation methodology of SDTEA and internal auditors have been defined during the process based on the above described methodology. The SDTEA evaluation methodology consists of nine steps, as follows:

Step 1. The Integrated Management System Responsible draws up and periodically updates three documents:

- The list of Internal Auditors within the organization, auditors who meet "qualified auditor" terms;
- The list of Technical Expert Auditors;
- The register of Technical Expert Auditors.

Step 2. The Technical Expert Auditor shows its intention to participate in an audit by signing up to audits directly on the Internal Audit Programming organization page. The selection is made on condition that no member of the audit team performs direct activities and has no responsibilities in the audited area.

Step 3. The Integrated Management System Responsible manages the Technical Expert Auditors' assessment; if needed, he/ she could ask for Feedback 3600 (assessment by each Technical Expert Auditor in the organization);

Step 4. The Integrated Management System Responsible updates, on the Internal Audit Programming organization page, the list of audited projects in the next period.

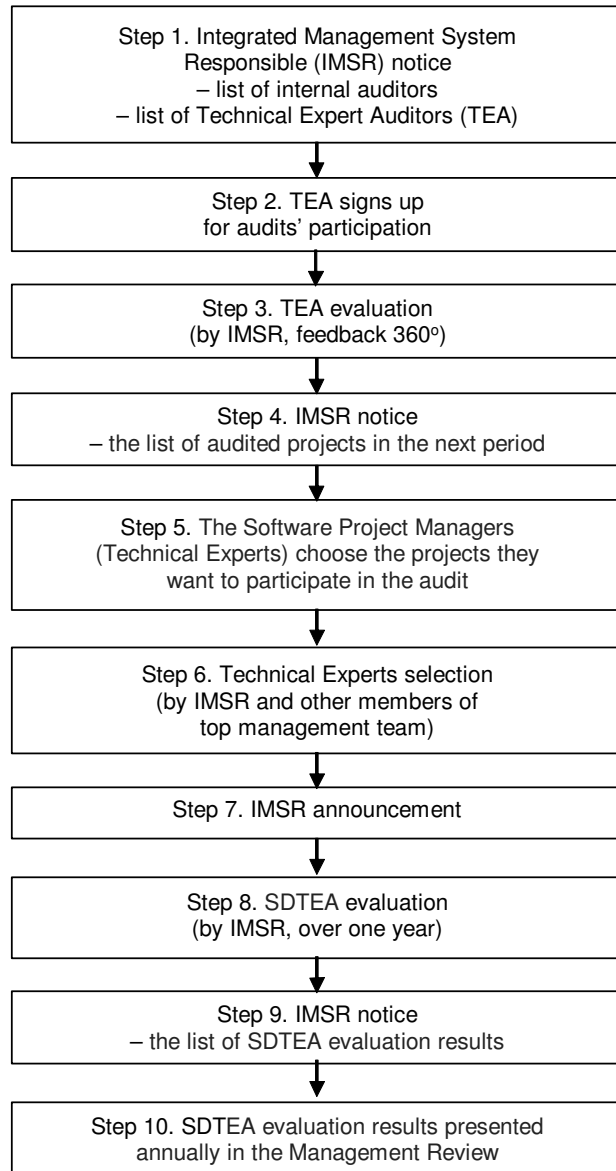
Step 5. The Software Project Managers choose the projects they want to participate in the audit.

Step 6. The Integrated Management System Responsible and other members of the top management team select the Software Project Managers (Technical experts or Technical expert observers) who participate in internal audits of production projects.

Step 7. The Integrated Management System Responsible sends an email or Skype message to Software Project Managers who have announced that they want to participate in internal audits on production projects.

Step 8. The Integrated Management System Responsible follows up the activity and results of Technical Expert Auditors and internal auditors during a calendar year. For the audit experience, the following score is awarded:

- 2 points – for auditing as the chief of the audit team;
- 1 point – for auditing as auditor in the audit team and submission of audit notes;
- 0.5 points – for auditing as auditor in the audit team and no submission of audit notes.



**Fig.3:** The methodology for SDTEA evaluation

If at three consecutive audits, the Technical Expert Auditor does not send the audit notes by email, he/she is automatically downgraded and loses the score received in the three audits.

Step 9. The Integrated Management System Responsible makes the list of Technical Expert Auditors evaluation results. Based on the scoreboard obtained by applying the evaluation



criteria, the following qualifiers can be awarded:

- Well – minimum 5 points;
- Good – between 6 and 12 points;
- Very good – between 13 and 25 points;
- Excellent – over 25 points.

If a Technical Expert Auditor does not meet the minimum score over one year, the Integrated Management System Responsible and other members of the top management team come with the suggestion of re-running the SDTEA training process.

Step 10. The auditor's assessment of Technical Expert Auditors is presented annually in the Management Review.

## 7 CONCLUSIONS

Starting from ISO 19011:2018, ISO 9001:2015 and ISO 27001:2013 requirements, this paper creates the conceptual framework regarding the training and evaluation of the software development technical expert internal auditors. The arguments we have for supporting the introduction of this new qualification in COR are:

- Related to organization: the development of the employees' competencies, the development of the company's image, the growth of the employees' devotion towards the company;
- Related to clients: a boost in customers' trust in the well-functioning of the quality and information security integrated management system;
- Related to employees: growth in their motivation to get involved in information security and quality internal audits, despite their limited amount of time they have available for other activities than software development project management.

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### **Noi aptitudini și calificări cerute de abordările curente în industria dezvoltării de software**

Rezumat: Organizațiile care sunt capabile să se adapteze rapid la schimbări sunt cele mai competitive într-un mediu de afaceri industrial în continuă schimbare. În industria software, dezvoltarea de noi competențe pentru angajați, care susțin obiectivele strategice, este o soluție în convingerea tuturor clienților că organizația este capabilă să se conformeze noilor abordări din domeniu. În lucrarea de față, au fost utilizate interviuri, sesiuni de brainstorming și ateliere de lucru realizate pe parcursul a doi ani de zile, în vederea dezvoltării cadrului conceptual care vizează o nouă ocupație - auditor expert tehnic în domeniul dezvoltării software (SDTEA). Pe de o parte, rezultatele se bazează pe standardele ISO 19011:2018, ISO 9001:2015 și ISO 27001:2013 și pot fi folosite de Managerul Sistemului de Management Integrat ca exemplu de bune practici în cadrul unei companii de dezvoltare software. Pe de altă parte, concluziile sunt utile pentru specialiști în procesul de dezvoltare a unor noi training-uri și pentru dezvoltarea unui nou standard ocupational.

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