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COMPETENCE APPROACH TO ACADEMIC AND PROFESSIONAL TRAINING OF AUDITORS OF INFORMATION SYSTEMS AND TECHNOLOGIES

Abstract. An analysis of the specifics of the formation of a set of of competencies formation for the system of academic and professional training of specialists in audit and monitoring of information systems and technologies is carried out. It is determined that the training system should be formed in accordance with the global system of service industry standardization and international requirements and standards. The essence of the competencies formation on the basis of American and European standards in the field of information systems and technologies is revealed. The hierarchical sequence of the implementation of the world system of standardization for audit and quality control of information systems and technologies functioning in order to determine requirements to competences of the auditor of information technologies is defined. Practical tasks of the process of obtaining objective, qualitative and quantitative assessments of the current state of information infrastructure in accordance with the defined criteria, requirements and quality indicators are highlighted. The main features of competencies, skills, knowledge of specialists in audit and monitoring of information systems and technologies formation are identified. Formation of basic academic and professional competencies of specialists in the audit of information systems and technologies on the basis of the domain educational model Competency Model Clearinghouse is presented. It has been created the competence model for formation of the set of knowledge, skills and abilities during organization and support of information systems and technologies audit, control and monitoring. Tasks and concept of specialists' integral competence are defined. The list of academic and professional competences is formed, basic abilities and skills of specialists in information systems and technologies audit are defined as well. Classes and levels of competencies are determined, as well as correspondent to them positions in the field of audit of information systems and information technologies of the industry sector. Special attention is paid to the international generally oriented approaches to standardization of educational services and competencies levels in accordance with professional

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requirements to specialists in the field of information technology audit system. Basic levels of professional certification of information systems auditors, which should provide a high quality level of a wide range of services in the field of information technologies and information security, have been determined.

Keywords: audit of information systems; professional competencies; business processes; infrastructure; maturity model.

1. INTRODUCTION

Problem statement. Rapid development of the state and the deepening of informatization processes in the society require implementation of the best world standards and practices, namely consideration of the industry sector through the prism of a processes model and implementation of risk management procedures. It is clear that usage and detailing of a company's business operations, as the basis of total management, set requirements for an effective system of control and monitoring of the level of services provided. Currently, during entering of organizations into the world economic and information space, the efficiency of the processes of audit, monitoring and support of information and communication systems (ICS) of different classes is becoming increasingly important.

Modern information and communication environment of the society is a complex information system (IS) with an integrated infrastructure that combines various information, program, technical, regulatory, human and other kinds of resources at the market of services. The organization is unable to perform qualitatively its basic services, carry out operations / transactions as well as provide its reliable activity and reporting, etc. without effective ICS and audit technologies.

Audit of ICS and technologies allows to estimate current state of IS functioning, identify and forecast risks, manage their impact on business / operational processes of a company; correctly and reasonably provide security of information assets, strategic plans of infrastructure development, corporate database content, etc. Audit of ICS and IT is investigation and comprehensive analysis of an enterprise existing infrastructure, helping to estimate its effectiveness, correspondence to certain standards, strategies, regulations and policies of total management. Effectively conducted ICS audit gives possibility to receive maximum return from the implemented information resources and technologies, and should be conducted in order to achieve a high quality level of provided services.

Thus, it is very urgent and actual to review and reform the system of academic and professional specialists training, changing qualification requirements for information technology (IT) specialists. Creation of the total management model and directly the process of IS audit and monitoring in accordance with the global system of standardization and requirements become the most perspective research area. These processes require formation of new practical skills, knowledge and learning outcomes in future bachelors and masters of IT specialties. Currently, effective usage of Ukrainian and international experience, as well as implementation of a competency-based approach to the system of highly-skilled staff training in accordance with requirements of the industry sector are very actual tasks.

Analysis of the recent research and publications. Investigation of specialists of different qualification levels training, subject content of educational and professional training of future specialists in IT and IT audit at higher educational institutions (HEIs) are extremely relevant problems. Main approaches to standardization of information and communication competencies at the international and domestic education systems have been described in the papers of well-known Ukrainian scientists in the field of IT, namely V. Bykov [1], A. Dzhurylo and others [2]. The works of S. Lytvynova, O. Ovcharuk, A.Gurzhii, O. Spirin, O. Burov [3] and other scientists are devoted to the conceptual issues of professional

certification of information and cybersecurity specialists in Ukraine.

Investigation of issues comprising creation of the global system of IT industry competencies is directly considered in the works of foreign scientists, namely Hinde David [4], determination of the main aspects for training of specialists of different qualification levels as well as development of new training standards in the field of IT education are considered in the papers of the following foreign scientifics: D.S. Rychen, Laura H. Salganik [5], Mary B. Curtis, Greg Jenkins, Jean Bedard, Donald R. Deis [6], David L. Cannon Brian T. O'Hara (With) [7] and others.

Due to the increasing role of the IS and IT audit in the global system of services, the American community of IT industry has established a Public Organization, called Information Systems Audit and Control Association (ISACA) [8]. ISACA together with IT Governance Institute are the leading institutions in the field of development of standards and requirements for IS and IT audit. These institutions and their experts, such as David L. Cannon, Timothy S. Bergmann, Brady Pamplin [7] also form educational and professional standards and develop the world's best practices for IT auditors training.

Within implementation of the methodology of competency-based approach to training of IT auditors, it can be mentioned that David L. Cannon is the founder of the leading training center CertTest CISA Training dealing with IT training and consulting in such areas as audit and management of business processes, information security, administration and IT operations control, etc.

Groups of researches, headed by David L. Cannon are working in the field of IT practical usage, academic and professional training of specialists in IT and audit at organizations of different forms of ownership [7]. David L. Cannon is the author of many textbooks, manuals and organizer of leading scientific and practical conferences at the world's leading universities. Currently, David L. Cannon works as a head of author groups, publishing leading textbooks on academic and professional training of IS and IT auditors, namely group of David L. Cannon, T. Brian, Brady Pamplin, O'Hara and Allen. Keele [7].

In order to satisfy the above mentioned needs, regular usage of the system of audit and control of information security (audit and IS control) in organizations management system is becoming increasingly important.

System of audit and control is a key component to provide the quality of protected IS and organization's infrastructure in general functioning.

The essence of the research is to develop a model of specialists'competencies in order to elaborate a training system for specialists in audit and monitoring the state of IS and IT (including information security) at the infrastructure objects of enterprises and organizations of different forms of ownership.

Aim of the research is to create a competency model of academic and professional training of auditors in IS and IT, based on the Ukrainian and international standards, as well as best world practices of the IT industry. Models and procedures for the system of audit and quality control of IT and organization's infrastructure in general functioning should be defined within the purpose of the research as well.

System of specialists training in the field of IT audit and control should be formed in order to increase the quality and efficiency of the educational and scientific processes management at universities within the branch "Information Technologies".

2. RESEARCH METHODOLOGY

The scientific approach to formation of the set of competencies for the system of academic and professional training of specialists in the field of IS and IT audit and monitoring has been developed by Prof. Yudin O.K. He also highlighted that the specialists' training

system should be formed in accordance with the global system of the service industry standardization, as well as in accordance with the international requirements and standards. During the research, the personal contribution of Assoc. Prof. Chernyak A.M. was clarification and description of the competencies on the basis of American and European standards in the field of IS and IT. Volodymyr Y. Artemov developed practical tasks for the process of obtaining objective qualitative and quantitative assessments about the current state of the information infrastructure in accordance with the determined criteria, requirements and quality indicators Artemov V.Yu. Assoc. Prof. Matviychuk-Yudina O.V. formulated key positions regarding the peculiarities of competencies, skills and knowledge formation in IS and IT audit and monitoring specialists.

Assoc. Prof. Ivannikova V.Yu. analyzed theoretical achievements of domestic and international scientists, who investigated the problem of competencies division into classes and levels, as well as correspondent to them positions in the field of IS and IT of the industry sector audit.

Particular attention is paid to the international generally oriented approaches to standardization of educational services, levels of competencies in accordance with the professional requirements to specialists in the system of IT audit, job classification.

3. INVESTIGATION RESULTS

3.1 International standards and best world practices in the field of audit and control of IS and IT functioning quality.

Current state of management processes, as well as company functioning in general cannot be imagined without procedures of business processes monitoring and controlling, taking into account criteria of risk management. Violation of procedures continuity, loss of access to the important information assets can have negative consequences, from impossibility to provide standard services and sustainable functioning of the organization to the partial loss of assets, company liquidation and criminal liability of managers. Thus, a company is obliged to provide a constant audit, monitoring and control over the operation of IS and its main properties on the basis of international standards and requirements, taking into account a high quality level of provided business services.

In order to provide quality and continuity of business operations, world industry leaders use a system (fundamental principle) of so-called Total Quality Management (TQM) [8]. TQM is a concept of institution (company, organization, etc.) management, which foresees general, purposeful and effectively coordinated application of technologies, methodologies, methods and models of business services quality management in order to provide receiving of permanent profit by an organization.

International Organization for Standardization (ISO) summarized all positive experience accumulated in the field of product quality improvement and developed a set of standards ISO 9000 [9]; ISO 10000 [10], which formed the basis of organizations TQM principles.

ISO 9000 Standards have received worldwide recognition as especially popular guidelines for quality management systems. It should be mentioned that quality specialists use new ISO 9001 Standards [11], with updates, made in 2005, 2008 and 2009-2015. These standards, meeting the growing consumers' needs, have become a universal tool for provision, estimation and controlling an enterprise quality systems [12].

These standards contain time-tested concepts, requirements and models both for internal and external audit, principles of products and services quality management, establish feedback between company and consumer.

Modern TQM system is implemented in order to achieve long-term success of an enterprise on the basis of maximum services and users market satisfaction.

TQM is aimed at constant improvement of business processes quality by means of systematic analysis (audit and control) of the results and corrective actions of an organization in order to provide competitiveness of enterprises. Management model should be improved through the usage of advanced technologies, as well as flexibility, timely delivery of services and products. Continuous quality improvement of products and processes, use of scientific approaches to the solution of industrial problems should take place, basing on the synergy of staff, company managers and product consumers.

Due to the integration of standardization of both IS and IT and providing a high quality level of IT industry services, efforts of two international organizations have been joined. Such organizations were the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO). This cooperation leads to the creation of the Joint Technical Committee. The Committee deals with issues related to the development and improvement of international standards in the field of IT [5].

Considering the audit and monitoring of IS and IT, it should be noted that the processes of Information Security Management System (ISMS) organization should be a composite part of the Total Management. ISMS is a part of an enterprise total management system and was created for provision and improvement of an organization information security.

It is clear that the ISMS system has both a “processing” and “risk-oriented” approaches and should be implemented within the TQM. That is, the main idea and task of the ISMS are processes of analysis and management of information risks during creation, implementation, functioning and monitoring information resources security at a company.

ISMS standards, directly related to the information security management, are the set of ISO / IEC 270xx standards and serve as the main regulatory document during ISMS creation and IS audit.

Audit and control of the ISMS level, as a composite part of an enterprise total management, is carried out in order to check compliance with the requirements of international and national standards as well as to provide the continuity of business and operational processes, based on the risk management. It is obviously that the basis of these processes should be regulations, which can be classified according to the directions: international standards of state institutions and associations ISACA, IETF, (ISC)2, ITIL, ANSI, SCC, NIST, USA, BSI, etc [12].

Necessity to carry out regular audit and control of IS and IT in a company lays in the performance of permanent assessment of the real state of information resources and their ability to perform organization tasks at the services market in accordance with set objectives and policies of an organization.

3.2 Formation of professional requirements on the basis of conceptual sequence of implementation of the world standardization system for audit and quality control of IS and IT functioning.

Defining the role of audit system as an integral part of the company’s total management, it should be noted that the quantitative component, devoted to the requirements and procedures for audit and quality control of IS for different groups of standards is about 30%. So, a third part of standards of the global standardization system is aimed directly on the processes of audit and control of a company’s business / operational processes continuity.

On the basis of authors’ research, it can be stated that not only in Europe, but also in America – the foundation, guidelines for the organization of audit system in the state and company, is a couple of European ISO / IEC set of standards. Standards ISO / IEC

17021: 2015 and ISO / IEC 17024: 2015 [10] form a conceptual ideology for the organization of auditors centers as well as auditors training and certification.

❖ ***First level of standardization and requirements to auditor competences.***

- ISO / IEC 17021 standard contains principles and requirements for the competence, consistency and impartiality of audit bodies and establishes the procedure for certification of all types of management systems. It is important to note that certification bodies operating in accordance with this part of the ISO / IEC 17021 do not need to offer certification of all types of management systems. Other types and classes of standards may be proposed by an organization at its own discretion according to the components of services market and regulatory requirements of the country-organizer of business operations.
- ISO / IEC 17024 standard "Personnel certification scheme. Conformity assessment expert in the field of technical regulations" [9]. The standard sets requirements and recommendations for certification of conformity assessment experts in the field of technical regulations. The required competence is determined by the specific requirements of a separate regulation. The competence of the examination board is ensured by the participation of experts and specialists of the appropriate level, who have sufficient level of knowledge in the field of separate technical regulations. So, the mandatory requirement for auditors' certification commission organization is existance of their own certification, both academic and professional. Both performance of personnel certification and creation of any certification center from audit in any country cannot be created without performance of specified requirements.

❖ ***Fundamentals of procedures for carrying out and assesment the quality of business and operational processes within the TQM*** model is the set of ISO 9000 \ 90xx standards "Quality Management System" (QMS) and ISO 10000 \ 100xx "Quality Management. Customer Satisfaction" [10]. They are developed on the basis of the best international practice in order to meet customers' needs. Modern standard ISO 9001: 2015 is one of the models of an organization activities management in order to ensure its effectiveness at the services market. The set of standards ISO 9001: 2015 and ISO 10000 \ 100xx are documents, which are the evidence that the quality system of management processes is successfully implemented and operates in a company.

❖ ***Second level of standardization and requirements to auditor competences***.

- It is clear that one of the primary steps in implementation of standardization system for IS and IT audit and quality control, should be development and detailing of all business processes of a company. The set of standards, which helps the auditor for the first time, should include procedures, models and methods for assesment the effectiveness of these processes implementation. Such set of standards is ISO / IEC 15504 named Information technology – Process assessment [9].

ISO / IEC 15504 are the leading standards for the IS and IT audit and monitoring, aimed at assessment of the effectiveness and maturity of a company's direct business and operational processes performance. This set includes a basic line of 10 standards, devoted to the recommendations and requirements for procedures, connected with assessment of the effectiveness of business and operational processes as well as IS; recommendations and assesment procedures for usage and improvement of processes, identification of their capabilities; applied models of procedures for assesment processes effectiveness, including applied models of system life cycle assessment; procedures for assesment the organization maturity; applied models for assessment the processes of IT services management and IT security, etc.

❖ ***Third level of standardization and requirements to auditor competences.***

- ISO / IEC 270xx. The next step in defining the scope of auditors' competence, based on the world standards in IT and information security is the set of standards ISO / IEC 270xx

for creation of ISMS.

Currently, in Europe and in the world, the following set of ISO / IEC standards have been officially adopted: ISO / IEC 27000, which describes basic concepts and definitions; ISO / IEC 27001: 2015, which both serves as the main standard during creation and maintenance of ISMS and determine basic requirements to IS and their security; ISO / IEC 27002: 2015, which contains more detailed requirements, recommendations and description of information security management processes; ISO / IEC 27005: 2015, devoted to the description of the main approaches to the system of processes risk management, management of the processes of systems provision and configuration [9], [13].

However, as it was mentioned above, any set of world standards has a special branch of recommendations, procedures and restrictions that is directly connected with IS audit. Thus, starting from the sixth standard of the ISO / IEC 270xx set, the normative section of audit and monitoring of an organization IT and security system has been introduced, namely:

- ISO / IEC 27006: 2015, "Information technologies. Methods of protection. Requirements for bodies providing services on audit and certification of information security management systems";
- ISO / IEC 27007: 2018 "Information technologies. Methods of protection. Guidelines for the audit of information security management systems ";
- ISO / IEC 27008: 2019 "Information technologies. Methods of protection. Guidelines for assessing protection of information security ", etc.
- ISO / IEC 15408 -1 ... 3, which specifies criteria for assessment and provision of an enterprise security system guarantees level. In Europe, all 3 parts of ISO / IEC 15408 standard have been adopted and published as national standards, which corresponds to the following directions: criteria and models for assessment IT security, estimation of security components functionality as well as confidence to IS and IT, ets. [12], [9].

❖ ***Fourth level of standardization and requirements to auditor competences.***

▪ Usage of knowledge, skills and abilities by auditor according to the standards of the American associations of IT industry sector (ISACA), can be considered as a stage of integration and practical implementation of IS and IT audit.

American Independent (Nonprofit) Association ISACA develops, implements leading industry knowledge and best practices for the audit and analysis of IS and IT. Standards, developed by its specialists, have been main and practically focused on the integration of IT audit system within the business process model of a company's total management for more than 20 years. Sure, the CoBiT 5 and ITAF standards are integrated base of knowledge, skills and abilities of modern auditor:

- CoBiT 5 "Control Objectives for Information and Related Technology" is an open IT standard, which in turn contains a number of documents with criteria, requirements, procedures for optimizing management of the IT audit system.
- ITAF ISACA "Information Technology Assurance Framework" is a comprehensive standard model for usage of the best practices, which can be used as a guidance by experts in the audit and trust to IS and IT. The standard is designed for investigation policies and procedures, receiving audit programs and confirmation of confidence to the systems, as well as formation of effective auditor reports and recommendations.

Taking into account main components of IT audit, it is possible to determine the list of knowledge and skills to the IT auditor professional competencies, based on the best world standards and practices as follows [14]:

- Standards COBIT 5, PRINCE 2, ASL, BiSL.
- Library of the best practices in IT technologies ITIL V3.
- Practice of audit and confirmation of confidence to IS and ITAF technologies.
- Global Technology Audit Guide GTAG-8.

- General audit program / applications gurantees CAATTs.
- Information Technology. Processes assesment. ISO / IEC 15504-1-5.
- ISO / IEC set of standards on security and audit of IS and IT [15], [16].

3.3 Development of a competency model for training specialists in audit and quality control of IS and IT functioning.

❖ ***Objects and tasks of IT audit.*** IT, used at enterprises of both public and private sectors, determine the quality level of labor organization. Such system-forming components of the infrastructure as: equipment, software, information resources of different classes and critical data, IS, configured to provide business and operational process, are the foundation of production activities efficiency. Developed IT infrastructure of the company is a basic factor of organization success at the services market. Audit of IS and IT should be understood in the context of analysis, monitoring and control of the company's infrastructure functioning in general.

Taking into account, integration approach typical to the global system of total management, the following classes and types of IT audit objects can be presented:

- infrastructure of organization in general;
- all classes of business and operational processes of an organization;
- organizational structure and personnel of specialized subdivisions;
- risk management processes and procedures;
- client and server environment and its equipment;
- databases and knowledge, software (operational, application, antivirus, etc.);
- network environment and equipment;
- local equipment and user workstations;
- composition, state and assortment of technical means, cable systems and other engineering communications;
- documentation on a company IT (development, implementation, operation, regulations, instructions, etc.).

The aim of audit is receiving of an objective assessment of IT infrastructure compliance with the strategic direction of company's development in accordance with the strategy and policy of providing services, as well as with solution of tactical and strategic tasks. In any case, the results of audit should give answers on the issues, formulated by company management, which allow to optimize functioning of existing IS and IT, business and operational processes, systems of services delivery, etc.

A specific work plan should be developed for the audit, in accordance with IT audit aims and objectives. The objectives of IS / Infrastructure audit may be as follows:

- analysis of risks, associated with the possibility of incidents, violation of sustainable business and operational processes, reducing the efficiency and productivity of IS;
- monitoring and assessment of the current level of IS security, security complexes functioning;
- detection and localization of vulnerabilities of information resources and IS processes;
- assessment of IS compliance with existing standards, requirements and recommendations in the field of IT and their security;
- providing quality assessment and development of recommendations regarding implementation of new, as well as improving efficiency of the existing mechanisms and services of IS functioning / Infrastructure of the company in general, etc.

❖ ***Formation of academic model of competencies.***

According to the world system of standardization educational model of new academic specialty implementation should be based on the positions as follows: University – Customer – Branch market of services. Model of education should be aimed at the implementation of professionally oriented subjects and specialized professional courses in order to organize qualitative level of specialists training within the dual education.

There is a global, sustainable system of general branch standardization of educational IT processes and services, as well as professional staff certification, according to the occupations classifiers, including discription of different classes of IT specialists competencies.

It can be stated that there are three basic documents for standardization of educational services, competencies, skills and classification of IT specialists positions:

- International Standard Classification of Occupations 2008 (ISCO-08) - International Labor Office Geneva (Geneva, UNESCO),
- European e-Competence Framework (e-CF) version 3.0 - Working Group of the European e-Competence Framework, e-CF,
- ETA Competency Model Clearinghouse, USA – Standards of Public Associations of National Initiative, namely the USA National Initiative and Education's (NIE) [17], [18].

Formation of a competency-based approach to specialists training in IS and IT audit, based on the American ETA Competency Model Clearinghouse, which has received worldwide recognition for its multilevel competency-based approach to formation of skills, knowledge and learning outcomes, will be considered below. One of the model advantages is the standard of detalized classification of occupations, which, on authors opinion, is more modern and better corresponds to the current requirements of industry sector.

The authors' research presents developed model of competencies of IS and IT audit through the prism of academic and professional education, integrated competence of specialists, list of academic and professional competencies, skills and abilities of specialists in IS and IT audit.

It should be noted that it is a more classical approach. The ETA Competency Model Clearinghouse (USA) foresees description of 8 levels of academic and professional education, from Bachelor Degree to Master Degree. In this article, there is no task to distinguish and detail professional competencies separately for bachelor's and master's levels. However, authors of the presented materials determined professional competencies at a higher level. Task of competencies clustering is an aim of further research.

Taking into account analysis of previous research, it is necessary to introduce basic definitions in the system of audit, monitoring and control of IS and IT:

IS and IT Audit *is a systematic process of obtaining objective, qualitative and quantitative assessments of current state of a company business and operational processes as well as IS and IT (IT infrastructure) in accordance with certain criteria and quality indexes of IT services functioning and delivery.*

IT Audit is a processes of research and comprehensive analysis of management process model as well as existing IT infrastructure at an enterprise, which allow to assess their effectiveness, compliance with certain standards, strategies, regulations and policies, established by standardization system and company policy at the services market [15].

Let's formulate and give the definition of the integrated competence of specialist in the IS and IT audit.

Integrated competence in IS and IT audit *is an ability of a person to solve complex tasks and problems, analyze, develop and maintain a system of audit and monitoring the effectiveness of IS and IT, as well as business and operational processes and infrastructure of an organization in general, which foresees researches and / or innovations and is*

characterized by uncertainty of conditions and requirements.

It should be noted that currently there is a stable educational practice to form academic and professional knowledge on the basis of such concept as domain education. Format of a basic education domains for training specialists in the field of IS and IT audit, monitoring and control varies from five to eight. There are small variations in the number and names of education domains. Authors of the article present the most common and stable domains of education and their names, both in terms of academic and professional training of specilists [19], [20].

Domains of academic and professional education in the field of audit, monitoring and control of IS and IT are as follows:

1 Domain. IS Auditor.
2 Domain. Audit Process.
3 Domain. IT Governance.
4 Domain. Networking Technology.
5 Domain. Life Cycle Management.
6 Domain. IT Service Delivery.
7 Domain. Information Asset Protection.
8 Domain. Disaster Recovery and Business Continuity.

❖ **Professional competencies.** Specialists training should be based on theoretical and practical materials, after mastering of which the specialist should be aware of the following main areas and have professional competencies as follows:

- Ability to reasonably use, integrate, develop and improve modern IT, scientific and technical developments, physical and mathematical fundamental knowledge and models, as well as technologies for creation and usage of applied and specialized software for solution of professional problems in the field of IS and IT audit.
- Ability to develop, implement and analyze normative documents, regulations, instructions and technical and organizational requirements, as well as to integrate, analyze and use world best practices and standards in order to carry out professional activities in the field of IS and IT audit.
- Ability to investigate, develop and maintain methods, models and tools for IS and IT audit at the objects of information activity and critical infrastructure.
- Ability to analyze and monitor basic information about order of organization and stages of procedures for audit, monitoring and controlling the effectiveness of IS and IT functioning, IT services delivery to enterprises and organizations of various forms of ownership.
- Ability to investigate, system analysis and provision of business and operational processes continuity in order to identify vulnerabilities of IS and resources, risk analysis and assessment of their impact in accordance with the established strategy and policy of an organization at the IT services market.
- Ability to analyze, develop and maintain the total management system of an enterprise on the basis of business and operational model and risk management (including information security management) of an organization, to form a company's strategy and policy taking into account national and international standards and requirements.
- Ability to investigate, develop and implement methods and measures against incidents (including information or cyber incidents), to carry out procedures of management, control and internal investigation of incidents (accidents), as well as to give recommendations for prevention and analysis of incidents (accidents) in general.
- Ability to conduct training activities and their planning, control and support work with staff, as well as to complete reporting documentation on the IS and IT audit, in accordance with national and international standards and requirements.

Structural and logical model for formation of the academic and professional training of IS and IT auditors according to the international standard ISO 27001 is shown on the fig. 1

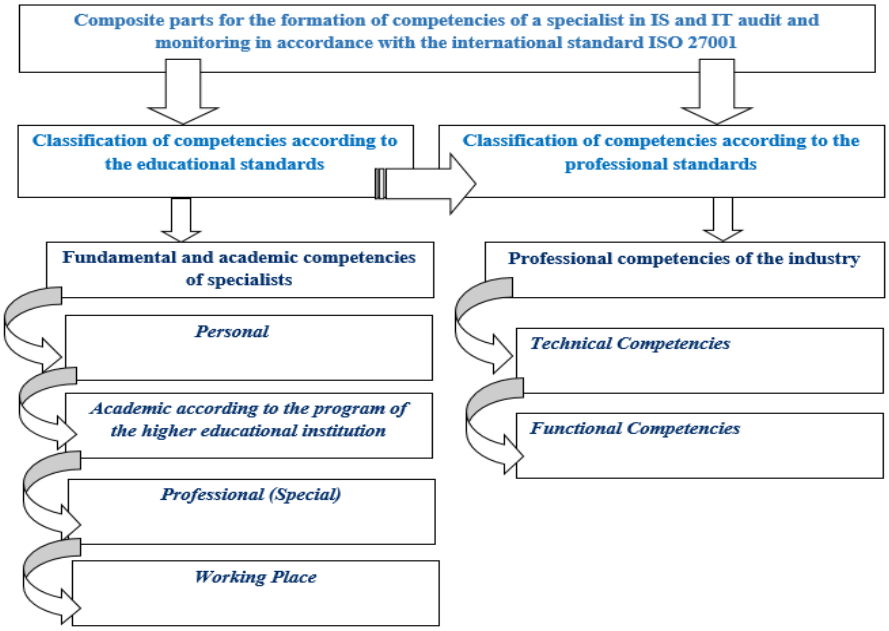

Fig. 1. Structural and logical model for formation of the academic and professional training of IS and IT auditors according to the international standard ISO 27001.

The authors propose a list of basic competencies of specialists in the field of IT and security audit, as composite parts of the model of information security management system according to the ISO / IEC 27001, 27006.

❖ **Basic skills and knowledge.**

As a result of academic training, a specialist must acquire the following basic skills and abilities:

- the ability to use national and international regulations in the field of audit, control, and standardization of total management and information security at enterprises and organizations of different forms of ownership;
- the ability to use basic procedures of management system and support of the system of IS and IT audit and control, to know methods and models for determination efficiency level of IS, as well as information and cyber security processes of enterprises and organizations;
- the ability to deliver audit procedures and provide basic information on the procedure and stages of the processes of analysis, monitoring and control of IS and IT (security systems) effectiveness at enterprises and organizations of different forms of ownership according to the IT services policy;
- skills in conducting, collecting and presenting the results of business and operational processes assesment, risk analysis of processes and critical applications, completion of documentation for provision of the processes of total management system audit and control at an enterprise, etc.;
- the ability to carry out advanced diagnostics of information resources and network environment, as well as skills in controlling and monitoring operation of used network equipment, application systems, applications and network services and infrastructure of an organization in general;

- the ability to organize certification of IS and complexes, means of information resources protection and cybersecurity;
- the ability to determine the quality level and control of IT infrastructure on the basis of technologies, criteria, models and methodologies for assessing the state of IS and IT, effectiveness of information protection functions as well as the guarantees level and their correctness;
- skills and abilities to collect data (arguments), statistical and visualization data of key performance indicators of IT services and network infrastructure operational parameters, skills to detect, respond to and prevent incidents of different classes;
- abilities and skills to detect and identify vulnerabilities, as well as to develop recommendations for improving the functioning efficiency of IS of information (cyber) security;
- skills to carry out inventory and advanced diagnostics of information resources according to the physical topology of the network space;
- the ability to plan, provide and control the continuity of business / operational processes of organizations and procedures of normal functioning rennovation after incidents;
- to develop system plans (requirements) for training in audit and monitoring of IS and IT, as well as working plans with staff;
- skills and abilities to carry out audit and control of existing normative documents, regulations, instructions, etc.;
- the ability to analyze, develop and provide a full profile of reports and recommendations on the audit results to an organization management team.

3.4. Classification of occupations and professional certification of IT auditors.

❖ **Academic and professional certification.**

The educational model "University – Customer – IT services market", should be aimed at implementation of professionally oriented subjects and specialized professional courses in order to organize a qualitative level of specialists training within academic and professional (dual) education.

According to the system of world classification of occupations and determined domains of education, the list of specialists positions in the field of IT audit includes: network and systems analysts; specialists and chief officers of information assurance, control and monitoring of IS and networks; software engineers, IT managers and IS compliance engineers; different classes of auditors, i.e. certification auditors, information assurance auditors, IS risk management auditors, etc.

The table of academic positions in the field of audit, analysis, monitoring and control of IS and IT effectiveness in accordance with the American model of competencies ETA Competency Model Clearinghouse is presented below (Table 1).

The most popular model in the global training system (including Europe) is the model of specialists training and classification, called Model Clearinghouse (USA). Unfortunately, the European competencies classification is still at the level of 2008, and does not provide a full compliance with the labor market and requirements of the modern IT industry sector.

❖ **Professional certification in the field of IS audit and control.**

Development and implementation of regulations, creation of organizational and legal bases of academic and professional education, determination of its conceptual areas should be based on the unification of universities, government programs and business partnership principles. The concept of specialists training system should also use modern innovation models, namely Triple Helix Model of Interaction between Government Industry and Academia.

According to this model, Information Systems Audit and Control Association (ISACA) and its regional organizations become the basis for development and implementation of both academic and professional competencies at universities. Main aim of the ISACA is investigation, development, publication and distribution of knowledge and experience in the fields of IS audit and management, standard set of documents on IT management and their usage by IS administrators and auditors.

Table 1.

Classification of academic positions in the field of IS and IT

➢ **Network Services** ✓ Network Analyst ✓ Systems Analyst ➢ **Systems Development** ✓ Information Assurance (IA) Developer ✓ Information Assurance (IA) Engineer ✓ Information Assurance (IA) Software Engineer ➢ **Information Systems Risk Management** ✓ IT Analyst/Manager ✓ IT Auditor ✓ Certification Agent ✓ Compliance Manager ✓ Designated Accrediting Authority ✓ Quality Assurance (QA) Specialist ✓ Risk/Vulnerability Analyst	➢ **Strategic Planning and Policy Development** ✓ Chief Information Officer (CIO) ✓ Command Information Officer ➢ **Information Systems Operations** ✓ Information Assurance (IA) Manager ✓ Information Assurance (IA) Program Manager ✓ Information Assurance (IA) Security Officer ➢ **Information Systems Risk Management** ✓ Accreditor ✓ Information Assurance (IA) Officer ✓ Information Assurance (IA) Auditor ✓ Information Assurance (IA) Compliance ✓ Information Assurance (IA) Manager

The worldwide recognized professional certificates of the IT audit system, issued by the ISACA are as follows:

- ✓ **CISA** - Certified Information Systems Auditor;
- ✓ **CGEIT** - Certified in the Governance of Enterprise IT;
- ✓ **CRISC** - Certified in Risk and Information Systems Control;
- ✓ **ITAF** - IT Assurance Framework;
- ✓ **COBIT** - Control Objectives for Information and Related Technologies.

4. CONCLUSIONS AND PERSPECTIVES OF FURTHER RESEARCHES

Research of modern conceptual approaches to the formation of academic and professional competencies of specialists in the field of IS and IT audit has been carried out. It is presented the hierarchical sequence of implementation of the world system of standardization for IS and IT functioning audit and quality control in order to determine a platform of knowledge, models and procedures for carrying total management of a company.

A competency model of academic and professional training of IS and IT auditors has been created on the basis of national and international standards, as well as taking into account the best world practices of the IT industry sector. Models and procedures of audit and quality control of IS and organization's infrastructure in general functioning are determined within the aim and tasks of the research.

Main issues of the system of academic and professional training of specialists in the

field of IT audit and control have been determined. Investigation of the set tasks is aimed to the solution of further fundamental problem. It is improving the quality and efficiency of the educational and scientific processes organization at Universities within the field of knowledge "Information Technologies".

The authors for the first time propose to introduce into the system of Ukrainian academic education of a specialty or specialization in the training of specialists in the audit of information security management system according to the world system of information and cyber security standardization. The authors propose a list of basic competencies of specialists in the field of IT and security audit, as composite parts of the model of information security management system according to the ISO / IEC 27001, 27006.The issue of interrelations with the field of information security and its standardization system is identified.

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КОМПЕТЕНТНІСНИЙ ПІДХІД ДО АКАДЕМІЧНОЇ ТА ПРОФЕСІЙНОЇ ПІДГОТОВКИ АУДИТОРІВ З ІНФОРМАЦІЙНИХ СИСТЕМ ТА ТЕХНОЛОГІЙ

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Анотація. Здійснено аналіз особливостей формування системи компетентностей під час академічної та професійної підготовки фахівців з аудиту та моніторингу інформаційних систем і технологій. Визначено, що система підготовки фахівців повинна формуватись відповідно до світової системи сектору індустрії послуг, а також згідно зі світовими вимогами і стандартами. Розкрито зміст формування компетентностей на основі американських та європейських стандартів інформаційних систем і технологій. Визначено ієрархічну послідовність упровадження світової системи стандартизації з аудиту та контролю якості функціонування інформаційних систем та технологій з метою встановлення вимог до компетентностей аудитора інформаційних технологій. Висвітлено практичні задачі процесу одержання об'єктивних якісних і кількісних оцінок про поточний стан інформаційної інфраструктури відповідно до визначених критеріїв, вимог та показників якості. Виявлено основні особливості формування компетентностей, навичок, знань фахівців з аудиту та моніторингу інформаційних систем і технологій. Представлено побудову базових академічних та професійних компетентностей фахівців з аудиту інформаційних систем і технологій на базі доменної освітньої моделі Competency Model Clearinghouse. Сформовано компетентнісну модель формування знань, навичок та вмінь з організації та супроводу процесів аудиту, контролю та моніторингу інформаційних систем і технологій. Висвітлено задачі, визначено поняття інтегральної компетентності фахівців,

сформовано перелік академічних і професійних компетентностей, а також визначено базові вміння та навички фахівців з аудиту інформаційних систем і технологій. Визначено класи та рівні компетентностей, а також відповідні їм посади у сфері аудиту інформаційних систем, інформаційних технологій сектору індустрії. Особливу увагу приділено міжнародним загальноспрямованим підходам стандартизації освітніх послуг, рівням компетенцій відповідно до професійних вимог до фахівців у системі аудиту інформаційних технологій, класифікації посад. Визначено базові рівні професійної сертифікації аудиторів інформаційних систем, які повинні забезпечити високий рівень якості широкого переліку послуг у сфері інформаційних технологій та інформаційної безпеки.

Ключові слова: аудит інформаційних систем; професійні компетентності; бізнес-процеси; інфраструктура; модель зрілості.

КОМПЕТЕНТНОСТНЫЙ ПОДХОД К АКАДЕМИЧЕСКОЙ И ПРОФЕССИОНАЛЬНОЙ ПОДГОТОВКЕ АУДИТОРОВ ИНФОМАЦИОННЫХ СИСТЕМ И ТЕХНОЛОГИЙ

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Аннотация. В статье проанализированы особенности формирования системы академической и профессиональной подготовки специалистов области аудита и мониторинга информационных систем и технологий. Определено, что система подготовки специалистов должна формироваться в соответствии с мировой системой сектора индустрии услуг, а также согласно мировых требований и стандартов. Раскрыто содержание формирования компетентностей на основе американских и европейских стандартов направления информационных систем и технологий. Определено иерархическую последовательность внедрения мировой системы стандартизации аудита и контроля качества функционирования информационных систем и технологий с целью установления требований к компетентности аудитора информационных технологий. Освещены практические задачи процесса получения объективных качественных и количественных оценок о текущем состоянии информационной инфраструктуры в соответствии с

определенными критериями, требованиями и показателями качества. Выявлены основные особенности формирования компетентностей, навыков, знаний специалистов в области аудита, мониторинга информационных систем и технологий. Представлено построение базовых академических, профессиональных компетентностей специалистов по аудиту информационных систем и технологий на базе доменной образовательной модели Competency Model Clearinghouse. Сформирована компетентносная модель формирования знаний, навыков и умений организации и сопровождения процессов аудита, контроля и мониторинга информационных систем и технологий. Освещены задачи, определено понятие интегральной компетентности специалистов, сформирован перечень академических и профессиональных компетентностей, а также определены базовые умения и навыки специалистов по аудиту информационных систем и технологий. Определены классы и уровни компетентностей, а также соответствующие им должности в сфере аудита информационных систем, информационных технологий сектора индустрии. Особое внимание уделено международным общенаправленным подходам стандартизации образовательных услуг, уровням компетенций в соответствии с профессиональными требованиями к специалистам в системе аудита информационных технологий, классификации должностей. Определены базовые уровни профессиональной сертификации аудиторов информационных систем, которые должны обеспечить высокий уровень качества широкого перечня услуг в сфере информационных технологий и информационной безопасности.

Ключевые слова: аудит информационных систем; профессиональные компетентности; бизнес-процессы; инфраструктура; модель зрелости.

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