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The Characteristics of the Diagnostic Apparatus for Studying the Formation of Managerial Competence of Master's Students in Cybersecurity and Information Protection

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Abstract. The article addresses the problem of forming managerial competence among master's students in cybersecurity and information protection, a task that has gained particular relevance in the context of digitalization and the rapid development of information technologies. The stability of governmental institutions, business structures, and the security of citizens increasingly depend not only on technical expertise but also on the managerial skills of specialists in this domain. The study emphasizes the necessity of a scientifically grounded diagnostic apparatus that enables objective assessment of the level of managerial competence formation, integrating both technical and pedagogical dimensions. The research is based on methodological literature, which highlights the importance of impartiality, representativeness, reliability, validity, and functional orientation in the development of evaluation criteria. The article substantiates the conceptual field of managerial competence and defines criteria as generalized qualitative attributes, while indicators are understood as their concrete manifestations. Four criteria are distinguished (value-motivational, informational-content, activity-operational, and personal-reflexive) corresponding to motivational, cognitive, technological, and personal components of competence. Each criterion is operationalized through specific indicators and differentiated across three levels of formation: basic, sufficient, and high. The findings confirm that managerial competence is a multidimensional construct requiring the integration of values, knowledge, skills, and personal qualities. The practical significance of the study lies in its potential to improve educational programs, enhance the professional readiness of graduates, and increase their competitiveness in the labour market. Prospects for further research include the development of a model for the formation of managerial competence of master's students in cybersecurity and information protection. Prospects for further research have been identified.

Keywords: cybersecurity, information protection, managerial competence, diagnostic apparatus, evaluation criteria, indicators, pedagogical methodology, higher education, professional training, competence formation.

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Характеристика діагностичного апарату для дослідження сформованості управлінської компетентності магістрів з кібербезпеки та захисту інформації

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Анотація. Стаття присвячена проблемі формування управлінської компетентності магістрів з кібербезпеки та захисту інформації, що набуває особливої актуальності в умовах цифровізації та стрімкого розвитку інформаційних технологій. Стабільність функціонування державних інституцій, бізнес-структур та безпека громадян дедалі більше залежать не лише від технічної експертизи, але й від управлінських навичок фахівців цієї галузі. У дослідженні наголошено на необхідності науково обґрунтованого діагностичного апарату, який забезпечує об'єктивне оцінювання рівня сформованості управлінської компетентності, інтегруючи технічні та педагогічні виміри.

Дослідження ґрунтується на методологічній літературі, що підкреслює важливість неупередженості, репрезентативності, надійності, достовірності та функціональної спрямованості при розробці критеріїв оцінювання. У статті обґрунтовано понятєво-термінологічне поле управлінської компетентності та визначено критерії як узагальнені якісні ознаки, тоді як показники розглядаються як їх конкретні прояви. Виокремлено чотири критерії: ціннісно-мотиваційний, інформаційно-змістовий, діяльнісно-операційний та особистісно-рефлексивний, що відповідають мотиваційному, когнітивному, технологічному та особистісному компонентам компетентності. Кожен критерій операціоналізовано через конкретні показники та диференційовано за трьома рівнями сформованості: базовим, достатнім та високим. Результати підтверджують, що управлінська компетентність є багатовимірним конструктом, який потребує інтеграції цінностей, знань, умінь та особистісних якостей. Практичне значення дослідження полягає у його потенціалі для вдосконалення освітніх програм, підвищення професійної готовності випускників та зміцнення їх конкурентоспроможності на ринку праці. До перспектив подальших досліджень віднесено розробку моделі формування управлінської компетентності магістрів з кібербезпеки та захисту інформації. Визначено перспективи подальших досліджень.

Ключові слова: кібербезпека, захист інформації, управлінська компетентність, діагностичний апарат, критерії оцінювання, показники, педагогічна методологія, вища освіта, професійна підготовка, формування компетентності.

Introduction

Topicality of the problem. In the contemporary context of societal digitalization and the rapid advancement of information technologies, issues of cybersecurity and information protection have acquired particular significance. The stability of governmental institutions, business structures, and the security of citizens increasingly depend on the effectiveness of professionals working in this domain. Consequently, the preparation of master's students in cybersecurity and information protection must be oriented not only toward the acquisition of solid technical knowledge but also toward the development of managerial competence, which ensures the ability to organize, coordinate, and control processes in the field of information security. The relevance of this study is determined by several factors: the growing importance

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of managerial skills in the professional activities of cybersecurity specialists; the need to establish a scientifically grounded diagnostic apparatus that enables an objective assessment of the level of managerial competence formation; the absence of established pedagogical methodologies that integrate both technical and managerial components in the training of master's students; and the practical significance of the research results for improving educational programs and enhancing the competitiveness of graduates in the labor market.

Literature review. A scientific-pedagogical study aimed at the formation of managerial competence among master's students in cybersecurity and information protection requires adjustments to their training in order to achieve the expected outcomes. To measure the effectiveness of this work, it is necessary to develop a diagnostic apparatus. Reference is made to methodological literature that highlights the specifics of organizing and conducting scientific-pedagogical research [2; 10; 15], where it is stated that "methodology is the doctrine of the structure, means, and methods of organizing scientific activity. It is a set of principles that function in practice for understanding regularities, research methods, and their interconnections, which are considered as a system of ideas" [2, p. 29].

According to O. Dubaseniuk, "diagnostics (of Greek origin: 'dia' – transparent and 'gnosis' – knowledge) is a general means of obtaining anticipatory information about the object or process under study" [10, p. 171]. Addressing the specifics of scientific research more broadly, scholars note that "measurement is the procedure of determining the numerical value of a particular quantity using a reference unit of measurement; as a result, precise information about the object under study is obtained" [2, p. 32].

Researchers emphasize that both quantitative and qualitative characteristics of the object under study should be taken into account [12, p. 54]. According to the authors, "quantitative characteristics can always be measured using certain units of measurement, and the results of measurement can be arranged in a specific sequence (increase, decrease, periodic recurrence, etc.). When grouping by qualitative characteristics (attributive grouping), the basis is features that cannot be described quantitatively, but they may recur in such a way that they can be identified (for example, the nationality or social origin of respondents). From qualitative characteristics, it is impossible to construct any sequence" [12, p. 54].

The aim of the article. The aim of the article is to present a diagnostic toolkit for studying the formation of managerial competence among master's students in cybersecurity and information protection.

Research results

The review of literature on the methodology of science [2; 4; 6; 7] and, more specifically, on pedagogical science [3; 10; 11; 13; 14; 15] indicates that, in the process of developing a criterion-level diagnostic apparatus for research, certain methodological principles must be observed to ensure the scientific validity of the defined criteria and their indicators. These include the principle of impartiality and autonomy, which guarantees the objectivity, universality, and independence of the criterion from the subjective judgments, preferences, or personal characteristics of the researcher. Adherence to the principle of representativeness and analytical completeness in the development of criteria ensures the comprehensiveness of their indicators, thereby enabling a holistic assessment of the impact on the object of evaluation. Consideration of the principle of reliability and validity presupposes the creation of criteria that allow for the collection, processing, analysis, and synthesis of empirical data sufficient for statistical verification. Finally, the principle of functional orientation substantiates the practical applicability of the developed criteria, through which it becomes possible to evaluate changes in the formation of components of managerial competence.

In our study, the criterion-level diagnostic apparatus was developed on the basis of the conceptual and terminological field of the research. In this regard, we agree with the thesis that

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“it is impossible to identify criteria without a qualitative conceptual and terminological analysis and the definition of the essence of the concept that characterizes the phenomenon under investigation. Conducting such an analysis is the first step toward identifying criteria; the second is the operationalization of this concept, which is understood as the identification of indicators that make it possible to evaluate the phenomenon under study. These indicators are the criteria themselves” [16, p. 147]. For this scientific inquiry, the author’s contribution is particularly important, according to which “criteria are the most essential properties of the phenomenon subject to evaluation; they characterize objective reality, which does not depend on the researcher” [16, p. 72]. The researcher emphasizes that “criteria make it possible to assess the state of solving a particular pedagogical problem, to identify directions for its further resolution, and to verify the effectiveness of proposed methodological systems. The formulation of the research hypothesis and the verification of its provisions are linked to the criteria” [16, p. 143].

According to reference literature, an “indicator” is defined as evidence, proof, or a sign of something, visual data on the results of a certain activity or process; data on achievements in a particular domain [5, p. 1024]. As Ye. Khrykov notes, “an important and complex task is to determine the indicators of each criterion. This is best done after the list of criteria has been finalized. If the number of criteria can be determined by the rule of 7±2, then the number of indicators can be determined by the rule of 5±2” [16, p. 153]. Therefore, we employ the concept of ‘criterion,’ which we understand as a generalized qualitative characteristic that reflects the essence of one of the components of managerial competence of master’s students in cybersecurity and information protection, and which is used in the study to evaluate its formation under the influence of implemented pedagogical conditions.

In methodological literature, criteria are considered together with indicators. While criteria are interpreted as generalized qualitative attributes that attest to the formation of distinct components within the structure of a given competence, indicators are understood as the concrete manifestations of these criteria. In our study, these indicators represent the available evidence that makes it possible to trace changes in the formation of managerial competence among master’s students in cybersecurity and information protection.

Having defined the essence of managerial competence for master’s students in cybersecurity and information protection, we identified its constituent elements, represented by motivational, cognitive, technological, and personal components. It is therefore logical to develop criteria and their corresponding indicators, which form the basis of the diagnostic apparatus of the study and allow for the assessment of the levels of formation of each component, thereby enabling conclusions about the overall formation of managerial competence among these students.

Our reasoning finds support in the scientific-pedagogical literature. In particular, according to L. Adaryukova, for studying the formation of value-motivational, procedural-informational, organizational, and control-reflexive components of self-educational competence among cybersecurity and information protection specialists, it is advisable to apply “personal, pragmatic, organizational, and reflexive criteria” [1, p. 84]. In her study of the development of managerial competence of school principals, T. Volotovska proposes the use of a criterion-level system encompassing motivational, cognitive, activity-based, and personal criteria, developed in accordance with the value-motivational, cognitive-technological, organizational-content, and reflexive-resultative components of managerial competence, with their formation assessed at reproductive, adaptive, and creative levels [8]. Within the structure of managerial competence of school principals, I. Darmanska distinguishes “value-motivational, cognitive-content, practical, and control-resultative” components [9, p. 162], the formation of which is proposed to be evaluated according to “high, medium, below medium, and low” levels of manifestation of the corresponding indicators [9, p. 164].

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Based on methodological literature, the contributions of previous researchers, and the structural composition of managerial competence among master's students in cybersecurity and information protection, we distinguish four criteria: value-motivational, informational-content, activity-operational, and personal-reflexive. These criteria correspond respectively to the motivational, cognitive, technological, and personal components.

We now turn to their characterisation, taking into account the assertion that "criteria and indicators are the core elements of an evaluation methodology, but its development also requires a description of the levels of manifestation of these criteria. If indicators truly reflect the essential characteristics of the criteria, then their presence in the phenomenon under study indicates a high level of criterion formation, their absence indicates a low level, and partial formation indicates a medium level" [16, pp. 153–154]. Accordingly, we distinguish three levels: basic, sufficient, and high.

Based on the structure of the motivational component of managerial competence among master's students in cybersecurity and information protection, namely motives (social, cognitive, professional-value, mercantile), values (universal, personal, corporate, societal), and aspirations (personally oriented, professionally oriented, socially oriented), we define the value-motivational criterion as one that reflects the formation of the internal convictions of a cybersecurity and information protection specialist, encompassing a complex of values and motives that justify behaviour and activity within the professional community.

In our view, its indicators should include the awareness of the professional and societal significance of cybersecurity and information protection from the standpoint of professional ethics, social responsibility, the stability of knowledge economy development, and the protection of citizens' rights. Equally important is the formation of universal, societal, and professional values that align with the norms of corporate culture and security policy.

At the basic level of formation of the motivational component of managerial competence among master's students in cybersecurity and information protection, the indicators of the value-motivational criterion include episodic understanding of the professional and societal significance of cybersecurity and information protection; sporadic development of universal, societal, and professional values; elementary cognitive motives and a low level of aspiration to acquire managerial competence; and isolated manifestations of the desire to realize personal potential and pursue continuous self-improvement.

At the sufficient level of formation of the motivational component, the indicators of the value-motivational criterion are reflected in a satisfactory awareness of the professional and societal importance of cybersecurity and information protection; an adequate level of development of universal, societal, and professional values; an acceptable level of cognitive motives and corresponding aspiration to acquire managerial competence; and a sufficient level of striving for self-realization and ongoing self-development.

At the high level of formation of the motivational component, the indicators of the value-motivational criterion are manifested in a clear awareness of the professional and societal significance of cybersecurity and information protection; a substantial level of development of universal, societal, and professional values; consistent and systematic predominance of cognitive motives and purposeful aspiration to acquire managerial competence; and a strongly expressed drive for self-realization and continuous self-improvement.

The definition of the cognitive component and its elements (scientific-theoretical knowledge (knowledge of the nature and functions of management, methodological approaches to management, knowledge of regulatory frameworks and standards); managerial thinking (systematicity, prognostic ability, flexibility, and adaptability); and professional understanding (awareness of the role of managerial competence, socio-psychological sensitivity) provides grounds for applying the informational-content criterion and its indicators. In this context, it is logical to conclude that this criterion should reflect a well-developed body of knowledge about management, awareness of the role of managerial

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competence within the structure of professional competence of cybersecurity and information protection specialists, as well as managerial thinking aimed at the effective performance of professional functions in the field of cybersecurity and information protection.

In our view, the indicators of the informational-content criterion should include a system of theoretical knowledge about the essence of management and its functions, methodological approaches applied in resource management, and a body of knowledge about security culture and the establishment of constructive relationships within a team. Particular importance is attached to managerial thinking, characterised by systematicity, prognostic ability, flexibility, and adaptability, as well as an understanding of the role and significance of managerial competence and its demand in the functioning of state authorities, local self-government bodies, and business organisations.

At the basic level of formation of the cognitive component of managerial competence among master's students in cybersecurity and information protection, the indicators of the informational-content criterion include sporadic theoretical knowledge about the essence of management and its functions, methodological approaches applied in resource management; unsystematic knowledge about security culture and the establishment of constructive relationships within a team; a basic level of managerial thinking characterized by elementary systematicity and prognostic ability, isolated manifestations of flexibility and adaptability; and partial understanding of the role and significance of managerial competence and its demand in the functioning of state authorities, local self-government bodies, and business organizations.

At the sufficient level of formation, the indicators of the informational-content criterion include adequate theoretical knowledge about the essence of management and its functions, methodological approaches applied in resource management; an acceptable level of knowledge about security culture and the establishment of constructive relationships within a team; optimal development of managerial thinking characterized by satisfactory systematicity and prognostic ability, an appropriate level of flexibility and adaptability; and a proper understanding of the role and significance of managerial competence and its demand in the functioning of state authorities, local self-government bodies, and business organizations.

At the high level of formation, the indicators of the informational-content criterion are manifested in comprehensive theoretical knowledge about the essence of management and its functions, methodological approaches applied in resource management; a high level of knowledge about security culture and the establishment of constructive relationships within a team; well-developed managerial thinking characterized by excellent systematicity and prognostic ability, significant flexibility and adaptability; and profound understanding of the role and significance of managerial competence and its demand in the functioning of state authorities, local self-government bodies, and business organizations.

In the context of our study, we characterise the activity-operational criterion, whose indicators are used to assess the formation of the technological component of managerial competence among master's students in cybersecurity and information protection. This component encompasses information-analytical ability (information collection and processing; risk analysis and assessment; data-driven decision-making), planning-prognostic ability (strategic security planning; threat forecasting and scenario modelling; development of regulatory and organisational documentation), and organisational-managerial ability (establishing interpersonal communication; coordinating teamwork; incident management and response). In our view, the activity-operational criterion reflects the formation of practical skills necessary for the implementation of managerial functions, based on the use of modern tools and management technologies for monitoring and responding to cyber threats and incidents; managing (planning, organising, coordinating, monitoring, and controlling) activities in the field of cybersecurity and information protection; and establishing effective communication and constructive teamwork.

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The indicators of the activity-operational criterion, in our opinion, should include information-analytical skills for collecting and analysing information, assessing risks, and making managerial decisions; planning-prognostic skills for organizing cyber defence, forecasting and modelling incident prevention, and developing organizational cybersecurity documentation; organizational-managerial skills for coordinating team activities, monitoring and controlling task performance, and making effective managerial decisions; and communicative-managerial skills for ensuring effective communication and collaboration within the organization, building constructive interaction, and fostering a culture of security.

At the basic level of formation of the technological component of managerial competence, the indicators of the activity-operational criterion include an elementary level of information-analytical skills for collecting and analysing information, assessing risks, and making managerial decisions; basic planning-prognostic skills for organizing cyber defence, forecasting and modelling incident prevention, and developing organizational cybersecurity documentation; rudimentary organizational-managerial skills for coordinating team activities, monitoring and controlling task performance, and making managerial decisions; and an initial level of communicative-managerial skills for ensuring communication and collaboration within the organization, building interaction, and fostering a security culture.

At the sufficient level of formation, the indicators include a satisfactory level of information-analytical skills for collecting and analysing information, assessing risks, and making managerial decisions; acceptable planning-prognostic skills for organizing cyber defence, forecasting and modelling incident prevention, and developing organizational cybersecurity documentation; optimally developed organizational-managerial skills for coordinating team activities, monitoring and controlling task performance, and making effective managerial decisions; and an adequate level of communicative-managerial skills for ensuring effective communication and collaboration within the organization, building constructive interaction, and fostering a security culture.

At the high level of formation, the indicators of the activity-operational criterion are manifested in a high level of information-analytical skills for collecting and analysing information, assessing risks, and making managerial decisions; advanced planning-prognostic skills for organizing cyber defence, forecasting and modelling incident prevention, and developing organizational cybersecurity documentation; well-developed organizational-managerial skills for coordinating team activities, monitoring and controlling task performance, and making effective managerial decisions; and an excellent level of communicative-managerial skills for ensuring effective communication and collaboration within the organization, building constructive interaction, and fostering a security culture.

Based on the identification of such elements of the personal component within the structure of managerial competence of master's students in cybersecurity and information protection (ethical, volitional, and organizational qualities (adherence to ethical norms, development of ethical policies and standards, organization of work in accordance with norms and standards); the ability for self-management, stress resistance, and leadership (crisis management, leadership in teamwork, the ability to serve as a role model under challenging conditions); and reflexivity (formation of corporate culture, support for team cohesion, reflection on the effectiveness of professional activity)) we substantiate the essence of the personal-reflexive criterion. In our view, this criterion reflects the formation of personal qualities that are crucial for ensuring the effectiveness of professional activity of cybersecurity and information protection specialists. It presupposes the ability to organize one's own activity on the basis of professional ethics, corporate culture, and integrity; the ability to exercise self-management of behaviour and activity under conditions of rapid change and uncertainty; the ability to work in a team, perform leadership functions, and make well-considered decisions; and the ability to analyse and critically evaluate one's own activity, identifying opportunities for improvement.

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At the basic level of formation of the personal component of managerial competence among master's students in cybersecurity and information protection, the indicators of the personal-reflexive criterion include a fragmented ability to organize one's own activity on the basis of professional ethics, corporate culture, and integrity; an elementary ability to exercise self-management of behaviour and activity under conditions of rapid change and uncertainty; a basic ability to work in a team, an initial ability to perform leadership functions and make decisions; and sporadic ability to analyse and evaluate one's own activity, identifying opportunities for improvement.

At the sufficient level of formation, the indicators of the personal-reflexive criterion are manifested in a satisfactory ability to organize one's own activity on the basis of professional ethics, corporate culture, and integrity; an acceptable ability to exercise self-management of behaviour and activity under conditions of rapid change and uncertainty; an optimal ability to work in a team, partially perform leadership functions, and make well-considered decisions; and an adequate ability to analyse and critically evaluate one's own activity, identifying opportunities for improvement.

At the high level of formation, the indicators of the personal-reflexive criterion include a high level of ability to organize one's own activity on the basis of professional ethics, corporate culture, and integrity; a stable ability to exercise self-management of behaviour and activity under conditions of rapid change and uncertainty; an excellent ability to work in a team, fully perform leadership functions, and make well-considered decisions; and a highly developed ability to analyse and critically evaluate one's own activity, identifying opportunities for improvement.

Conclusions

The conducted study substantiates the methodological foundations and practical significance of developing a criterion-level diagnostic apparatus for assessing the formation of managerial competence among master's students in cybersecurity and information protection. The research highlights that managerial competence is a multidimensional construct, encompassing motivational, cognitive, technological, and personal components, each of which requires clear criteria and indicators for reliable evaluation. The proposed diagnostic toolkit integrates four criteria (value-motivational, informational-content, activity-operational, and personal-reflexive) corresponding to the structural components of managerial competence. Each criterion is operationalized through specific indicators and differentiated across three levels of formation (basic, sufficient, high), thereby ensuring both analytical completeness and practical applicability.

The findings confirm that the development of managerial competence in cybersecurity specialists cannot be limited to technical training alone; it must also include the cultivation of values, managerial thinking, practical skills, and personal-reflexive qualities. The diagnostic apparatus presented in this study provides a scientifically grounded means of monitoring these processes, enabling educators to evaluate progress, identify gaps, and adjust pedagogical conditions accordingly.

Thus, the research contributes to the advancement of pedagogical methodology in higher education, offering a structured and reliable framework for assessing managerial competence. Its application can enhance the quality of training programs, strengthen the professional readiness of graduates, and increase their competitiveness in the labour market.

Among the prospects for further research, we include the development of a model for the formation of managerial competence of master's students in cybersecurity and information protection.

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