ANNOTATION

of the dissertation by **Naumenko V.V.**
on the topic: «**Development of models of the infrastructure platform for the development of human capital**», submitted for the degree of Philosophy Doctor (PhD) in the field of 6D070400 – Computer systems and software engineering.

Military education is a purposeful learning process and is one of the priority, quantitative and qualitative dimensions of human capital. In modern conditions of the development of military professional activity, the tasks of training military personnel with in-depth knowledge at the level of state and military control become decisive. The issues of admission to training, the specifics of training cadets and trainees, the distribution of graduates to specific positions in military units, promotion, advanced training and retraining of military personnel should be clearly regulated in regulatory legal documents and reflected in a single information system.

Accordingly, the military education system is characterized by content specificity, which reflects its own rules for admission, the rules for the operation of military educational institutions, the organization of the educational process, educational and methodological work, the distribution of human resources, scientific and technical developments, etc. In this paper, an innovative methodology for the visual representation and organization of knowledge and models for the development of human capital, based on an ontological model and engineering, has been researched and developed in order to form knowledge expressions and a database, as well as the corresponding knowledge components, with their subsequent use for designing knowledge content. on the development of human capital and an individual trajectory for its construction.

This methodology provides an opportunity to implement a project-oriented approach, where the main task is to plan the sequence of training, in accordance with the stages of the international CDIO initiative to develop the project and the stages of achieving the goals. If this approach and the competence-based approach are used, then the methodology allows the formation of a knowledge trend and a Smart contract, configuring the scenario for achieving the goal in military education. Human capital is based on a certain set of individual characteristics of a person and social trends. If this basis can be formalized and structured, as well as documented, such information becomes the starting point for the development of educational programs for the preparation of future specialists in this field and trainings to improve their skills, as well as for the accreditation of academic programs and professional certification.

The research results presented in this paper are based on the author's concept of creating and applying an innovative methodology for the formation of educational resources for planned learning, focused on solving the problem of digitalization of the development of human capital and education in general, adapting processes and rules to modern requirements, developing creative, cultural, professional skills , taking into account the interests and characteristics of the individual, giving the opportunity to individualize training to increase human capital. In recent years, many scientists have widely covered the issues of human capital as an integral part of a developed state.

According to the latest data published by the World Bank in 2020, Kazakhstan ranks 55th in this index with an indicator of 0.63. (https://factcheck.kz/claim-checking/verdict/indeks-chelovecheskogo-kapitala-063-tak-li-eto-ploxo-dlya-kazaxstana/) The reference indicator is 1, which the whole world aspires to, Singapore has the highest score of 0.88. The Human Development Index is also calculated by the UN Development Program, in which it is published that Kazakhstan is in 51st place with an indicator of 0.825 among 189 states. The achievements of a country are measured by the level of education and its accessibility, measured by the adult literacy rate and the total gross enrollment rate, as well as the use of their skills and knowledge by the population for the benefit of themselves and the country. July 27, 2022 at the Academy of Elbasy, a meetup "Overview of research in the field of education and human capital development" was held. In Kazakhstan, 2022 has been declared the Year of Children. The quality of human capital and economic development of any country depends on the social well-being of children and youth. (https://bilimdinews.kz/?p=209307)

Human capital has no depreciation losses. It accumulates more and more every year and with experience increases on a progressive scale. (Simonovich, N.E. Formation of human capital in an organization / N.E. Simonovich. - Text: electro nic // NovaInfo, 2017. - No. 60. - P. 401-407. — URL: https://novainfo.ru/article/11335 (date of access: 09/05/2022).) The sufficient significance of the dissertation research is emphasized by the scientific works of the Eurasian National University named after L. N. Gumilyov, Astana IT University and Nazarbayev University, during the Forum of Science and Higher Education "Human capital is a key resource for the development of the new Kazakhstan".(https://enic-kazakhstan.edu.kz/ru/forum-nauki-i-vysshego-obrazovaniya-2022-chelovecheskiy-kapital-klyuchevoy-resurs-razvitiya-novogo-kazahstana/forum-nauki-i-vysshego-obrazovaniya-1) Economist Olzhas Tuleuov's research highlights the main obstacles to a more significant and large-scale growth of human capital in Kazakhstan. (https://kapital.kz/economic/88469/chelovecheskiy-kapital-nezamenimyye-yest.html)

Russian specialist Irina Ryabova provided a vivid historical background on research on the history of the emergence of the concept of human capital (https://econs.online/articles/ekonomika/samyy-tsennyy-ekonomicheskiy-resurs/)

Military education is one of the key factors in the formation and development of human capital. The relevance and role of education in the development of effective human potential is confirmed by the fact that at present this particular component is considered one of the most profitable types of state investments. The dissertation research is aimed at improving the system of military professional education through the development of a military multifunctional educational platform for the needs of domestic military educational institutions.

March 2022 at a meeting with the leadership of the Armed Forces, the Head of State focused on the development of the military education system and personnel policy in order to improve the professional level of military personnel, career growth based on the principle of meritocracy [The Head of State held a meeting with the leadership of the Armed Forces (https://www.akorda.kz /ru/glava-gosudarstva-provel-soveshchanie-s-rukovodstvom-vooruzhennyh-sil-223748). Currently, about 2,600 military personnel are trained in more than 750 specialties under the system of joint training of military personnel of the CSTO member states [How officers of the CSTO countries are trained, Timofey Borisov, (https://rg.ru/2022/07/13/kak-proishodit-podgotovka-officerov-stran-odkb.html). Increasing the level of operational and tactical training of military personnel is inextricably linked with the use of modern software and hardware complexes in the educational process, which provide the trainees with conditions of activity that are adequate to the real ones in terms of external environmental influences and systemic connections. The given brief analysis of the authors within the framework of the presented study is a necessary and sufficient part to confirm the relevance of the study.

The relevance of the study lies in: – Support for the procedures of the Government of the Republic of Kazakhstan for the implementation of the State Program for the Development of Science and Education for 2016-2022; – Digitalization of Kazakhstan: one of the main tasks of the development of our country in the post-COVID period; – Providing a new paradigm of the information base of the infrastructure platform that meets the needs of the digital economy, with an emphasis on developing skills in information analysis and creative thinking; – Diversification of electronic information on the Internet and the range of information services through the development of new educational methods of self-development, including Smart technologies, in order to increase the human capital of military educational institutions; – The need to apply the methods of knowledge engineering and ontological engineering, as well as the introduction of information technology in the development of human capital; – Formalization of knowledge representation in the ontology model format, in the form of knowledge components. Application of the concept of a smart contract for configuring knowledge components, in accordance with the learning scenario, and designing a knowledge architecture.

The concept of Smart Education includes the creation of an intellectual environment for the continuous development of the competencies of participants in the educational process and the formation of the skills necessary for successful operation in a digital society, a smart economy.

Knowledge as a special resource has the properties of continuous reproduction, growth, both at the level of their volumes and at the level of qualitative characteristics, such as complexity and fundamentality, adequately to changes in science, society or culture. However, like any resource, knowledge is subject to very rapid aging. Therefore, to work with knowledge, special methods of their processing, storage and use are required. The research results presented in this paper are based on the author's concept of creating and applying an innovative methodology for the formation of educational resources for planned learning, focused on solving the problem of digitalization of the development of human capital and education in general, adapting processes and rules to modern requirements, developing creative, cultural, professional skills , taking into account the interests and characteristics of the individual, giving the opportunity to individualize training to increase human capital indices.

Research Hypothesis 1: If it is determined what methods and technologies, algorithms we need to develop for an adaptive, commutative-cognitive educational platform for military structures, taking into account information security, then we will be able to create an operating base for the full-fledged work of the National Defense Control Center, therefore, we will be able to automate the switching and security process, followed by a rapid response to all the technological needs of the National Defense Control Center.

Research hypothesis 2: Human capital is based on a certain set of individual characteristics of a person and social trends. If this basis can be formalized and structured, as well as documented, such information becomes the starting point for the development of educational programs for the preparation of future specialists in this field and trainings to improve their skills, as well as for the accreditation of academic programs and professional certification. The practical implementation of educational platforms in a military educational institution will allow: - develop fundamentally new pedagogical approaches to the organization of the educational process; - simplify the process of developing and adapting various applications (due to the knowledge base available on the platform, electronic educational tools, as well as built-in tool systems); - use in the educational process testing and diagnostic systems that contain a bank of questions, tasks and exercises in all subjects of the cycle under study with the possibility of making changes and additions to questions and tasks; - track the dynamics of the development of the abilities of cadets and the professionalism of teachers; - to exchange documents with higher authorities of military education.

The purpose of the dissertation work: Creation of a model of a multifunctional educational platform, based on ontological engineering, for the development of human capital with the ability to structure knowledge using a competency-based approach based on prof. standards in the form of knowledge expression with the possibility of building an individual learning path and the CDIO project approach.

The objectives of the research, realizing the purpose of the dissertation research: 1. Conducting a review and analysis of existing research in the field of military education, models and solutions to the problems of developing an innovative education system for the development of human capital, as an optimal combination between classical education and its practice-oriented component, subject to the transition to a new paradigm of representation and organization of knowledge and skills. 2. Development of an innovative methodology for visual representation, organization of knowledge and models in order to increase indicators of human capital, based on an ontological model and engineering, in order to form knowledge expressions and a database, as well as the corresponding knowledge components, with their subsequent use for the design of knowledge content and individual trajectory for its construction. 3. Development of a methodology for designing an individual educational process based on the project method of human capital development and the concepts of the Worldwide CDIO Initiative. 4. Research and create a prototype of a system for processing natural language texts.

Object of study: - Software educational resources. -Principles of human capital development.

Subject of study: - Methodology for the formation of educational content and its structuring in the form of knowledge expression based on ontology and management of human capital development processes. - Processes of information interaction of users with the Smart-system in the

project approach to self-development.

       Scientific novelty: - Study of the structure of formal data representation and development of the syntax of the knowledge specification language in the field of human capital development. - Development of a model of an infrastructure platform for the development of human capital; - Modeling and designing competency-based approach methods in the practical plane of project self-development according to the CDIO World Initiative, the method of foresight research and ontological engineering. - Software implementation of the Smart-portal AEE.kz with different access levels and the ability to create knowledge expressions, download visually presented knowledge in the form of ontologies or build an individual self-development plan. At present, the level of scientific elaboration of the research topic requires new approaches to the analysis of the data obtained. This dissertation provides tools for mixed research methods, as well as for statistical and qualitative data analysis and the development of text analysis methodology and ways of visualizing information, the development of methods and algorithms for processing large data sets. The end result of the study is the development of a military multifunctional educational platform that meets new trends in military education.

       The economic effect of the implementation of this scientific technical research is due to the development of the military IT-sphere, the expansion of existing and the emergence of new requirements for military education; a multiple reduction in the cost of education compared to the existing one; an increase in the ratio of indicators: efficiency / cost, by saving time, eliminating paper workflow. The rapid pace of development of new technologies gives rise to the growth of services and infrastructure of modern military formations, while the problems of lagging behind its effectiveness are increasing. The payback of the program of the proposed project is high: 34 military departments at the universities of the Republic of Kazakhstan, more than 13 universities of law enforcement agencies, as well as according to information from various open sources, from 74 thousand to 80 thousand people serve in the Armed Forces of the Republic of Kazakhstan. Also, units of the National Guard and other military formations, subordinate, for example, to the structures of the Ministry of Internal Affairs, can act as users of the system; in our country, with a population of just over 18.5 million inhabitants, there are up to 120 thousand people (https://kursiv.kz/news/politika/2018-05/silnee-li-vsekh-kazakhstan-v-centralnoy-azii).

       The social effect of the study is expressed in the creation of new jobs in the field of IT, the growth of scientific potential, the use of scientific and technological achievements in the educational process, which will contribute to the introduction of innovative views on science and the educational process, as well as to strengthen indicators of the human capital of the Republic of Kazakhstan.

       Researcher's personal contribution. - A model for the formation of knowledge content has been developed, this opportunity provides, together with an expert represented by a representative of the IT industry and a teacher, to form the requirements and content of educational material for specific disciplines or for additional education and training courses. As a result, we get the basic structure of the curriculum, in the form of knowledge expressions. - Implementation of a project-oriented approach and this methodology, which consists in planning the sequence of training, in accordance with the stages of the international CDIO initiative for project development and the stages of achieving the set goals. If this approach and a competency-based approach are used, then the technique allows you to form a knowledge trend and a Smart contract, configuring the scenario for achieving the goal.

       Approbation of work. The results of the dissertation work were reported and discussed at seminars and conferences: scientific. conf Modern problems of informatics and computing technologies: (Almaty: IIVT MES RK); IEEE 12th International Conference on Application of information and communication technologies-AICT2018, Almaty, Kazakhstan; educational-methodical and scientific seminars of MUIT; scientific conference "Problems of optimization of complex systems" - Cholpon-Ata: IIHT MES RK; IV international scientific and practical conference. "Computer Science and Applied Mathematics", dedicated to the 70th anniversary of prof. Biyarova T.N., V. Vuytsik and the 60th anniversary of prof. Amirgalieva E.N. - Almaty; scientific conference IIHT KN MES RK "Modern problems of informatics and computing technologies. - Almaty;

International Scientific and Practical Conference on Software Engineering and Computer Systems, MICSECS St. Petersburg: ITMO; V International Scientific and Practical Conference "Computer Science and Applied Mathematics", Institute of Information and Computing Technologies of the CS MES RK; Eighteenth Open All-Russian Conference "Teaching Information Technology in the Russian Federation": a collection of scientific papers. Materials (Moscow).

The connection of the topic with the plans of scientific research programs. The presented results were obtained during the implementation of the following projects of the IIHT CS MES RK (funding source Committee of Science MES RK): 1) GF "Research and development of models and methods for the representation and organization of knowledge using the ontological approach and tools of Smart technology, in the implementation of educational programs and processes", No. state. registration 0118RK00187 , scientific supervisor of the project, Ph.D., associate professor, Kubekov B.S. (2018-2020) 2) GF AR09058441 "Building a system of intelligent control over the processes of development and harmonization of standards within the framework of interstate and national standardization based on ontological engineering", scientific supervisor of the project Baymuratov O.A. (2020-2023) 3) PTF "Development of an adaptive, commutative-cognitive educational platform for military structures with information potential and protection of the information environment containing state secrets" scientific supervisor of the project Utegenova A.U. (2022-2024, under consideration by the MoD)

Publications. The main results of the research on the topic of the dissertation are presented in 13 publications, of which 3 are in scientific publications recommended by the Committee of Science of the Ministry of Education and Science of the Republic of Kazakhstan, 2 are in international scientific publications included in the Scopus and Web of Science database, 8 are in the materials of international scientific practical conferences, including those included in the Scopus and Web of Science databases.

The structure and scope of the dissertation. The total volume of work is 131 pages. The dissertation consists of an introduction, 3 sections, a conclusion, a list of sources used from 70 titles, 2 appendices, includes 47 figures and 1 table.

In the introduction, the substantiation of the relevance of the chosen topic of the dissertation research is given. The purpose, object, subject and tasks of the study are formulated. The results of the conducted studies are described, their scientific novelty and practical significance are shown. The data on approbation of the results of the dissertation work are presented.

The first section is devoted to the study of issues of military education, distance learning, knowledge extraction, human capital modeling concepts, known methods and means, examples of the use of the ontological approach in various industries. The principles of building information protection in the database during user authentication are described.

The second section presents the results obtained in the development of a five-dimensional model of education for the development of human capital. The developed model based on the use of Smart-capital, Smart-contracts and modeling of the self-development scenario. The project-competence approach and the use of the search engine are described.

The third section presents the results of software implementation of the proposed algorithm. An information system has been developed, consisting of 3 interacting modules: a user, a mobile application and a server part. The structures of each of these modules are considered.

In conclusion, the main results and conclusions of the dissertation are presented. The results of the study are included in the reports of the above projects of the Global Fund for 2018–2020 and the Global Fund for 2020, carried out at the Laboratory of Computer Engineering of Intelligent Systems of the IIHT CS MES RK.

Level of reliability and results of approbation. The validity and reliability of the study correspond to the justified responsibilities of the task, the analysis of the criteria and the state of research in this area, the large number of experiments carried out and their successful implementation in practice. The results of the dissertation were discussed and reported at the following scientific and methodological conferences: 1. Eighteenth Open All-Russian Conference "Teaching Information Technology in the Russian Federation": a collection of scientific papers. Materials (Moscow, online,

May 14–15, 2020) 2. V International Scientific and Practical Conference "Computer Science and Applied Mathematics", Institute of Information and Computing Technologies of the CS MES RK, Almaty. - 29.09-01.10.2020. 3. Proceedings of the 10th International Scientific and Practical Conference on Software Engineering and Computer Systems, MICSECS St. Petersburg: ITMO, CEUR Workshop Proceedings, 2019. 4. Materials of the scientific conference IIHT KN MES RK "Modern problems of informatics and computing technologies. - Almaty. - 2019. 5. Materials of the IV international scientific-practical conference. "Computer Science and Applied Mathematics", dedicated to the 70th anniversary of prof. Biyarova T.N., V. Vuytsik and the 60th anniversary of prof. Amirgalieva E.N. - Almaty, - 2019. 6. Materials of the scientific conference "Problems of optimization of complex systems" - Cholpon-Ata: IIHT MES RK, 2018. 7. IEEE 12th International Conference on Application of information and communication technologies-AICT2018, Almaty, Kazakhstan, 17-19 October 2018. 8. Modern problems of informatics and computing technologies: Mat. scientific conf. (July 2 - 5, 2018). - Almaty: IIHT MES RK, 2018.

On the topic of the dissertation, 14 articles were published and 2 copyright certificates were received:

1. Kubekov, B., Bobrov, L., Utegenova, A., Naumenko, V., Ibraimkulov, A. Ontologic design of software engineering knowledge area knowledge components, Advances in Science, Technology and Engineering Systems, 2020, 5(4), pp. 30–34, https://www.scopus.com/authid/detail.uri?authorId=56826094200

2. Kubekov B.S., Utegenova A.U., Naumenko V.V., Ibraimkulov A.E. Planning the knowledge content of an educational program using ontological engineering and a project-based competence approach. Journal "Scientific Journal of Astana IT University". Issue 1, March 2020 S.84-95. DOI: 10.37943/AITU.2020.1.63684. https://www.researchgate.net/scientific-contributions/A-Utegenova-2155147258

3. Kubekov B.S., Konysbaev A.T., Utegenova A.U., Naumenko V.V., Ibraimkulov A.E. Concepts of pedagogical design and educational environment. Eighteenth Open All-Russian Conference "Teaching Information Technology in the Russian Federation": a collection of scientific papers. Materials (Moscow, online, May 14–15, 2020) – p. 200-203

4. Kubekov B.S., Utegenova A.U., Naumenko V.V., Ibraimkulov A.K. Training of specialists and adaptation of IT education in the digital economy. V International Scientific and Practical Conference "Computer Science and Applied Mathematics", Institute of Information and Computing Technologies of the CS MES RK, Almaty.- 29.09-01.10.2020.- p.

5. Kubekov B.S., Uskenbaeva R.K., Naumenko V.V. The role of smart technologies in the development of human capital and a modern approach to education International Journal of Information and Communication Technologies, Vol.1, Issue 3,56-62.

6. Wojcik W., Kubekov B., Naumenko V., Narynov S., Toibayeva S., Utegenova A. Project - competency based approach and the ontological model of knowledge representation of the planned learning. INTL Journal of Electronics and Telecommunications. - 2019. - Vol. 65, no. 1.- r.45-49. February 2019, Warsaw University of Technology, Institute of Electronic Systems. DOI: 10.24425/123564 // https://www.scopus.com/authid/detail.uri?authorId=56826094200.

7. Kubekov B.S., Ashimov U.B., Utegenova A.U., Naumenko V.V., Alenova R.A. An innovative knowledge mapping model for engineering learning. Bulletin of KazNITU them. K.I. Satpaev. Section - technical sciences, No. 2, 2019, pp. 95-100. ISSN 1680-9211. https://official.satbayev.university/ru/research/vestnik-satbayev-university/publications

8. Kubekov B.S., Bobrov L.K., Savelyeva E.A., Naumenko V.V., Utegenova A.U Project-competent paradigm of Knowledge representation of the Three-level engineering education System. // Proceedings of the 10th International Scientific and Practical Conference on Software Engineering and Computer Systems, MICSECS St. Petersburg: ITMO, CEUR Workshop Proceedings, 2019, 2344 // https://www.scopus.com/authid/detail.uri?authorId= 56826094200

9. Kubekov B.S., Utegenova A.U., Naumenko V.V., Alenova R.A. Competence model of knowledge representation and the concept of a smart contract in the design of an educational program. Materials of the scientific conference IIHT KN MES RK "Modern problems of informatics and

computing technologies. - Almaty. - 2019.- p.190-201.

10. Kubekov B.S., Naumenko V.V., Utegenova A.U. The concept of a modern smart environment based on a project approach. Materials of the IV international scientific-practical conference. "Computer Science and Applied Mathematics", dedicated to the 70th anniversary of prof. Biyarova T.N., V. Vuytsik and the 60th anniversary of prof. Amirgalieva E.N. - Almaty, - 2019. - p. 353-359.

11. Kubekov B.S., Utegenova A.U., Naumenko V.V., Zhaksybaeva N.N., Alenova R.A. Methodology for the formation of educational resources based on ontology. Materials of the scientific conference "Problems of optimization of complex systems" - Cholpon-Ata: IIHT MES RK, 2018.- p. 327-337.

12. B. Kubekov, A. Utegenova, V. Naumenko, N. Zhaksybaeva, R. Alenova. Methodology of formation of educational resources on the basis of ontology. IEEE 12th International Conference on Application of information and communication technologies-AICT2018, Almaty, Kazakhstan, 17-19 October 2018. P.408-413.

13. Kubekov B.S., Utegenova A.U., Naumenko V.V., Alenova R.A. Ontological approach to semantic modeling of educational programs in higher education. Modern problems of informatics and computing technologies: Mat. scientific conf. (July 2 - 5, 2018). - Almaty: IIHT MES RK, 2018. -p. 136-143. ISBN 978-601-332-124-0. //https://iict.kz/wp-content/uploads/2019/10/mpcsct-collection-02-05.07.2018.pdf

14. Usatova O.A., Naumenko V.V. "Statistical studies of the infrastructure platform using data protection systems"// VIII International Scientific and Methodological Conference dedicated to the 90th anniversary of the Kazakh National Pedagogical University named after Abai - Almaty, 2018428, pp. 113-116 ..

15. Author's certificate for software. USA No. 610144525, dated 10/12/2020 INFORMATION AND EDUCATIONAL ENVIRONMENT AEE&SP //"International Copyright Company, USA, New