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THE BASIC ISSUES OF KNOWLEDGE MANAGEMENT BIONICS

Increasing the effectiveness of knowledge management in enterprises is possible if one takes into consideration the characteristics of a person to work with information and knowledge, remove the confusion with the basic concepts, determine the authentic object of knowledge management and see the roots of all that affects the result of the activity. This is helped by the main assertions (postulates, axioms) discussed in the paper, which are formulated with the involvement of research results from a number of areas, such as psychology, artificial intelligence, business organization, information systems and technologies, adult education, etc.

KNOWLEDGE, KNOWLEDGE MANAGEMENT, KNOWLEDGE DESCRIPTION, PERSONAL FEATURES, MODEL, AXIOM

М.Ю. Вишняк, И.Н. Климова. Основные вопросы бионики управления знаниями. Повышение эффективности управления знаниями на предприятиях возможно, если учитывать особенности человека по работе с информацией и знаниями, убрать путаницу с основными понятиями, определить действительный объект управления и увидеть корни всего того, что влияет на результат деятельности. В этом помогают рассмотренные в работе основные положения (аксиомы), которые сформулированы с привлечением результатов исследований целого ряда областей таких, как психология, искусственный интеллект, организация бизнеса, информационные системы и технологии, обучение взрослых и др.

ЗНАНИЕ, УПРАВЛЕНИЕ ЗНАНИЯМИ, ОПИСАНИЕ ЗНАНИЙ, ОСОБЕННОСТИ ЧЕЛОВЕКА, МОДЕЛЬ, АКСИОМА

М.Ю. Вишняк, І.М. Климова. Основні питання біоніки управління знаннями. Підвищення ефективності управління знаннями на підприємствах можливо, якщо враховувати особливості людини по роботі з інформацією і знаннями, прибрати плутанину з основними поняттями, визначити дійсний об'єкт управління і побачити коріння всього того, що впливає на результат діяльності. У цьому допомагають розглянуті в роботі основні положення (аксіоми), які сформульовані з залученням результатів досліджень цілого ряду областей таких, як психологія, штучний інтелект, організація бізнесу, інформаційні системи і технології, навчання дорослих та ін.

ЗНАННЯ, УПРАВЛІННЯ ЗНАННЯМИ, ОПИС ЗНАНЬ, ОСОБЛИВОСТІ ЛЮДИНИ, МОДЕЛЬ, АКСІОМА

Introduction

As is known, bionics is engaged in revealing patterns of living nature and applying the obtained results in the development of modern technologies and systems. The most important applications are those where the key element is a person. These include knowledge management and systems implementing this technology.

Despite the fact that knowledge management is a powerful tool for increasing competitiveness, and research in this field has been conducted for more than 25 years, yet still practical applications do not meet expectations. Several authors carried out research to identify the causes of failure [11, 13, 16, 24 and etc.]. Also, opinions were expressed on the delimitation of the concepts "information" and "knowledge"[5, 17, 19 and etc.]. Distinguish these concepts is important because often information management is called knowledge management, and if the management object is another, then the results are different too. Improvement of the situation can occur if you pay attention to the root causes of problems [3]. The core of the reasons is the ignoring of an integrated approach that takes into account the person peculiarities in working with information and knowledge.

Person is the main link in knowledge management. This position is stated by many authors, but in practice it is neglected. In knowledge management, knowledge itself becomes a "compelled" object of research, which should be studied. The problem of the concept of "knowledge" is also that everything that is in the person memory is taken to as knowledge, since we traditionally say: "I know, ...", if it is contained in the memory.

The aim of the work is to find the basis for constructing systems that will better meet the expectations from knowledge management than existing ones.

According to the authors, to move forward in the field of knowledge management, as it does in any other theory, it is required formulate the basic provisions that will become the "starting point" for further research and in-depth analysis of previously obtained results. These statements will be perceived as axioms. This article provides a block of axioms that relate to the person peculiarities and allow these features to be taken into account in knowledge management.

The list of positions (axioms) is formulated on the basis of analysis and comprehension of the results of research conducted by many scientists and practitioners in the field of knowledge management and a number of other areas such as psychology, artificial intelligence, business organization, information systems and technology, adult education, etc.

Axiom 1: Accept the model: Man is a "bio-computer", and knowledge is his "programs"

If we consider a person as a "bio-computer", i.e. to take a projection or, in other words, allocate only its abilities to work with information and knowledge, then the level of confusion between the content of these two basic concepts is significantly reduced.

A self-learning, potentially developing "bio-computer" performs physical and mental actions, in accordance with the "programs" that are embedded in it and, usually, constantly complicated and modernized, which are knowledge.

The "Man is a bio-computer" model allows us not to identify knowledge with truth, which occurs in philosophical theories and classical ideas about knowledge, when only what is true can be knowledge. Although there is some softening: "practice is the criterion of truth", but there one forgets that practice contains not a small portion of subjectivity based on available knowledge. The ancients believed that the Earth was flat, and their practice confirmed this. In his activity a person does not realize the degree of his knowledge truth, and it is not always true that on the basis of what he lives and acts. One can only say that some knowledge (often these statements) can claim the true, for example, Pythagorean theorem. The identification of knowledge with truth introduces a significant and unjustified restriction on working with them.

Axiom 2: Knowledge locates only inside their owner. Knowledges are a model and abilities

As it turned out, it seems very difficult to give the most appropriate definition to the notion "knowledge", and to establish than we manage all the same. There are a lot of definitions of the basic concept of knowledge management, as well as a number of publications that analyze and identify the flaws of these definitions, for example, [6 and etc.].

Knowledge can be defined as mental objects that make up the system and combine two in one:

— a subjective image of objective reality (reflection of the external and internal world in the conscious and unconscious of a person) and

— mental "programs" (skills and abilities, i.e. accumulated prerequisites for) purposeful coordinated actions (at that mental and motor actions), which the brain operates through the nervous system.

For the formulation of the first component of the definition, the main provisions of the philosophical theory of reflection are taken (the subjective image is a model). For the second component, the extract of the views of M. Zeleny [5] and Witzel [1], the ideas of neurolinguistic programming and psychology was used.

In general, knowledges provide the possibility to act and the ability to understand (understanding can be seen as a kind of mental actions). Knowledge is interpreted as a model of the person's world and as its potential actions.

The subjective image (mental models [21]) has a predominant position. Mental "programs" obey it in the process of obtaining the result. The result is understood in the broad sense of the word: the taken decision, the written article, the developed scheme of the device, the organized work of the team or the created conditions at the enterprise, etc.

Axiom 3: Knowledges are formed as a system

Knowledge of a particular person is a complex self-organizing system [21]. This provision is practically not taken into account in the implementation of knowledge management systems. The system is inherent in maintaining its state and resisting changes. In this case, this is manifested in the fact that the information received by a person is filtered [9] and distorted by a "prism" [15].
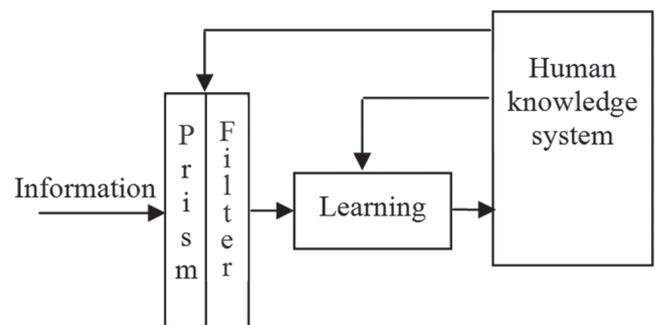

Fig. 1. The impact of the current state of the knowledge system on incoming information and the learning process

This process is simplified in Fig. 1. As a result, information that corresponds to the current state of knowledge passes and strengthens it, and the one that goes against it is often ignored. Therefore, even if the employee is provided with the necessary information, he will not obligatorily use it.

In the process of fulfilling the functional duties by an employee, as well as operating with "raw" or poorly structured content relevant to activities, "fragmentary" knowledge is formed, for the systematization of which time and effort are required. "Fragmentary" knowledge often unable to provide the needful result. Document management systems, data warehouses, and other should not be fully related to knowledge management.

It is recommended to take into account that the subject knowledge, with which knowledge management works, is only a subsystem of the knowledge system.

Axiom 4: Beliefs and settings are hidden drivers

From psychology and neurolinguistic programming it is known that beliefs and settings significantly influence our behavior, therefore we distinguish this part of knowledge separately. Beliefs and settings are difficult to change, and some of them are in the unconscious, which in itself is difficult to access. If you ignore the presence of specific beliefs and settings from the employee, then again, he may be unsuccessfully dispose with the timely provided and necessary information, and, consequently, to show the wrong result.

Axiom 5: People operate by knowledge descriptions in their interactions. Knowledge descriptions are model of a model

Some of the knowledge can be described. They are represented in the form of texts and graphics. Using text and graphics we are trying to display what is in our mind, i.e. to build some model of our knowledge concerning a particular matter or topic.

From psychology it is known that terminology has a very strong influence on the thinking process, and if unsuitable terms are used, then the results may not be appropriate. The problem is that descriptions of knowledge are called "knowledge", i.e. object is identified with its model. In a number of encyclopedias, dictionaries and, for example, in [10], knowledge is defined as "the result of the cognition process, usually expressed in language or in some sign form". The term "codified" knowledge has long been used in English-language publications [18, 25 and etc.]. But it is better to use the term "knowledge descriptions" because when we say "codified knowledge," it is meant that it is still knowledge, and in fact it is not so, and the term "knowledge descriptions" emphasizes that it is all the same descriptions, and not knowledge itself.

By the knowledge description we mean the mapping (model) of the person's knowledge in sign form on any medium or their embodiment in some artifacts ("in some" means knowledge cannot be restored from all artifacts, for example, the recipe of bulat has been lost, the samurai's sword gives us no information about technology of its manufacture, etc.). Knowledge that is relevant to obtaining a certain result can have different descriptions, and each of these descriptions is not a complete representation of the knowledge itself. Since knowledge is a model, then knowledge descriptions are model of a model. In the knowledge transfer chain, there is always an error in composing the description and other error in its perception. The scheme shown in Fig. 2 was proposed in [4] and modified in [2].

The following provisions supplement the notion of "knowledge description" and facilitate its practical application:

— knowledge descriptions are a subset of information received by a person;

— a person can perceive knowledge descriptions, if he has the necessary knowledge for this;

— the knowledge description implies the presence of the language, carrier and description tool;

— mastering the language, a person takes possession of certain knowledge;

— language allows forming complex images in consciousness, corresponding to knowledge;

— to make use of the knowledge descriptions, one must master the language of description;

— the language of the individual can be poor, which limits the individual in gaining knowledge.

Axiom 6: People do not exchange knowledge but information, and this requires knowledge

Knowledge is not transferred from the source to the recipient, but the person perceives information (knowledge descriptions) and recreates the corresponding knowledge in his brain. Exchange can be carried out if there is a transmitting and receiving party. If the receiving party does not have the necessary knowledge, then the message is simply skipped.

The person thinks in images, i.e. objects, phenomena, processes, etc. receive an inner holistic image in his consciousness. Information transmitted by the message, usually relates to some part of the image. Receiving a fragment of the image, a person attracts the contents of his memory and mentally completes the
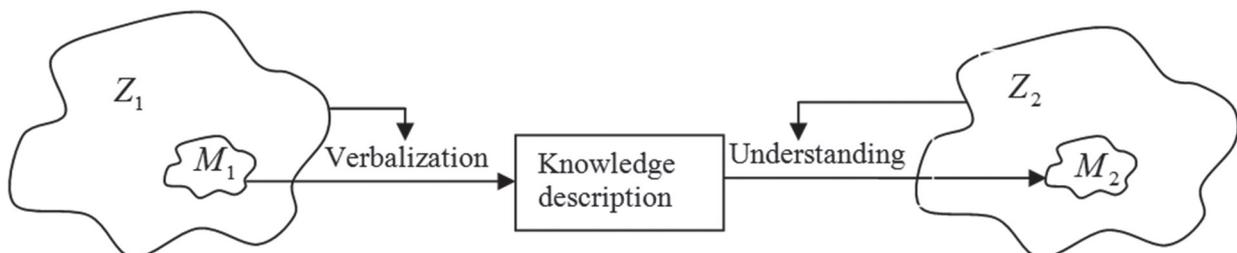

Fig. 2. The scheme of knowledge "transfer"
Z_1 — the knowledge, which author possesses, Z_2 — the knowledge, which recipient possesses;
μ_1 — knowledge (meaning), laid down by the author of the description;
μ_2 — knowledge (meaning), recreated by the trainee.
$\mu_1 \subset Z_1,\ \mu_2 \subset Z_2,\ \mu_1 \neq \mu_2$

whole, but already his own internal image. The degree of inconsistency between the internal images of the person who transmits information and the person who receives it is determined by the differences between their knowledge. Possible options: sufficient understanding, poor understanding, weak misunderstanding, complete misunderstanding. It is important to take into account the regularity, derived from the practice of teaching and communication, that if the knowledge of the interlocutors on the topic under discussion differs greatly, then the greater the difference, the more information is required to be transmitted.

Axiom 7: Information is extracted from the data, ensures application and improvement of knowledge

In a number of works [5, 14, 20, 22, etc.] is considered DIKW - "hierarchy" of data-information-knowledge-wisdom. But it's important to pay attention to where information comes from and on what basis knowledge is formed. In [12] a good example with a bushman illustrates the need for knowledge to understand the data and the difference between data, information and knowledge. The bushman has knowledge about the lion's tracks, and he can recognize the tracks, but he has no knowledge about street traffic lights, and is only able to observe the change of colors, not understanding why and how it happens.

We explain axiom 7 by the example of a bushman. In order for the data (the lion's traces) to become information, the bushman must have the knowledge that this small deepening in the sand is the trace of a lion. Here he applies knowledge to the small deepening seen on the sand and receives information. Then, to make use of this information, the bushman must again turn to knowledge to understand when there was a lion here. Further, depending on his intentions (hunting for a lion or wanting to avoid meeting him), the bushman again, on the basis of his knowledge, makes a decision for the subsequent actions. Carrying out actions and observing what is happening, the bushman improves his knowledge concerning the recognition of lion's tracks. Thus, we arrive at the following transformations:

Data + knowledge $\rightarrow$ information

Information + knowledge $\rightarrow$ knowledge$^+$

Information + knowledge $\rightarrow$ decision

Information + knowledge + decision $\rightarrow$ knowledge$^+$, where $\rightarrow$ — means "it turns out"; knowledge$^+$ — means modernized knowledge.

The first transformation in a somewhat expanded form is presented in [9], where is shown a process of human perception of information: the signal passes through physical, semantic and pragmatic filters. Interpretation of the scheme [9] in this context can be such. The signal, namely, the data, passes through the sense organs (the physical filter). Then there is access to

knowledge (a semantic filter), and the data can become information. After that, again, knowledge helps to evaluate the usefulness of the received information (a pragmatic filter). And that's all. But the above conversions show the continuation of actions with information.

In general, the information received can: 1) initiate actions, 2) identify (specify) the situation (object, ...), 3) become an ingredient in the process of improving personal knowledge.

Axiom 8: The result of the knowledge application is not knowledge itself

Many authors consider decisions as knowledge, but decisions are generated, discussed and accepted on the basis of already existing knowledge and incoming information. For example, the method of "brainstorming" is psychologically arranged so that it allows stimulating and involving almost all the knowledge of participants. At the output a set of ideas for overcoming the discussed problem is gotten, which can subsequently affect the improvement of knowledge of participants and not only them (see figure 3).
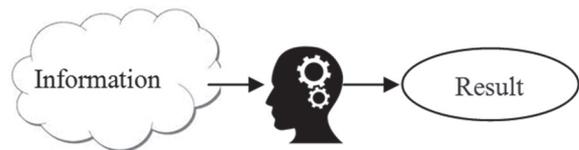

Fig. 3. A person converts information into a result on base of his knowledge

Information arrives at the "input", a person transforms it by the application of knowledge, the result is the "output" of the transformation. "Transformer" and "output" is not the same thing. The result can be perceived as new information and subsequently it can influence the change in the state of the personal knowledge system. This feedback is shown in Figure 4.
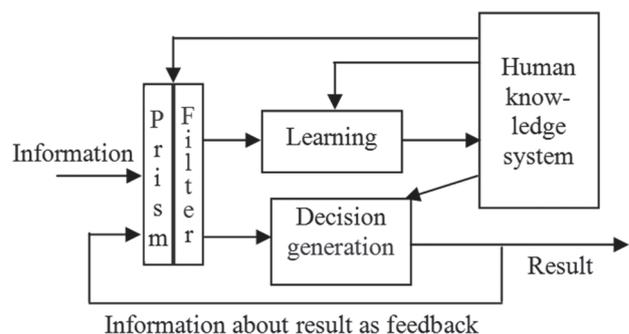

Fig. 4. Feedback loop in the human knowledge system

Axiom 9: Different people process the same information differently

Since the information that comes to a person passes through the "filter" and the "prism" of his knowledge (Fig. 1), different people perceive and process the same information differently. On base of this information,

people build their internal representations, which do not completely coincide with those of other people, or even they may be opposite. Consequently, solutions generated by them are also various (see Fig. 5).
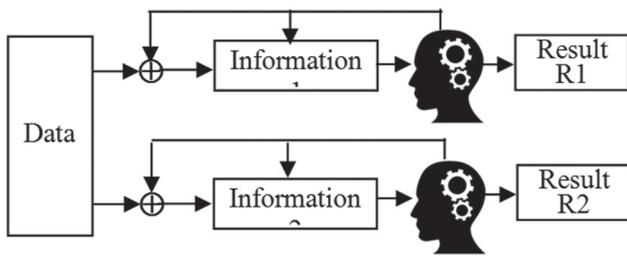

Fig. 5. Different people handle the same information differently. The solutions they generate may be different R1 ≠ R2

For example, two managers have access to the same data, but they do not always produce the same decisions and receive not the same results, the same happens with two employees of the same department; a group of students listen to a lecture, but then they have different assessments.

Traditionally knowledge management relies on the fact that information (of almost any kind, but relevant) is sufficient for the employee to obtain the necessary knowledge in the course of his work. Such position, at a minimum, does not take into account the time required for obtaining knowledge, the degree of preparedness of the employee for perceiving information, the level of sufficiency of the information itself (knowledge descriptions).

Axiom 10: Knowledge is not transmitted, but recreated

This assertion intersects with axiom 6. Some authors state this provision, for example [7, etc.], but, as a rule, they do not follow it further. The main reason is problems with basic concepts (see axiom 5, [3]).

Axiom 11: Person performing actions uses knowledge of various levels

A person, performing actions, simultaneously uses knowledge of various levels of commonality (hierarchy of knowledge) and each of them can be of varied quality. The quality of knowledge is determined by the quality of the result obtained with their help [5].

In practice, all attention is focused on knowledge only from an enterprise activity field, that is, it does on the knowledge of the lowest level of commonality. For example, a realtor is trained what to say on the phone and what to ask, but almost never it is taught him how to talk. But from practical psychology it is known that the outcome of the conversation largely depends on how to talk. In Fig. 6 shows an example of a truncated hierarchy of knowledge that a realtor actually uses in his practice, but neither he nor his leadership can guess it.
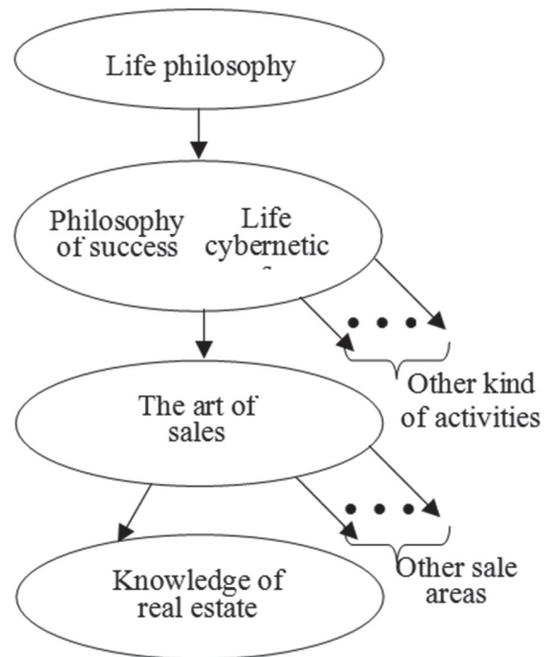

Fig. 6. The hierarchy of knowledge by commonality

Axiom 12: Learning is the only way to gain knowledge

A person can recreate his knowledge (axiom 10) only on the basis of already existing knowledge and perceived information (axiom 6). It is carried out by a permanently acting function it is called learning. A person can learn both with the teacher, and independently. Here we mean the obtaining of knowledge not only directly necessary for the performance of work, but in a broader sense, that is, the formation of knowledge as a model of the world and the development of various abilities (axiom 2). A person during wakefulness receives signals from the sensory organs. On the base of his knowledge, some of these signals are translated into information. And information affects the state of knowledge (axiom 7). Thus, a person constantly performs the function of "updating" his knowledge system: some elements are added, some connections are strengthened, and some are weakened.

Targeted staff training with knowledge management requires appropriate techniques and can be implemented in various ways. Herewith the existence of different types of learning should be taken into account: learning is simple and generative [21], learning by memorizing and cognitive learning [23], etc.

A person makes skills and abilities (coordinated actions) through repetitions and he uses feedback in this process. For example, wrestling techniques, writing articles, etc. you can not acquire only according to information from books, it is necessary to work out coordinated actions.

Scientific research can be considered as a kind of

self-learning process. Carrying out research, the scientist self-learns and creates own knowledge about the unknown nature of phenomena, objects, about the possibilities of constructing new structures, creating new materials, etc.

There are "obstacles" to learning, for example, mental models, dynamic complexity [21], etc. In the process of practice, the function of self-learning can work out and fasten false mental views and incorrect skills. For example, Casson G. in [8], illustrating this provision, notes that a woman, referring to her experience, can make bad coffee every day for forty years.

All these nuances should be taken into account when drawing up knowledge descriptions, methodologies and training programs, and also, if desired to achieve greater efficiency in knowledge management.

Axiom 13: Person generates not knowledge, but decisions

Often in publications there is an idea that specialists generate knowledge. Axiom 8 has already dealt with this situation. But the point of view that a person generates knowledge has proved to be quite stable, so we have to formulate a separate axiom.

It is usually believed that a person generates knowledge in the process of improving skills and abilities, cognizing something new, etc., when he changes mind views (templates, paradigms), improves efficiency and / or quality of results, etc. But "knowledge generation" is not a very suitable term. Knowledge is not generated, but the system of personal knowledge is improved. In the process of work, the employee generates ideas and checks them. Then information may be formed which, by feedback, may affect the change in person's knowledge (see figure in (8) and (axiom 7)).

Axiom 14: Those or other conditions in the enterprise are created by managers on the basis of the current state of their knowledge

During realization of knowledge management at enterprises, failures lie in wait when suitable conditions are not created. But these conditions are created by managers based on their knowledge. It is often forgotten that it is necessary to organize management not only of the performers' knowledge, but also of managers' knowledge.

Axiom 15: The result of an activity is determined by the available knowledge and conditions in which this activity is performed

M. Zeleny in [5] notes that knowledge can be demonstrated by action and the quality of knowledge can be assessed by the quality of the result achieved. An employee can get information about what and how to do, but he may not be able to do it or do it badly. He may not have enough motivation.

Conditions in which the knowledge of the performer is applied are determined by the knowledge of managers (axiom 14), the state of the equipment, the quality of the materials, a sufficient number of relevant information, and so on.

The result is given by a knowledgeable and motivated person supplied with sufficient information, and for whom the working conditions are organized by the managers.

Axiom 16: Knowledge is the main object of management

Although the term "knowledge management" is used, but it is often found that information is managed instead knowledge (for example, the main task is to provide the right information at the right time) or simply it needs organize the opportunity for communication and collaboration. Some authors argue that human knowledge cannot be managed at all. But humanity has been doing this for a long time, for example, by educating, joining to culture or creating a certain information environment (as an instrument of unstructured governance). To eliminate ambiguity, we define knowledge as the main object of management.

Knowledge management is a complex process, therefore, in addition to the main object; it is also expedient to define management subobjects such as knowledge descriptions, training system, infrastructure, corporate culture, IT architecture, etc.

Conclusions

To manage knowledge, not something else, and to receive results from the management of this particular object, and not some other, it is necessary to rely on the features of knowledge in their studies. Such a possibility is given by the totality of the axioms presented.

Axioms allow us to specify which functions and processes should be related to knowledge management, and which ones do not, which IT-tools, -facilities, -technologies and -systems directly participate in knowledge management, and which perform infrastructure or auxiliary roles, and so on, that is, more clearly define the boundaries between knowledge management and other types of management. It is important to understand this when creating knowledge management systems in enterprises where IT systems already function, and knowledge becomes a new object of management for enterprises.

The axioms of knowledge management differ from the axioms of mathematical theories. They should not be subject to analysis by formal logic, since knowledge management is not a formal theory. It is interdisciplinary in nature, with some of the disciplines studying very complex constantly evolving objects such as the human brain, management of organizational systems, etc. In addition, the basis of knowledge and reasoning

of person is nonmonotonic logic. For the same reasons, the set of axioms proposed in the paper is most likely not complete. In the course of further research, it can be expanded and corrected.

References:

1. *Витцель М.* Знание, определения понятия. / Информационные технологии в бизнесе / Под ред. М. Желены. — СПб.: Питер, 2002. — 1120 с. С. 198–210. **2.** *Вишняк М.Ю., Климова И.Н.* Управление знаниями на автоматизированном предприятии/ АСУ и приборы автоматики. 2015. № 172. С. 38–43. **3.** *Вишняк М.Ю., Климова И.Н.* Корни проблем и вызовы управления знаниями. //Материалы 5-й Международной научно-технической конференции «Информационные системы и технологии». Харьков, 12-17 сентября 2016 г.: тезисы докладов/ - Х.: Друкарня Мадрид, 2016. — С. 200–201. **4.** *Гаврилова Т.А., Червинская К.Р.* Извлечение и структурирование знаний для экспертных систем. — М.: Радио и связь, 1992. — 200 с. **5.** *Желены М.* Знание против информации. / Информационные технологии в бизнесе / Под ред. М. Желены. — СПб.: Питер, 2002. — 1120 с., С. 211–218. **6.** *Костромина С.Н., Гнедых Д.С.* Информация и знание: подходы к пониманию процессов усвоения информации и формированию знаний в обучении // Вестник Ленинградского государственного университета им. А.С. Пушкина. 2015. — Т. 5. — №. 2. — С. 5–14. **7.** *Кудрявцев Д.В.* Системы управления знаниями и применение онтологий: Учеб. пособие / Д.В. Кудрявцев. — СПб.: Изд-во Политехн. ун-та, 2010. — 344 с. **8.** *Кэссон Г. Н.* Искусство делать деньги: /Пер. с англ. — СПб: Издательство «Литера», издательство «ВИАН», 1997. — 160 с. **9.** *Лопатников Л.И.* Информация (Information) // Экономико-математический словарь. Москва, «Наука», 1987. — 509 с. С. 145. **10.** Философия: Энциклопедический словарь / Под ред. А.А. Ивина. — М.: Гардарики, 2004. — 1072 с. **11.** *Akhavan P., Pezeshkan A.* Knowledge management critical failure factors: a multi-case study //VINE: The journal of information and knowledge management systems. — 2014. — Vol. 44. — № 1. — pp. 22-41. **12.** *Boisot M.H.* Knowledge assets: Securing competitive advantage in the information economy. — Oxford: Oxford University Press, 1998. — 306 pp. **13.** *Chua A., Lam W.* Why KM projects fail: a multi-case analysis //Journal of knowledge management. — 2005. — Vol. 9. — №. 3. — pp. 6–17. **14.** *Cooper P.* Data, information, knowledge and wisdom //Anaesthesia & Intensive Care Medicine. — 2017. — Vol. 18. — №. 1. — pp. 55-56. **15.** *Covey S. R.* The Seven Habits of Highly Effective People. Publ. by Simon & Schuster. 1989. — 291 pp. Available at: https://img1.wsimg.com/blobby/go/5fa7ac32-9e78-4f70-87ef-a31ffec045f2/downloads/1c5kl999q_263813.pdf **16.** *Frost A.* A synthesis of knowledge management failure factors //Recuperado el. — 2014. — Т. 22. Available at: https://www.knowledge-management-tools.net/A_Synthesis_of_Knowledge_Management_Failure_Factors.pdf **17.** *Galandere-Zile I., Vinogradova V.* Where is the Border Between an Information System and a Knowledge Management System? //Managing Global Transitions. - 2005. — Vol. 3. — №. 2. — pp. 179-196. **18.** *Kimble, C.* Knowledge management, codification and tacit knowledge // Information Research, 2013. 18(2) paper 577. [Available at http://InformationR.net/ir/18-4/paper577.html]. **19.** *Krźál M., Kubiź M.* Differences between Knowledge and Information Management Practices: Empirical Investigation //Proceedings of the International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management. — SCITEPRESS-Science and Technology Publications, Lda, 2016. — pp. 190–198. **20.** *Nake F.* Data, information, and knowledge //Organizational Semiotics. — Springer, Boston, MA, 2002. — pp. 41–50. **21.** *O'Conner J., McDermott I.* The art of systems thinking: Essential skills for creativity and problem solving //Thorsons. Google Scholar. — 1997. - 288 pages/ **22.** *Rowley J.* The wisdom hierarchy: representations of the DIKW hierarchy //Journal of information science. — 2007. — Vol. 33. — № 2. — pp. 163-180. **23.** *Schildt H.* Artificial Intelligence Using C - Mcgraw-Hill Osborne Media — 1987 — 412 pp. **24.** *Weber R. O.* Addressing failure factors in knowledge management //Electronic Journal of Knowledge Management. — 2007. — Vol. 5. — №. 3. pp. 333 346. **25.** *Zack M. H.* Managing codified knowledge //Sloan management review. — 1999. — Vol. 40. — №. 4. — pp. 45–58.