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APPLICATION OF THE SOFTWARE AGENTS SOCIETY IN THE KNOWLEDGE MANAGEMENT SYSTEM LIFE CYCLE

Introduction

Modern organizations, looking for new ways to improve their competitiveness, are focused on the application of innovative solutions that can improve the efficiency and effectiveness occurring in these activities. As a result the IT solutions market for ERP class systems, focused on improving the efficiency of operations and business in the field of decision effectiveness, is constantly evolving. These systems are used to assist in the processing of data and information sharing, as indicated by the literature, can be considered in terms of knowledge management (KM) systems. The result is that the modern knowledge-based organizations must be on one hand used with systems oriented on primary processes such as sales, generating profits, and on the other hand they are aware that competitive advantage requires the use of solutions that support knowledge management in an organization. As a result, modern organizations, aware of the significance of the application of organizational knowledge, require exploration of modern information systems in order to support the different stages of the life cycle of a knowledge management system and perfecting the execution of the processes occurring in them. Software agents can be such a solution; and in the context of multi-agent solutions – software agents communities.

The aim of this article is to present the concept of software agents community and its impact on the areas of knowledge-based organizations on the basis of the life cycle of a knowledge management system.

The scientific purpose of this article is to present the possible influence of software agent technology on knowledge management system's life cycle. These research methods include the literature review in this field. In author's opinion, using software agents as a part of information systems organization increases

their functionality, usability and gives an opportunity to enhance them with semantic knowledge representation standards like OWL.

Author's previous studies tend to indicate the possible use of community software agents as part of a supportive and perfecting business processes in organizations [StZy2010]. This paper will address the aspects of modeling such solutions as elements enabling support for modern knowledge-based organizations in the field of their business processes. In the first part of this article the issues of software agents will be presented, then their predisposition characteristics for use in the field of knowledge management organization will also be presented. Finally, the aspects of the use of software agents on the basis of the life cycle of a knowledge management system will be shown.

1. The use of software agents in the area of supporting the business processes in an organization

Modern approaches to the theory of organization and management development are focused on the processing approach, associated with the flattening of the organizational structure and related to the rejection of the classical functional structures of the task forces, created cross-organizationally, which are established for specific tasks [ZaZy2013]. The organization is treated as a set of processes that permeate each other, are reproducible and clearly defined. Process approach towards activities taking place in organizations may also result from their consideration in a systemic perspective. This approach aims to increase the competitiveness of the organization in a dynamic environment, by reducing costs, improving service quality and improve its operations with clearly defined stages of the process, the possibility of monitoring and elimination of potential "bottlenecks". The process approach supports effective implementation of the objectives adopted by the organization. Competitiveness requires them to not only improve the efficiency of the business processes, but requires consideration in the context of knowledge management processes. Knowledge management is defined as the process of identifying, capturing, and organizing and dissemination an organization's intellectual assets which are important to its long term performance [SD2006].

Modern organizations, which must compete in a changing environment, require the systems to support both of these trends. However, this is an extremely difficult task. On one hand, systems targeted at business processes operate on data and are related to the current activities of the organization in obtaining rele-

vant results such as sales. Knowledge management systems, which are created there, are not built for achieving the basic processes, but as part of the employees support and to provide knowledge on these existing processes. The result is that the IT solutions built at the junction of two streams require further exploration of the methodological aspect of the construction and the impact on the organization itself and its effectiveness. Agent based solutions can be considered as an aid to both approaches.

According to the definition of an autonomous agent, it is a system situated inside and is a part of the ambient environment and is capable to analyze and affect it in time, strive to set goals and to simulate the impact of changes in the environment [LAI2004]. Such solutions, using different mechanisms of artificial intelligence, can assist human activities or replace him. Software agent groups allow to consider them as multi-agent systems. The development of the concept of software agents allowed to define the concept of a multi-agent system, which can be regarded as an organized community of individual units, where agents play specific roles and interact with other agents. The scope and the subject of research conducted so far indicated that the current development of agent technology research is focused on the design of open, mobile systems with broad functionality and high dynamic range. As a result, the use of agents generates new features of the system, which include focus on knowledge, self-organization and distributed decision making [IvBu2013]. In the literature, such arrangements are referred to as organization agents [FM2007]. In this case organization agents are treated as a united group of agents to achieve specific goals. They form a social entity, with defined structure, resources and authorities. They are created for the implementation of emerging goals and may also be referred to as electronic institutions/gent institutions [CLR2008]. One of the trends is the concept of agent society, which typology proposed in the context of their use as an item of information systems supporting knowledge-based organizations is presented in this paper [Zy2013b].

The development of the multi-agent systems concept makes the static architecture of multi-agent systems in a hierarchical architecture become insufficient mainly in the context of the construction of self-organizing solutions (for network architecture, market), where mobile agents become members of the community in a dynamic way. Artificial community of software agents can be regarded as a set of agents who act on each other using certain rules and standards. Alike in human societies such artificial community members must have permission to coexist in this environment and for the completion of their objectives in

the presence of other units. The purpose of using standards in such systems is to manage the rules for participation in the community and to provide mechanisms for the achievement of desired behavior [DJ2009]. As a result, agent-based solutions should, on one hand, be used with defined standards of their structure (e.g. the use of multi-agent platforms defining the norms and principles of the system's operations), and on the other for the co-operation with the user they should use the mechanisms that allow them to semantically interpret the stimuli received from the environment. Depending on their use as part of an information system organization, they should operate on the knowledge contained therein concerning the standards and principles of the organization. The result is that the communities of software agents, considered in the context of their use as part of a knowledge management system, should:

- support the different stages of the life cycle of a knowledge management system,
- not only automate tasks carried out during the implementation of the organization's business processes, but also to apply the knowledge within the organization for their improvement and support,
- use a common conceptual base processable by the mechanisms of semantic processing of knowledge,
- be associated, by semantic descriptions of resources, in organization's information systems, as well as a part of the organization's knowledge portals that can be supported by agents or constitute a centralized knowledge bases for them,
- use currently applied multi-agent environment construction standards, which helps in their design and creation, and be supported by the modeling methodology aimed at defining their relation structure, but taking on aspect of the knowledge of the system in terms of knowledge within the organization.

In order the software could be considered agent oriented solution, it must have certain characteristics. From the point of view of software agents features such as proactivity, autonomy, mobility, openness, personification, and personality are undertaken in the literature [SS2007]. From the point of view of the application of software agents in the area of supporting organizations we can distinguish:

- 1. The ability to learn and interact with the environment** – the process of collecting, processing and sharing the knowledge and information requires the cooperation of the participating stakeholders. Developed agent

communication standards support processes of semantic representation along with inference on the basis of their content.

2. **The ability to adapt to new conditions and effects in real time** – the distribution of knowledge requires the involvement of stakeholders and analysis of the environment in which the agent is located. Software agents have characteristics which allow them to take real-time actions based on the changes of the codified knowledge and resources to respond to user needs in real time.
3. **The ability to adapt to their tasks** – the use of semantic knowledge representation method allows for interpretation of the purpose and determining whether the knowledge is sufficient to perform the agent's tasks. In the absence of adequate knowledge the agent is able to communicate with the environment in order to acquire it.
4. **The ability to store codified partial knowledge concerning given problem** – the use of agents and methods of semantic representation of knowledge allow mobile agents to perform tasks with only a selected portion of the codified knowledge related to the task that it performs. The result is that such units do not need to have direct access to the knowledge management system and can work remotely in terms of ubiquitous communication.

2. The use of software agents in knowledge-based organizations on the background of the life cycle of knowledge management system

It can be stated, based on the above characteristics, that the knowledge-based organizations use intellectual capital to manufacture products, provide services, but also consciously manage intellectual capital and are capable of learning. In other words, knowledge-based organizations are those that adjust their offer and the way they work to the knowledge resulting from the reflection on the current course of action and consciously manage knowledge resources, which are the organization's part and which show signs of co-operation. General architecture of the analyzed systems can be seen in [GBA2004], [AlChu2004], [XiZhXu2006] as a three-tier architecture. The first tier is the interface layer, which can be seen as user interface to enable user's access to information or knowledge represented in system, gather information/knowledge from them and

help users in better understanding of the information and knowledge. The second tier is business/knowledge tier. It is responsible for generating knowledge, sharing it among users, giving access to the codified knowledge and supporting its creation. The third tier is infrastructure services which can be represented by structured resources or data representation mechanism. In previous publication [ZyKo2013] authors reviewed different implementations of software agents as part of KM system and proposed a general concept of knowledge management system supported by software agent society in the area of knowledge evaluation.

From the point of view of knowledge management processes we can distinguish the following stages of the process, defined as the life cycle of a knowledge management system:

- 1. Knowledge generation** – the use of software agents in this area can concern their communication with users or systems. In the first case, the use of interface agents allows, during direct contact with the user, to gather knowledge on the subject and on the actions that he takes. If such a solution is a part of the organization's knowledge portal, it allows to collect knowledge such as the needs of potential customers, their expectations and information needs. In the case of linking software agents with the organization's information systems, software agents can be part of the automation process of knowledge discovery in the data. If the organization is equipped in a knowledge portal, software agents can support its operation, treating it as a repository of knowledge within the organization and allowing it to describe the organization's information resources based on the developed concept map. Such metadata, defined using description languages ontology, can be interpreted by software agents and used in the performance of their activities.
- 2. Knowledge evaluation** – the use of the organization's knowledge portal gives the software agents the ability of analysis to support awareness and use of processes in organizations. In this case, codified knowledge stored in the portal, through the mechanisms of agent's artificial intelligence, can be assessed and used in the organization's business processes. Audit knowledge is a key element of knowledge management. Thanks to the analysis of the knowledge base the software agents can support the operation of the organization to generate new knowledge about it and support the decision-making processes. This requires ontology description languages such as OWL, allowing the agents' inference. An example of the use of software agents in this process has been shown in [ZyKo2013].

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- 3. Knowledge sharing/dissemination** – it is currently the most common use of software agents by organizations. Currently created solutions, that have their own knowledge base, enable direct communication with the end user. Although anthropomorphism is indicated as a key element of the impact of human agents, it depends on the knowledge that an agent has whether the agent software will be considered as a useful tool. In the case where such entity is linked by organization's information systems, the use of descriptive semantic knowledge contained in them allows agents to draw conclusions based on the defined rules and knowledge from e.g. a BI system and for the interaction and business processes course. An example of applying semantics in the BI system's resources description area can be found in this work.
 - 4. Knowledge leveraging** – although this phase is seen in the literature with regard to the knowledge management system users, here you can also search for items related to the use of software agents. Main feature of software agents is their ability to communicate. In the case of communication between agents it is necessary to determine how to interpret the generated transmission between these units. The use of semantic description of knowledge gives program agents and their creators a conceptual basis which allows defining the interpretation/meaning mechanisms of the specified knowledge. Using semantic knowledge description methods results in the improvement of human-computer communication and the communication within the system.
 - 5. Knowledge discovery** – from the point of view of the use of software agents in knowledge-based organizations, knowledge discovery process may concern two aspects. The first is related to the creation of agents' community, which must support such an organization. For the purpose of the creation of such solutions adequate preparatory measures for diagnosis of knowledge and its sources are required, along with knowledge codification process, which will be used by software agents. In this case there is a problem of encapsulating the knowledge of the agent, and inability of its updating and development. The use of the knowledge portal in this area allows for agent's integration on the knowledge representation layer level, so that software agents can exploit new resources of codified knowledge placed on the site by users and the agents themselves.

Conclusion

Presented issues indicate that the undertaken problems are an innovative approach to knowledge management processes in knowledge-based organizations using the concept of community of software agents. Especially in the era of the semantic Internet development and the currently under construction Web 4.0 concepts, which essential aspect is the use of agent technologies for processing of knowledge on the Internet. Thanks to the community of agents and ubiquitous communication it will be possible to easily integrate distributed devices within business processes where a man is involved, a dynamic specification of business processes with their participation and the codification of such processes within the concept of composite software, and ultimately to obtain a competitive advantage in the knowledge-based organization, thanks to the possibility to obtain new knowledge about the processes and the participating entities. The use of semantic solutions in this process will assist in the representation of acquired knowledge and its processing by information technology and by the man himself. This way of codifying the knowledge about the dynamic business processes and entities participating in them makes it is possible to use the agents' community also for the purpose of managing of acquired knowledge.

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WYKORZYSTANIE SPOŁECZNOŚCI AGENTÓW PROGRAMOWYCH W CYKLU ŻYCIA SYSTEMU ZARZĄDZANIA WIEDZĄ

Streszczenie

Nowoczesne organizacje, poszukując nowych dróg poprawy swojej konkurencyjności, są ukierunkowane na zastosowanie innowacyjnych rozwiązań informatycznych, które mogą poprawiać efektywność oraz skuteczność zachodzących w nich działań. W efekcie rynek rozwiązań informatycznych w obszarze systemów klasy ERP zorientowany na poprawę efektywności działań oraz Business Intelligence w obszarze skuteczności decyzji stale się rozwija. Systemy te stosowane dla wspomagania przetwarzania, udostępniania danych i informacji, jak wskazuje literatura, mogą być rozpatrywane w kategoriach systemów wspierających przetwarzanie wiedzy w organizacji. Powoduje to, iż nowoczesne organizacje oparte na wiedzy muszą wykorzystywać z jednej strony systemy ukierunkowane na procesy podstawowe, np. sprzedaż, generując zyski, a z drugiej mają świadomość, iż przewaga konkurencyjna wymaga stosowania rozwiązań wspierających zarządzanie wiedzą w organizacji. W efekcie nowoczesne organizacje, zdając sobie sprawę z istotności zastosowania wiedzy organizacyjnej, wymagają poszukiwania nowoczesnych systemów informatycznych, które wspierałyby różne etapy cyklu życia systemu zarządzania wiedzą oraz doskonaliły realizację procesów w nich zachodzących. Takimi

rozwiązaniami mogą być agenty programowe, a w kontekście rozwiązań wieloagentowych – społeczności agentów programowych.

Celem niniejszego artykułu jest przedstawienie koncepcji społeczności agentów programowych oraz obszarów ich oddziaływania w organizacjach opartych na wiedzy na tle cyklu życia systemu zarządzania wiedzą. Dotychczasowe badania autora skłaniają do wskazania możliwego zastosowania społeczności agentów programowych jako elementu wspierającego i doskonalącego procesy biznesowe w organizacjach. W niniejszym artykule zostaną poruszone aspekty modelowania takich rozwiązań jako elementu pozwalającego wspierać nowoczesne organizacje oparte na wiedzy w zakresie realizowanych przez nie procesów biznesowych. W pierwszej części zaprezentowano zagadnienia dotyczące agentów programowych, dalej przedstawiono ich cechy predestynujące je do zastosowania w obszarze zarządzania wiedzą organizacji. Na koniec ukazano aspekty stosowalności agentów programowych na tle cyklu życia systemu zarządzania wiedzą.