ZESZYTY NAUKOWE POLITECHNIKI ŚLĄSKIEJ 2015
Seria: ORGANIZACJA I ZARZĄDZANIE z. 83 Nr kol. 1941

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STRUKTURA ZARZĄDZANIA NOWATORSKIMI TECHNOLOGIAMI INFORMACYJNYMI, KOMUNIKACYJNYMI I AUTOMATYKĄ

Streszczenie. Celem tego artykułu jest przedstawienie koncepcji struktury zarządzania nowoczesnymi technologiami informacyjnymi, komunikacyjnymi oraz stosowanymi w automatyce. Koncepcja ta opiera się na nowoczesnych trendach w zarządzaniu, takich jak: technologie semantyczne, ontologia zarządzania oraz systemy cyberfizyczne. Współcześnie technologie informacyjne odgrywają kluczowe znaczenie dla rozwoju i efektywności przedsiębiorstw. Istniej również istotna zależność pomiędzy systemem informacyjnym przedsiębiorstwa a jego strategią i strukturą organizacyjną. Zarządzanie nowoczesnymi technologiami informacyjnymi i komunikacyjnymi jest ściśle powiązane z przemianami społecznymi. Zrozumienie systemów informacyjnych ma zasadnicze znaczenie dla zrozumienia procesów zmiany technologicznej w przedsiębiorstwach.

Słowa kluczowe: nowoczesne technologie, technologie semantyczne, ontologia zarządzania, systemy cyberfizyczne.

A FRAMEWORK FOR MANAGEMENT OF NOVEL ICT AND AUTOMATION TECHNOLOGIES

Summary. The aim of this article is giving the idea of management framework for the novel ICT and information technologies. This concept is based on modern trends in management, such as semantic technologies, ontology management and cyber physical systems. Nowadays Information Technologies (IT) has absolutely fundament importance for the growth and effectiveness of enterprises investments. There is a relationship between Information System, Organization and Strategy. The management of novel ICT/AT technologies is connected with social change. Understanding the emergence of innovation systems is recently put central in research analyzing the process of technological change.

Keywords: advanced technology, semantic technology, ontology management, cyber physical systems.

1. Introduction

Nowadays the role of information and communication technologies (ICT) and automation technologies (AT) is increasing rapidly. It is the effect of economy globalization and the shortening of products and technologies' life-cycles. Evolution of IT infrastructure from 1950 till today is a result of enormous developments in technologies: electronics, chemistry, telecommunications and also in methods used in software development, standards and management methods. Great influence did have, and still do have, political and economical conditions – globalization, human resources (e.g. India, China, Taiwan) [1].

The aim of this article is giving the idea of management framework for the novel ICT and information technologies. This concept is based on modern trends in management, such as semantic technologies, ontology management and cyber physical systems.

2. New Challenges in Advanced Technologies

In these days there are many important trends in modern ICT/AT technologies. Among trends in advanced technologies, semantic ones play very important role. Semantic technology is a concept in computer science that aims to bring semantics — the meaning and context behind words and sentences — to the world of computers. A number of approaches to implementing the concept have been developed, ranging from advanced artificial intelligence to formal, machine-readable descriptions of content. The Web is a key focal point for semantic technology, though it may benefit business and academic fields as well [11]. Although computers excel at mathematical calculations, they struggle with many aspects of human language, especially semantics. A computer program can defeat even the most skilled humans in a game of chess, but would fare poorly in a trivia contest against a child because it lacks the ability to accurately interpret the context, meaning, and subtleties of the language in the trivia questions. This has implications for a great range of applications and services: Without a thorough understanding of context, a search engine may not return accurate results for words with multiple meanings, such as desert and cold, and voice recognition software might struggle with words that sound the same, such as "witch" and "which." Semantic technology could also benefit a large number of industries and academic disciplines. Online advertisers are looking to something called semantic targeting to analyze the content of a Web page and deliver ads relevant to that content. Large corporations and enterprises are eager to eliminate compatibility problems between different information technology systems with software and database architectures that better understand the meaning and context of different content.

Ontology are one of the most modern management technologies in organizations, especially from ICT and AT sectors. Formal ontology is *designed*. When we choose how to represent something in an ontology, we are making design decisions. To guide and evaluate our designs, we need objective criteria that are founded on the purpose of the resulting artifact, rather than based on *a priori* notions of naturalness or Truth. Here we propose a preliminary set of design criteria for ontology whose purpose is knowledge sharing and interoperation among programs based on a shared conceptualization: clarity, coherence, extendibility, minimal encoding bias and minimal ontological commitment [4].

A cyber-physical system (CPS) is a system of collaborating computational elements controlling physical entities. Today, a precursor generation of cyber-physical systems can be found in areas as diverse as aerospace, automotive, chemical processes, civil infrastructure, energy, healthcare, manufacturing, transportation, entertainment, and consumer appliances. This generation is often referred to as **embedded systems**. In embedded systems the emphasis tends to be more on the computational elements, and less on an intense link between the computational and physical elements. Unlike more traditional embedded systems, a full-fledged CPS is typically designed as a **network** of interacting elements with physical input and output instead of as standalone devices [6]. The notion is closely tied to concepts of robotics and sensor networks. Ongoing advances in science and engineering will improve the link between computational and physical elements, dramatically increasing the adaptability, autonomy, efficiency, functionality, reliability, safety, and usability of cyber-physical systems. This will broaden the potential of cyber-physical systems in several dimensions, including: intervention, precision, operation in dangerous or inaccessible environments, coordination, efficiency and augmentation of human capabilities [2].

Mobile cyber physical systems, in which the physical system in question has inherent mobility, are a prominent subcategory of cyber-physical systems. Examples of mobile physical systems include mobile robotics and electronics transported by humans or animals. The rise in popularity of smartphones has increased interest in the area of mobile cyber-physical systems. Smartphone platforms make ideal mobile cyber-physical systems for a number of reasons, including:

- Significant computational resources, such as processing capability, local storage
- Multiple sensory input/output devices, such as touch screens, cameras, GPS chips, speakers, microphone, light sensors, proximity sensors
- Multiple communication mechanisms, such as WiFi, 3G, EDGE, Bluetooth for interconnecting devices to either the Internet, or to other devices
- High-level programming languages that enable rapid development of mobile CPS node software, such as Java [9], Objective C, or C#
- Readily-available application distribution mechanisms, such as the Android Market and Apple App Store
- End-user maintenance and upkeep, including frequent re-charging of the battery.

For tasks that require more resources than are locally available, one common mechanism for rapid implementation of smartphone-based mobile cyber-physical system nodes utilizes the network connectivity to link the mobile system with either a server or a cloud environment, enabling complex processing tasks that are impossible under local resource constraints [10].

3. Information Systems and their elements

Information systems are not only computers. Shortly, system is a group of interdependent units working together to achieve common goal. System receives data, processes them and produces information using organised process of transformation. Information systems join organization, technology and management [1].

There are four levels in the pyramid of Information and Knowledge Management:

- Data - these are facts or observations of physical events or business transactions. More specific definition could be: "data are objective measures of characteristics of objects like: people, places, things or events"
- Information - these are data processed for the user into a meaningful and useful way,
- Knowledge - combination of information and skills; clever (skilful) application of information to a specific goal,
- Wisdom – combination of knowledge and experience, which develops in time: in a person, in the population, in the nation.

Information system contains data about the organisation and about surrounding environment. Three basic functions: data input, processing and data output supply necessary information for effective operation of an organisation. Feedback supplies necessary information to the appropriate personnel or processes in order to evaluate and improve data input. Environment elements: customers, suppliers, stockholders and market regulatory agencies, they all influence organizational operation, and therefore they also influence their information system. Information Systems play the important role in business world. New name has emerged to describe a company which are fully digital, "Digital Firms". They are characterized by:

- All important business transactions can be negotiated and settled in digital form;
- Basic business processes operate through digital networks;
- Key organizational assets are managed digitally.

"Digital firms" offer greater flexibility in operation and management. They are independent of time zones and geographic location.

4. The importance of Information and Communication Technologies and Automation Technologies

Nowadays Information Technologies (IT) has absolutely fundament importance for the growth and effectiveness of enterprises investments. The IT is already critical for the company success. It influences nearly every aspect of the company's activities. It is reflected, beside others, in the amount of money being spend on IT investments – in average 50% of all investments and it is still increasing. For some companies IT enables productivity growth, for others it changes their business models and provides opportunities to obtain a competitive advantage [7, p. 40].

In the same time different researchers show that effectiveness of IT investments is very low. For example the research "The Chaos Report" carried out by Standish Group revealed that less than 10% of IT projects ends with full success, it means on time, in budget and providing desirable business results. It is worth to note the nature of using information technologies has been change lately: they are no longer the domain of IT hobbyists. There is a huge need to implement a systematic approach to IT management in the enterprise which will lead to maximizing the value of the company.

The main measure of IT value is delivering products or services on time, in the budget, in the agreed quality and providing desirable business results, such as competitive advantage, customer satisfaction, shorter to time to market, shorter period of orders realization, higher productivity of employees, higher profitability of the company etc.

The value IT adds to the business is connected with the level of alignment of IT strategy to the strategy of the whole business. For effective IT management both IT costs and returns must be managed. The value of IT is perceived differently on a different levels of management and it requires different methods of measuring. Therefore, it is important not only to focus on a measurement of financial impact, but also to take into account the impact IT has on whole enterprise's performance in creating value.

Automation Technologies (AT) or automatic control, is the use of various **control systems** for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching in telephone networks, steering and stabilization of ships, aircraft and other applications with minimal or reduced human intervention. Some processes have been completely automated. The biggest benefit of automation is that it saves labor, however, it is also used to save energy and materials and to improve quality, accuracy and precision. The term *automation*, inspired by the earlier word *automatic* (coming from *automaton*), was not widely used before 1947, when General Motors established the automation department. It was during this time that industry was rapidly adopting **feedback controllers**, which were introduced in the 1930s. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic and computers, usually in

combination. Complicated systems, such as modern factories, airplanes and ships typically use all these combined techniques.

5. Management of novel ICT technologies

There is a relationship between Information System, Organization and Strategy. Business strategy is one of the most important elements of organization management. It defines principal directions, procedures, rules and instruments of organization activities. Decision about the choice of strategy must be based on verified information and is taken after thorough analysis of all probable variants of economic political and environmental situation [1].

Both people and organizations need to establish a strategic framework for significant success. This framework consists of:

- a vision for your future,
- a mission that defines what you are doing,
- values that shape your actions,
- strategies that zero in on your key success approaches, and goals and action plans to guide your daily, weekly and monthly actions.

A mission statement is a brief description of a company's fundamental purpose. A mission statement answers the question, "Why do we exist?" The mission statement articulates the company's purpose both for those in the organization and for the public.

A vision statement is sometimes called a picture of your company in the future but it's so much more than that. Your vision statement is your inspiration, the framework for all your strategic planning. A vision statement may apply to an entire company or to a single division of that company. Whether for all or part of an organization, the vision statement answers the question, "Where do we want to go?"

In the management of novel ICT/AT technologies, mentioned above semantic technologies play key role. Also in Service-Oriented Architecture (SOA), where semantic technologies create internal and external integrations of business resources and processes. According to S. Strzelczak [8] "SOA architecture was suggested as a mean to enhance interoperability and openness, in reference to both, internal and external integrations of business resources and processes. SOA supports service orientation, which is a way of integrating ICT resources by linked services and the outcomes that they bring. Service orientation enables applications to invoke each other as a service, i.e. a repeatable task which meets specified requirements, is discoverable, is self-describing and can be managed through governance. Whereas a software component is a unit of code that can be executed to provide functionality, a service is a component that is actually running, often in its own process, which is hosted independently from the applications that are invoking it. Actually,

applications themselves can be broken into parts that each run in their own process and invoke each other through services. This makes a composite application, a set of related and integrated services that support a particular process, e.g. business process, which is built on SOA. SOA offers the potential to provide the necessary system visibility and device interoperability in complex automation systems subjected to frequent changes. SOA is basically an architectural paradigm that defines mechanisms to publish, find, plan and coordinate services, adopting loose coupling logic and openness. Hence, the SOA paradigm is particularly applicable for such environments, which require reconfigurability and transformability. This is the case of ICT/AT intensive business resources and processes". Semantic technologies and novel ICT/AT technologies can cause the development of methods and techniques used in the management of business systems, especially in high-technology industries, such as Information and Communication Technologies, Automation Technologies, micro- and optoelectronics, advanced airspace technologies etc.

The management of novel ICT/AT technologies is connected with social change. Moreover, understanding the emergence of innovation systems is recently put central in research analyzing the process of technological change. Especially the key activities that are important for the build up of an innovation system receive much attention. These are labeled "functions of innovation systems" [5].

For the growth of technologies' competitiveness the strategic flexibility plays the essential role. Strategic flexibility is proposed as an expedient capability for managing capricious settings, such as those confronted in technology-intensive areas. A conceptual framework is consequently developed, which integrates the temporal and intentional dimensions of flexibility. Four archetypal manoeuvres, derived from the framework, are proposed as a means of attaining strategic flexibility. The deployment of these manoeuvres is exemplified by means of selected strategic engagements of firms in the computer peripherals arena [3].

6. Conclusions

It is obvious, that at the beginning of 21th century ICT/AT technologies play very important role in the management of enterprise, especially operating in high-technology industries. Nevertheless there is a question about the role of modern trends in advanced technologies for the development of business systems in management. In this article it has been done the attempt of building framework of management, based on modern concepts of management, especially semantic technologies and ontology management.

Taking into account the above analysis, the main conclusions are following:

- Semantic technology plays key role in the development of advanced ones. It is a concept in computer science that aims to bring semantics – the meaning and context

behind words and sentences – to the world of computers. Semantic technology could also benefit a large number of industries and academic disciplines.

- Ontologies are one of the most modern management technologies in organizations, especially from ICT and AT sectors. Generally formal ontologies are *designed* moreover, preliminary set of design criteria for ontologies are following: clarity, coherence, extendibility, minimal encoding bias and minimal ontological commitment.
- A cyber-physical system (CPS) is a system of collaborating computational elements controlling physical entities. A precursor generation of cyber-physical systems can be found in areas as diverse as aerospace, automotive, chemical processes, civil infrastructure, etc. Mobile cyber physical systems, in which the physical system in question has inherent mobility, are a prominent subcategory of cyber-physical systems.

ICT/AT technologies create and support the framework of novel management, including advanced technologies, such as mentioned above ontologies, semantic technologies, and cyber-physical systems.

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Abstract

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In the management of novel ICT/AT technologies, mentioned above semantic technologies play key role. Moreover, the management of novel ICT/AT technologies is connected with social change. On the other hand, for the growth of technologies' competitiveness the strategic flexibility plays the essential role. Strategic flexibility is proposed as an expedient capability for managing capricious settings, such as those confronted in technology-intensive areas.