Applied Computer Science, vol. 13, no. 3, pp. 41–54
doi: 10.23743/acs-2017-20

Submitted: 2017-09-01
Revised: 2017-09-12
Accepted: 2017-09-15

maintenance, knowledge acquisition, knowledge management, knowledge bases, electronic report

Małgorzata ŚLIWA[*], *Ewelina KOSICKA*[**]

A MODEL OF KNOWLEDGE ACQUISITION IN THE MAINTENANCE DEPARTMENT OF A PRODUCTION COMPANY

Abstract

The knowledge acquisition model proposed in this paper is designed to assist with the acquisition of knowledge in a company possessing its own maintenance department. The model is built on the basis of knowledge bases. The authors focus on basic information required for maintenance department operation and expert archiving of technical documentation. Three main areas are covered by the model: knowledge acquisition and formalization, knowledge systematization and knowledge retrieval by problem or field. It is assumed that the implementation of the model coupled with an electronic knowledge acquisition report and with an application for information retrieval will bring benefits for the company.

1. INTRODUCTION

In a knowledge-based company, the need to minimize manufacturing costs encourages the management of not only material and financial resources but of intangible resources too. Intangible resources include explicit knowledge available in the procedures and operating instructions that is necessary to preform business processes in a company, pointing to external and internal sources (Falkenberg, Woiceshyn & Karagianis, 2003). One can also distinguish tacit knowledge that is accumulated in the minds of workers, supported by their

[*] University of Zielona Góra, Institute of Machine Construction and Operations Engineering, Prof. Z. Szafrana 4, 65-516 Zielona Góra, 68 328 29 50, m.sliwa@iizp.uz.zgora.pl
[**] Lublin University of Technology, Department of Production Engineering,Nadbystrzycka 36, 20-618 Lublin, 81 538 42 40, e.kosicka@pollub.pl

hands-on experience. For this reason, there is a need to acquire and accumulate this type of resource in the form of simple knowledge bases. Some experts working for a company may show a reluctance to share their knowledge because they may be afraid of losing their position resulting from years of experience. The exchange of explicit knowledge within a company is mainly done through informal communication, which reduces the quality of this knowledge (Padzich, 2004) and does not allow for duplication.

In the realities of a manufacturing company, knowledge acquisition can lead to establishment of conditions supporting the work of the maintenance department. Maintenance services have specialized knowledge of machinery maintenance and repair. Owing to their participation in the process of restoring machinery efficiency, the specialists are able to determine the type of a fault and its location, name the cause of the fault, and to identify shortcomings or design mistakes that may affect failure frequency. Correct archiving of maintenance reports and further classification of key information from this area lead to optimization of processes related to maintenance and care of the machinery stock. Proper knowledge management brings a number of benefits for the company. They result from an easier access to knowledge for employees and reduction of erroneous activities. This, in turn, leads to faster completion of tasks and cost minimization.

The knowledge acquisition model proposed in the paper was created based on the company's databases and technical documentation. One of the tools supporting knowledge acquisition is an electronic report. When drafting it, the authors focused on the basic knowledge useful for maintenance work, proper archiving of documentation containing the characteristics of a fault along with a brief description of repair actions. In the case of devices that make part of an already existing stock of machines, it is possible to develop modernization solutions to eliminate the mistakes of the design engineer. Consequently, three main areas should be included in the model:

- knowledge acquisition and its formalization,
- knowledge systematization,
- knowledge retrieval depending on the problem or the field of knowledge/project.

This paper describes the types of knowledge available in a production company and its sources. The knowledge acquired during the design of modernization and operation of machines is described. A research model is developed based on the characteristics of work of a specified production company with its own maintenance department based in Lubuskie Province. For the purpose of streamlining the work, the structure of an electronic reports dedicated to maintenance services is proposed together with examples of how it can be supplemented. The conclusions point to potential benefits of the proposed solution.

2. KNOWLEDGE IN A COMPANY

According to Bernaert and Poels (Bernaert & Poels, 2011), we can distinguish four types of knowledge depending on the identification of acquired information: know what (structural knowledge based on models), know why (interpretation of collected information), know how (knowledge of activity procedure), know who (identification of individuals who could help in problem solving).

The implementation of new tasks is based on interdisciplinary knowledge that is born in the minds of experts. It is argued that companies suffer from gaps in the exchange of information and experience gained from projects and that "the accumulated knowledge is dissipated and unprofitable after the project completion" (Wąsowicz, 2013). It is necessary to focus on the identification of sources of knowledge: explicit knowledge that is accessible and simple to transfer and tacit knowledge that is difficult to express and formalize (Piotrowska, 2012). The acquisition of explicit knowledge is based on the transfer of knowledge in a written or oral form. The problem is to systematize and write down tacit knowledge that requires engaging and motivating the workers (Beyer, 2011). In this case, it is important to extract the knowledge from the worker's mind by means of metaphors or hypotheses and to transform it into explicit form (externalization) (Nonaka, Ryoko & Konno, 2000).

Hands-on experience acquired during project implementation, testing and research, complaint analysis, informal discussions and brainstorming is considered to be the underlying source of tacit knowledge (Mendryk, 2011). Explicit knowledge comprises information contained in paper and electronic form – expert systems, guides, books, standards, design support software, manufacturing or the Internet, intranet etc. The external sources include: applicable laws, quality and safety standards, customer requirements, material specifications, competitive characteristics, customer or supplier feedback, expert consultation, and research analyses (by external R&D units). The internal sources include: reports, forms, instructions, intranets, simulations, analyses or technical documentation.

The organization of knowledge, storing it and making the repository available lead to repeating good practices and encourage the development of joint solutions. Through knowledge transfer, organizations can provide employees with access to the resources needed to implement innovative projects. In network environments (of work groups), white collar workers have different roles and tasks; often, they are scattered over different departments, branches and units. Nowadays standard models based on bilateral and personal exchange of knowledge cannot exist any longer. In advanced models, the management of innovative projects is based on information technologies. It is necessary to define the knowledge transfer process using IT and to show the synergies between project requirements, knowledge competencies of the partners and IT

tools (Dąbrowski & Patalas – Maliszewska, 2016). The core business benefits of sharing knowledge include the reduction of (Gasik, 2011, Tabaszewska, 2008) project implementation time, costs, the number of complaints or employee training. In addition, this leads to faster generation of innovative processes in the company, the development of new areas for business activity, the improvement of employee motivation and development of the entire organization (Maier, 2002).

3. KNOWLEDGE ACQUIRED FROM DESIGN AND MACHINERY OPERATION

3.1. Knowledge acquired from design, modernization

Sometimes maintenance department workers use parts available in on the premises to design simple devices for the company or for improved work ergonomics. When designing or modernizing the maintenance services – similarly to the R&D staff – select optimum solutions based on their own experience and knowledge acquired from the co-operating departments (technology, quality, control, HR, supplies and production) (Śliwa & Patalas-Maliszewska, 2016) or from external sources (tests, consultations, opinions). When solving a new problem (similar to previous one but described by other boundary conditions), experts create solutions (tacit knowledge) based on explicit knowledge accumulated in technical documentation, operating procedures, guidebooks, etc. It is necessary to use methods enabling the codification of the applied knowledge and preserving it in a continuous form. The methods supporting the acquisition of tacit knowledge include (Śliwa & Patalas-Maliszewska, 2015):

- filling in knowledge acquisition forms (Fazlagić, 2014),
- the making of video recording showing actions taken by an experienced worker,
- talk to an expert about the topic/ problem and steps to take,
- the engagement of experts from external companies,
- the creation of a place where knowledge workers can report/record their observations,
- registering logs generated in the course of creative work of an expert, e.g. by CAD programmes,
- schematic designs of processes and models in the form of associations, visualizations, holograms, cyber-world etc.

The sources of explicit knowledge in production companies include (Skarka, 2007):

- systems such as CAD/CAM/CRM, etc.,
- standards, customer requirements,
- books, textbooks, brochures, manuals, leaflets,
- expert knowledge bases,

- internal designs and documentation bases,
- internal knowledge bases such as intranet, wiki…,
- vademecum for staff (repository of manuals, brochures informing about behavioural procedures, guidebooks for novice workers).

The acquisition of knowledge by maintenance department workers resulting from simple actions when working on the designs, infrequently conducted in co-operation with other departments, takes place in the course of :

- concept development,
- conducting tests,
- creation of design and technological documentation – determining work specification,
- creation of machine operation manuals,
- creation of machinery specification, operation and maintenance documentation,
- training of machine-operating workers.

3.2. Knowledge acquired during machinery operation

The operation of a stock of machines requires implementation of actions under the maintenance process. The chief responsibility of the maintenance department is to maintain machines in a state of operational reliability and to ensure continuity of the production process. The tasks of the maintenance services include:

- performing maintenance and repair works such as: maintenance works resulting from the operation and maintenance documentation, i.e., lubrication, oiling, machine parts exchange after a given number of man-hours; machine operation adjustment,
- removal of failures,
- monitoring and analysis of the record of machine operation parameters (e.g. temperatures of subassemblies, cooling liquids, lubricants, oils, machine parts vibration, noise level),
- keeping a record of the number of spare parts available in the store,
- contact with the suppliers of parts for key subassemblies,
- development of maintenance and repair works schedule based on operation and maintenance documentation and production schedule,
- modernization of the technical infrastructure of a company,
- being in contact with Office of Technical Inspection units, in particular: keeping a record of equipment available at the Office of Technical Inspection (UDT); organization of routine tests; performing actions connected with acceptance tests of new devices (in the case of outsourcing) and maintenance works on equipment reported to the UDT; coordination and supervision of works and resulting recommendations.

To perform the above tasks, maintenance department works must have skills in the following areas: the ability to read operation and maintenance documentation , analysis of the technical condition of machines and devices, selection of suitable spare parts. Also important is the knowledge of the design and maintenance of machines and devices (knowledge from the field of mechanics, automatics, robotics, electronics). The next one is knowledge about the methods of performing repair and maintenance works on machines and devices and environmental protection (in case of environmental-hazard failure and when utilizing operational materials).

The acquired knowledge and skills result to a large extent from repair works performed by maintenance services. Due to its practical nature, the acquired knowledge should be classified as tacit knowledge. Some of it is stored by workers in databases, programs and systems supporting maintenance work. Their structure proposed by Rybińska and Sekieta (Rybińska & Sekieta, 2009) is shown in Fig. 1.

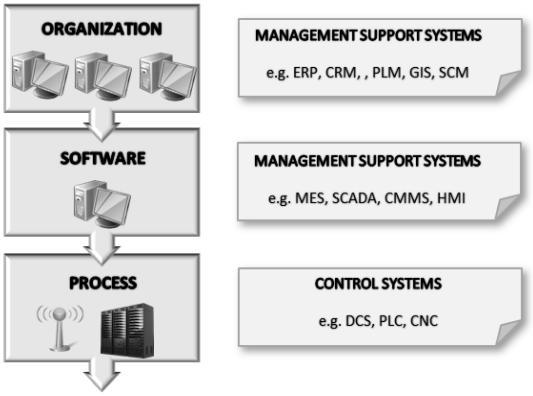

Fig. 1. Structure of IT tools supporting individual process layers (Kosicka & Mazurkiewicz, 2015)

The business layer contains, among others, systems for the management of resources, supplies and suppliers, and their tasks include the support of decision-making and planning of current activities. The operational layer supports maintenance in the managing of production processes through special systems. All kinds of maintenance data from repair and maintenance works are archived in computer systems and can be used for generating reports.

On the Polish market there are applications supporting the work of maintenance services in production companies. These applications consist in the management of data and their number, and are mainly dedicated to larger maintenance departments that take care of extended machinery stocks. These are sample programs: CMMS.net (http://cmms.net), KMS Maintenance (http://www.komtech.pl), MESO CMMS (http://www.utrzymaniemaszyn.pl)

and Maintpartner products (http://maintpartner.fi/index.php/en/). These software are often modular, with many features and attributes to complement, which, on the one hand, may prove to be an asset but, on the other, the excessive-formalization and multiplicity of options poses the need to introduce new employees to their duties and motivate them to implement these programs, without pointing to key elements.

Due to the realities of work, time constraints and intensive inspections of machines at downtimes, the engineers do not control the reports generated by the maintenance services. The reports are often in paper form, and the information contained therein is not used again. They are mainly used for archiving, job accounting and are dispersed in many places (maintenance engineers office, maintenance services documentation, workshops). For this reason, it is important to choose the most important information about work with machines or installations. The data must be sorted out, linked together and, finally, offer a tool enabling easy search alongside a brief description of the actions taken or reasons that makes a compendium of knowledge gained from hands-on experience.

As a result of machinery maintenance and day-to-day work, workers increase their knowledge in four areas: process and work control, machine operation and work ergonomics, repair ergonomics and actual availability of machine parts. The increase in knowledge of machine operation ergonomics occurs when the machine is operated for a longer period of time (e.g. the worker proposes feeder position adjustment or a minor upgrade of the shield system or soundproofing). Repair ergonomics is significant to determine the availability of particular subassemblies. For instance, when a manufacturer provides additional engine gears. Despite no need to work using specific parameters, repair and fault identification are easier. As regards actual availability of parts, it involves verification of the and cost and time of components provided by manufacturers, components manufactured on request from specific materials, and components that are hard to get on the market. Then it is possible to propose a different technological solution or the use of substitutes. The control of processes and operation indicates key machine components that require monitoring. Focus is put on the need to provide additional sensors at stands responsible for the correctness of performed processes or statistics.

4. PROPOSED MODEL

The maintenance department of a manufacturing company should have an IT tool for systematization, quick identification and search of knowledge about workstations, equipment, machinery or installations. This need arises from the observed penetration of knowledge regarding machine design and maintenance. In response to the problem connected with knowledge acquisition and the often

chaotic archiving of documents in manufacturing companies, a model of application based on knowledge bases is proposed for locating knowledge and information flow from the maintenance department. It is also assumed that access to specified information is given to external units within the company and outside it. The model is shown in Fig. 2.

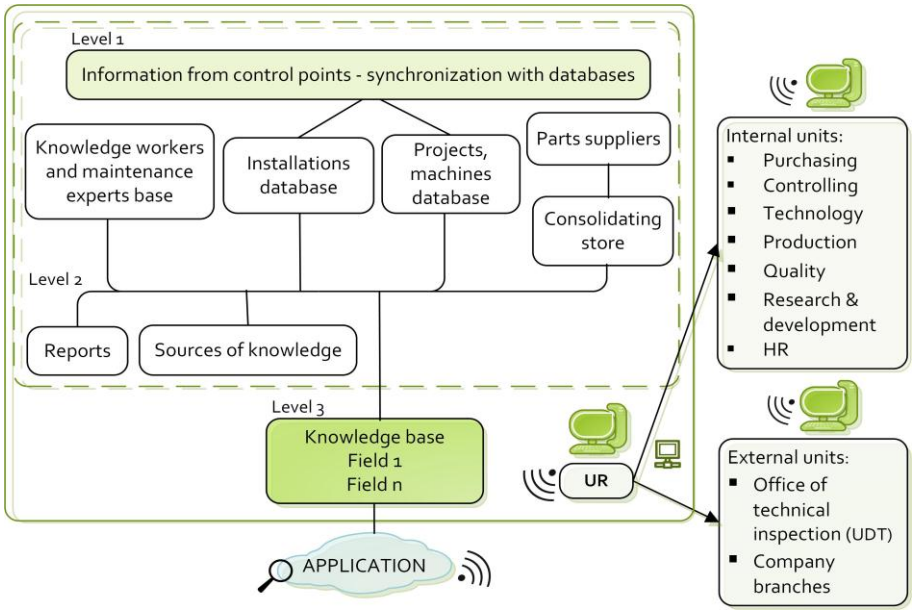

Fig. 2. Model of knowledge management system in a maintenance department

The proposed model illustrates the relationship between the main modules of the support system for acquiring and sharing knowledge in the maintenance department of the analysed manufacturing company. Structure of model complexity refers to the definition and relationship between: data (level 1), information (level 2) and knowledge (level 3) (Grabowski & Zając, 2009). Data and information contained in the knowledge bases (marked by a dashed-line rectangle) supplementing the program are entered and edited by maintenance department workers. The implemented tool is based on linking the existing technical documentation of a machine, device or workstation with modernization, repairs and machine parts used for this purpose. This is due to the fact that the machine is described by information contained in a report (presented later in the paper), illustrating the chronology of works at the same time.

The information in the reports is supplemented by authorized maintenance department workers. Optionally, the maintenance services are provided with mobile devices (computers, tablets and smartphones) with a report template.

The task leader and maintenance engineer should approve information synchronized with the knowledge base every single time in order to maintain control over the quality of entered data and their verification, or to reject unnecessary information. Upon approval, the engineer decides whether certain attributes should be made available or not to workers of other department or a co-operating unit treated as a knowledge client.

The application created on the basis of the presented model would act as a search engine automatically cooperating with e-reports. It would be placed in an external cloud computing environment that offers access to different knowledge bases depending on the client (recipient).

To determine boundary conditions, a series of assumptions were made concerning the analyzed real company based in Lubuskie Province:

- industry branch: automotive,
- type: a big production company,
- range: an international corporation with foreign capital,
- with its own maintenance department,
- the number of maintenance workers: 6 engineers, about 16 labourers,
- supplied media: gas, electricity, water, air, closed cycle of coolant.

The maintenance department uses an application for the structuring and dividing the knowledge connecting the access to bases and sources located within the organization (set B0):

B1: Knowledge workers and experts base,
B2: Designs base – machines, devices or production, assembly and logistical processes supporting lines,
B3: Media supplying installations knowledge base,
B4: Reports base (repairs, preventive maintenance, maintenance),
B5: Sources of knowledge,
B6: Spare parts base (specification of parts in the consolidating store),
B7: Machine parts suppliers

At the same time, the company's maintenance department could be authorized to access external databases with a similar data structure that belong to the company's branch. Ideally, it is also important that the model involves cooperation with the local Office of Technical Inspection. The possibility of downloading data on the validity period of technical inspection and operational admittance of a machine, tank, hoist, etc. would be an additional advantage of the proposed model, because it would relieve the worker of continuous updating of records or remembering to schedule upcoming inspections.

The designs base includes both operation and maintenance documentation necessary for proper machine operation as well as extended design documentation containing technical drawings, spare parts lists and manuals. It is also assumed that the base is used for archiving the documentation produced during the upgrade or installation of an additional module or component.

The other type of technical documentation refers to the media supplying installations and includes the documentation of basic equipment, e.g. in the case of a compressed air network such equipment comprises compressors, tanks, driers and filters, as well as designs and technical specifications of the accessories supporting the supply of a given medium, e.g. pipeline type, measuring points, cut-off points.

Elements allowing to organize knowledge are introduced and edited by a maintenance department worker who runs a given project, supervises or approves of maintenance services actions. The key elements here are "designs base" and "installations knowledge base," where every component, i.e., action taken, is described by the attributes from Section P0. The electronic report on the actions of the maintenance services is shown in Figure 3, where the blue sections suggest the possibility of association with a reference or attachment.

P1: Worker

This indicates a person who performs the task and hence enters the data. There is also a function of automatic reading of the worker's ID after logging to the application.

P2: Manufacturer

P3: ID

This indicates a topic (name of a machine read by its rating plate or scanned bar code),

P4: Knowledge source – basic

This indicates an access path to the location of electronic documentation (attachment), if necessary with the hard-copy description of material.

P5: Knowledge sources – created

This indicates an access path to the documentation produced while solving the problem (attachment), i.e., description, modernization, technical documenttation, etc.

P6: Problem

Indicates a specified unit or machine part by its ID, name.

P7: Solution

This indicates a problem-solving action from a closed list of entries such as exchange, installation (e.g. of a module), repair (of existing part), maintenance (e.g. oiling), etc.

P8: Parts ID

If the entry "exchange" occurs in Section P7, the availability of an element for exchange is checked in the consolidating store and, if available, it is fetched in a required number.

P9: Justification

This indicates a justification for the solution described by entries such as burnout, nick, breakage, unscrewing, loosening, wear, protection etc.

P10: Notes

This section is completed at the worker's own discretion. It can contain a hint or reference to the operational instructions (attachment).

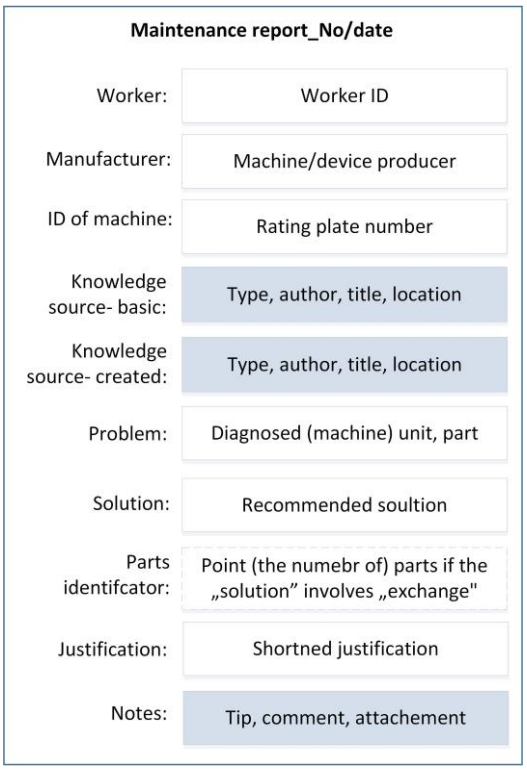

Fig. 3. Electronic report made by maintenance services

The final result of the work of the application is a knowledge search engine displaying the results by type (optionally by hyperlinks) in response to the key entered in the coupled knowledge bases.

The search results include:

- designs denoted under specified entry,
- media supplying installations denoted under specified entry,
- internal workers (so-called experts) – figures in the report,
- sources of knowledge – basic – list of hard-copy and electronic materials available in the company – representation of explicit knowledge sources,
- created sources of knowledge – representation of externalized tacit knowledge in the company (e.g. formulation of instructions for action).

In addition, it is assumed that materials are sorted by knowledge type, i.e., base affiliation, edition and addition order in an alphabetical order.

One example of a completed electronic report refers to the real problem of the enterprise under investigation and to the way it was resolved.

A production line worker reported on the splashing of the cooling water of the CNC machine cutter, which caused discomfort (splashed goggles) and an excessively wet floor around the station, which should be cyclically drained to the grate. Activities taken by the maintenance services included: CAD cover design, material selection, cover design and mounting, and then obtaining the CE certificate from the machine's manufacturer. The modernization was undertaken by the maintenance services following consultation with the manufacturer of a CNC machine. The completed report is presented in Fig. 4.

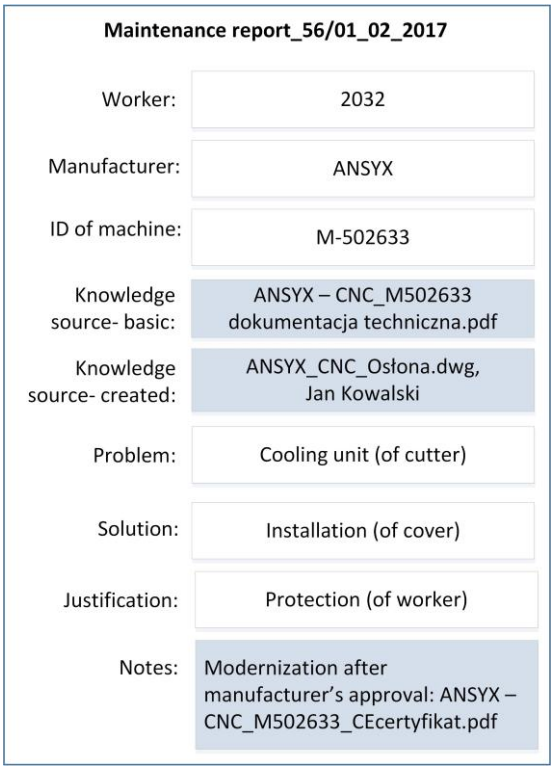

Fig. 4. Example of a filled-in maintenance services e-report

The solution is useful for quick and easy sorting out of key documentation collected in the maintenance department. It helps with analysing the history of activities undertaken by the maintenance services. It can be a source of knowledge for new employees by providing information such as: problem-solution-justification.

5. CONCLUSION

Production companies must implement knowledge management supporting tools that take account of the source of knowledge and its two types (tacit and explicit knowledge). The maintenance department must use methods that support the formalization of knowledge, its acquisition, collection and conscious exchange with co-workers. The systematic collection of information about the operations performed on machines, installations and equipment such as repairs and upgrades, the workers can significantly improve the quality of their work, save time dedicated to filling in and rewriting information from the reports. The accumulated knowledge is also a source of information for new workers, which leads to shorter times of their training and their getting used to new duties and taking actions on their own. The implementation of a computer application based on the proposed model enables quick and easy search of the necessary information by combining the available technical documentation with the history of operations performed by the machine. It also indicates workers who solve problems in a given category, which allows to select the person responsible for actions that must be taken. Archived knowledge can also be useful for verifying expectations when ordering a similar machine or improving simple workstations for the company's own purposes by maintenance department workshops.

REFERENCES

Bernaert, M., & Poels, G. (2011). The Quest for Know-How, Know-Why, Know-What and Know-Who: Using KAOS for Enterprise Modelling. *Advanced Information Systems Engineering Workshops*, *83*, 29–40.

Beyer, K. (2011). Wiedza jako kluczowy zasób w nowej gospodarce. *Studia i prace Wydziału Nauk Ekonomicznych i Zarządzania*, *21*, 7–16.

Dąbrowski, K., & Patalas – Maliszewska, J. (2016). Knowledge Transfer in the International Scientific Project Groups. In: T. A. Grzeszczyk (Ed.), *Challenges of New Technology Applications in Project Management and Evaluation* (pp. 59–73). Warszawa: Wyd. Politechniki Warszawskiej.

Falkenberg, L., Woiceshyn, J., & Karagianis, J. (2017, April 10). Knowledge sourcing: internal or external? Theme: Strategy, Competitiveness and Learning. *Conference: Organizational Learning and Knowledge, Lancaster, UK, Volume: 5th International Conference 2003*. Retrieved from https://www2.warwick.ac.uk/fac/soc/wbs/conf/olkc/archive/olk5/papers/paper16.pdf

Fazlagić, J. (2014). *Innowacyjne zarzadzanie wiedzą*. Warszawa: Wyd. Difin.

Gasik, S. (2011). A Model of Project Knowledge Management. *Project Management Journal*, 42(3), 23–44. doi: 10.1002/pmj.20239

Grabowski, M., & Zając, A. (2009). Dane, informacja, wiedza - próba definicji. *Zeszyty Naukowe, Uniwersytet Ekonomiczny w Krakowie*, *798*, 99–116.

http://cmms.net, Retrieved May 15, 2017.

http://maintpartner.fi/index.php/en/, Retrieved May 15, 2017.

http://www.komtech.pl, Retrieved May 15, 2017.

http://www.utrzymaniemaszyn.pl Retrieved May 15, 2017.

Kosicka, E., & Mazurkiewicz, D. (2015). Support of predictive maintenance processes using mobile devices. In: R. Knosala (Ed.), *Innowacje w zarządzaniu i inżynierii produkcji. T. 2* (pp. 536–543). Opole: Oficyna Wydawnicza Polskiego Towarzystwa Zarządzania Produkcją.

Maier, R. (2002). *Knowledge Management Systems. Information and Communication Technologies for Knowledge Management.* Springer-Verlag Berlin Heidelberg.

Mendryk, I. (2011). Źródła wiedzy organizacyjnej – wyniki badań polskich przedsiębiorstw. *Zeszyty naukowe: Współpraca w łańcuchach dostaw a konkurencyjność przedsiębiorstw i kooperujących sieci*, *32*, 315–331.

Nonaka, I., Ryoko, T., & Konno, N.(2000). SECI, Ba and Leadership: a Unified Model of Dynamic Knowledge Creation. *Long Range Planning, 33*, 5–34.

Padzich, K. (2004). *Zastosowanie technologii informacyjnej (IT) w podnoszeniu efektywności pracy zespołowej. Model organizacji transmutacyjnej* (doctoral dissertation). Wydział Zarządzania UW, Warszawa.

Piotrowska, A. (2012). Wiedza jawna i niejawna jako zasób decyzyjny w zarządzaniu personelem. In A. Grzegorczyk (Ed.), *Procesy decyzyjne w warunkach niepewności* (pp. 79–95). Warszawa, Wyd. Wyższa Szkoła Promocji.

Rybińska, M., & Sekieta, M. (2009). Komputerowe wspomaganie zarządzania utrzymaniem ruchu. *Komputerowo zintegrowane zarządzanie, t.2* (pp. 369–376). Opole: Oficyna Wydawnicza Polskiego Towarzystwa Zarządzania Produkcją.

Skarka, W. (2007). *Metodologia procesu projektowo-konstrukcyjnego opartego na wiedzy*. Gliwice, Wyd. Politechniki Śląskiej.

Śliwa, M., & Patalas-Maliszewska, J. (2015). Model of converting tacit knowledge into explicit knowledge on the example of R&D department of the manufacturing company, including evaluation of knowledge workers' usefulness. *Journal of Theoretical and Applied Computer Science*, *9*(3), 25–34.

Śliwa, M., & Patalas-Maliszewska, J. (2016). A Strategic Knowledge Map for the Research and Development Department in a Manufacturing Company. *Foundations of Management. International Journal*, *8*(1), 151-166. doi: 10.1515/fman-2016-0012

Tabaszewska, E. (2008). *Nowoczesne koncepcje zarządzania – zarządzanie wiedzą.* Wrocław, Wyd. Uniwersytetu Ekonomicznego.

Wąsowicz, M. (2013). Zarządzanie wiedzą w portfelach projektów. In G. Bełz, M. Hopej, & A. Zgrzywa (Eds.), *Wiedza w zarządzaniu współczesną organizacją* (pp. 130–137). Uniwersytet Ekonomiczny we Wrocławiu.