13. Sturzenegger Federico, Werneck L. F., Rogerio: Fiscal Federalism and Procyclical Spending: The Cases of Argentina and Brazil, Fiscal Policy, Stabilization and Growth, Prudence or Abstinence, The World Bank, 2008, p. 121-157
14. Sutherland, D., Price, R., and Joumard, I.:Fiscal Rules for Sub-Central Governments: Design and Impact, OECD Network on Fiscal Relations Across Levels of Government Working Paper N.1., 2006
15. Tornell, A. and Lane P.R.: The Voracity Effect, The American Economic Review, Vol. 89, 1, 1999, p. 22-46,

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IDENTIFICATION OF THE AREAS OF THE PRODUCTION KNOWLEDGE IN STANDARDIZED WORK DOCUMENTATION

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ABSTRACT

This paper concerns the identification of the areas of the production knowledge in standardized work documentation. Production knowledge management and standardized work were briefly described as well as their relations. Standardized work documentation was presented as a production knowledge management tool. The paper demonstrates the results of the research studies that have been conducted by the research team at Faculty of Management at Warsaw University of Technology in 2012 (grant: "Standardized work as a method to codify production knowledge management"). The study concerns the recognition of the areas of the production knowledge in standardized work documentation. The research refers to the possibilities of using tacit knowledge by standardized work documentation.

Key words: standardized work, Lean Manufacturing, knowledge management, production knowledge management, production knowledge

1. INTRODUCTION

Within international organizations, **knowledge management** has been known for several dozen years. However, it is still not used in a wide range of manufacturing companies, because its practical utility is not yet recognized in an operational activity. Manufacturing companies are interested in management concepts which are directly dedicated to the manufacturing area. The solution to that problem could be an implementation of a new concept of **production knowledge management**, which directly refers to manufacturing field.

The other solution, in fact, uses interest in modern **manufacturing management concepts**. Recent years have shown increased interest of international organizations in these concepts, including, but not limited to: Lean Manufacturing, Agile Manufacturing, Theory of Constraints, Kaizen, or Six Sigma. The intense development of the mentioned concepts is driven by the development of supporting methods and tools. Originally adaptable to manufacturing management, these tools may be seen both as production knowledge carriers and production knowledge management methods, and, as such, they constitute the subject matter of this paper in so far as they relate to standardized work.

2. PRODUCTION KNOWLEDGE MANAGEMENT

Production knowledge management is a relatively new area – first definitions of the "production knowledge management" appeared in 2009 [Paszek, 2009]. Production Knowledge Management is the process of acquisition and development, codification, transfer and use of production knowledge, with particular components interacting, whose execution is supported through the use of suitable methods, techniques, and tools (Figure No. 1).

The very concept of knowledge management has been developing since the 1960s. In the 1960s it was noticed for the first time that knowledge gathered through experience can be applied to solve repeatable problems within various organizations [Perechuda, 2005]. The knowledge management concept is detailed in numerous reference publications [Nonaka & Takeuchi, 1995; Probst, 2002; Davenport & Prusak; 2000]. The literature of the subject offers various approaches to knowledge management, e.g.

functional, process, instrumental, and institutional ones. One can also distinguish a Japanese (holistic) and Western (quantitative) perspectives. The **process approach** is the one which should be used for production knowledge management purposes. Essential for manufacturing organizations is all-embracing insight into the execution of processes, starting from a customer, through production, and ending with a supplier. It prevents deepening functional division within organizations (division into separated units that carry out assigned tasks). Therefore, this paper will view production knowledge management as a continuous process (process approach), with particular components interacting (systems approach), whose execution is supported through the use of suitable methods, techniques, and tools (see Figure No. 1).

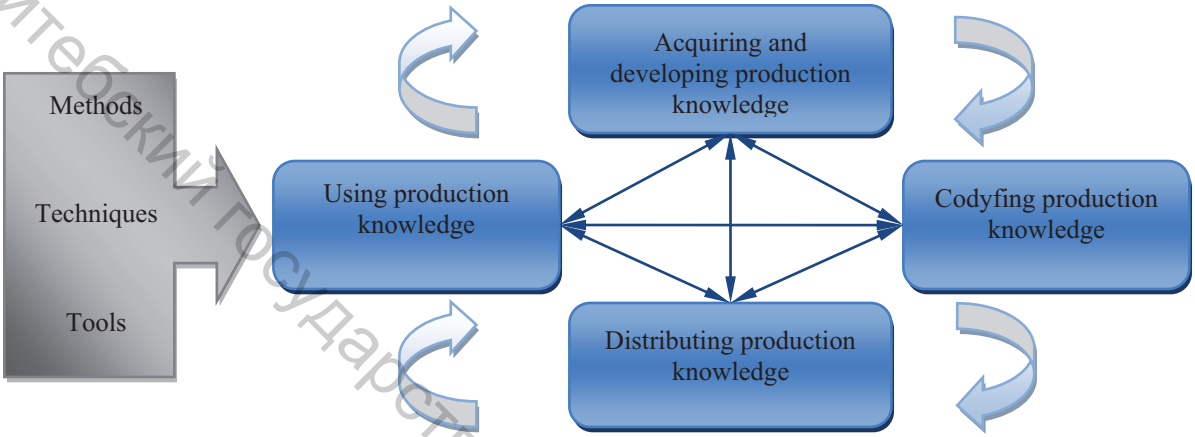

Figure 1 – The Production Knowledge Management Process

Source: self study

Production knowledge means knowledge of products as well as of manufacturing systems, processes, and methods (Figure No. 2). Production knowledge comprises knowledge of production preparation and execution in terms of the best manufacturing practices in production planning, organizing, leading, and controlling [Kąkol, 2010].

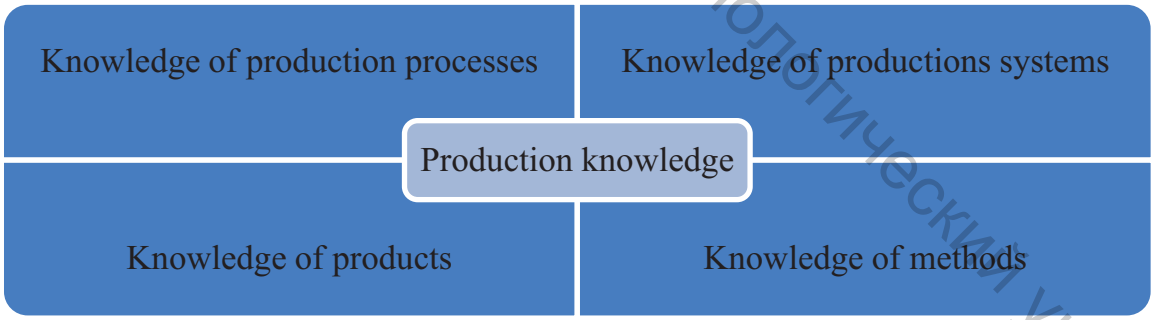

Figure 2 – Production knowledge components

Source: self study

3. RELATIONS OF PRODUCTION KNOWLEDGE MANAGEMENT AND STANDARDIZED WORK

There are many different definitions of **standardized work**. The most popular ones are:

- *"documentation of the agreed (approved) best way of executing a certain task, for the purpose of communication, training, and streamlining processes in a manufacturing unit"* [Feld, 2007],
- *"processes that are safest and easiest for workers, and are the most-effective and productive way for the company to assure quality for the Customer*" [Imai, 2006].

These definitions refer to Lean Manufacturing (LM) and Toyota Production System (TPS) approach. Moreover, they include reference to processes or the best ways of executing a certain task, which presents a practical function of standardized work. Standardized work is a useful method used to execute and improve tasks, operations and processes mainly in manufacturing areas. It includes lots of information

about manufacturing processes and systems, as well as methods. Because of that, it is known as a helpful method of production knowledge management.

There are following **possibilities of using standardized work as a production knowledge management method**:

- gathering knowledge about the best ways and practices of executing a certain task from workers, who by directly performing that operation has the greatest knowledge,
- identification of tacit knowledge, which have highly qualified employees,
- selection knowledge, which is crucial to the manufacturing process needs,
- preservation production knowledge in an organization, by filling documentation.

Standardized work uses a standard forms, which help to identify, gather, select, transfer, update and develop, which results in managing knowledge. These tools can be used to improve production processes and, as were mentioned before, as production knowledge management tools. Standardized work is based on few tools. The authors of "The Toyota Way. Fieldbook. A practical guide for implementing Toyota's 4P", Liker and Meier, emphasize that the basis for the application of standardized work in the company is the implementation of three key documents, which are:

1. Standardized Work Sheet
2. Standardized Work Combination Table
3. Production Capacity Sheet

The Standardized Work Sheet is used as a tool to identify and eliminate wastes in the manufacturing process. At first, this paper appeared in the form of a diagram representing the work area and the flow of the employee. During the years has been updated with information about the timing of operations, transition times between each operation, and even chart the course of each operation in time [Liker & Meier, 2006]. The main purpose of the document is to present the scheme of work performed on the analyzed work station but also identify and eliminate of identified irregularities and disturbances of the process.

Standardized Work Combination Sheet (sequence of operations) shows the time dependence of two or more operations performed at the same time. The document is specially used when two or more operators performed their work at the same time or in case of both manual and machine work at the same time. Standardized Work Combination Sheet is particularly useful in carrying out activities kaizen at the workplace. It allows to identify activities and time movements performed by the operator and then refer them to machine time [Dennis, 2002]. **The main objective** of the Standardized Work Combination Sheet is the improving operator efficiency by minimizing the non-value-added activities (such as transportation, waiting, control). Keep in mind that **the operator, not the machine is the most important corporate resource.** That's why the machine can wait for the execution of the man, but the reverse is not allowed.

Production Capacity Sheet determines the capacity of the machines on the workplace. This document includes cycle time (defined as the time to process the element) as well as planned downtime when the tools are changed and the equipment is setup [Liker & Meier, 2006]. The main objective of this document is to optimize the level of machine's utilization by identifying bottlenecks in the process.

Some publications mentioned also the fourth document - Balance Operators (developed for the production line), but in the further consideration the authors focus on the three documents mentioned above.

4. RESULTS OF THE RESEARCH

4.1 THE SURVEY SAMPLE

The research includes three basic types of standardized work documents, which are recommended to implement in manufacturing companies along to implementation of standardization work and Lean Manufacturing [Liker & Meier, 2006]. There are as follow:

- Standardized Work Sheet,
- Standardized Work Combination Table,
- Production Capacity Sheet.

The research was taken in 2012 and included polish as well as foreign production companies which implement Lean Manufacturing. Also literature studies were included in the research. The summarized results of 37 cases are presented in the paper.

4.2 SYNTHETIC RESULTS OF THE RESEARCH

The result of the research is the classification of information included in standardized work documentation according to the areas of the production knowledge.

Information included in the mentioned documents was divided to two areas:

– general information – contained basic information about organization, document itself and linked documents,
– information about the process – the specific knowledge about detailed execution of analyzed process.

In the recognized areas categories of information were identified. The classification with share of nine recognized categories in the information included in standardized work documentation is presented in Table 1.

Table 1. Categories of the information included in standardized work documentation

No.	Area	Categories	Share
1	General information	Documentation	16%
		Organization	2%
		Related documents	2%
2	Information about the process	Work methods	39%
		Basic characteristics	14%
		Machines / Equipment	11%
		Employees	9%
		Product	5%
		Workstation	2%

Source: self study

The results of analyzed documentation show, that share of **general information** is only 20 %, while 80 % of information is **about the process** (Figure No. 3).

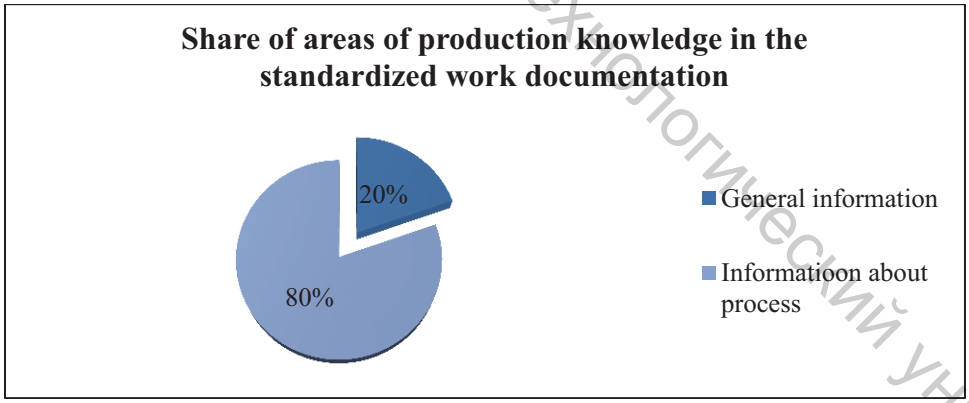

Figure 3 – Share of areas of production knowledge in the standardized work documentation
Source: self study

Significant share of **information about process** is an implication of the idea of standardized work, which is understood as the best working methods used by workers and defined as *"documentation of the agreed (approved) best way of executing a certain task"* [Feld, 2007]. Transfer of detailed information about analyzed process is simplified, because the vast majority of information included in standardized work documentation contains practical directions about the process execution. Information is transmitted in a clear and plain way, which also refers to their validity. Documentation do not contain information, which is unimportant from the process viewpoint. Inclusion of this information would cause lack of transparency in the documents. **General information** enable transfer ones, which leads to identification of process and its basic indicators. In-depth analysis of both production knowledge areas is presented below.

The results of **general information** analyze show, that the share of information about *related documents* and *organization* is the smallest – both categories have 9% ratio of a share. The vast majority of information refers to *documentation* (e.g. name of document, date of document preparation). The results are presented in Figure 4.

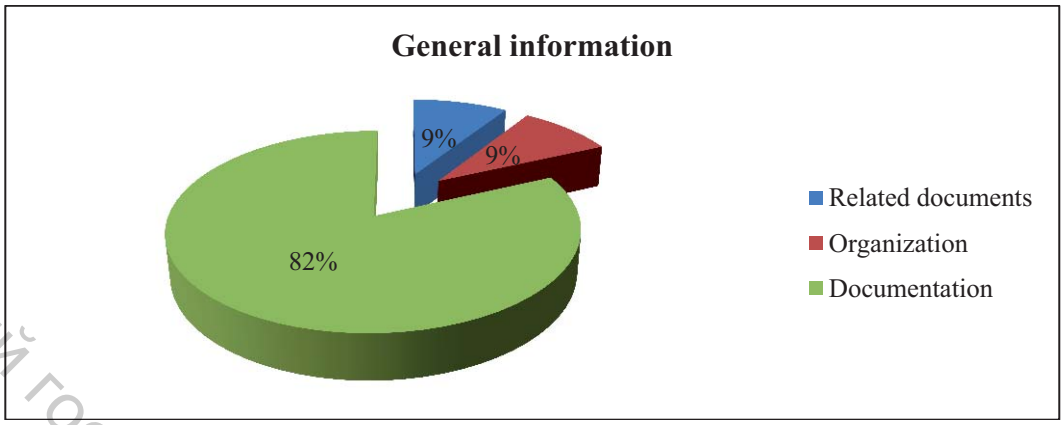

Figure 4 –Share of categories in the general information

Source: self study

The category *documentation* contains information, which is general, but nevertheless it can be very useful from the process viewpoint. For instance *a list of the document changes* is a kind of an archive of all disruptions identified in the process as well as methods of their elimination. This type of knowledge is crucial in case of improvements implementation. With this sort of information, it is possible to check, whether the similar solution was applied in the past and what process implications were. Described type of knowledge is an organization's tacit knowledge. If the implemented modifications of the process are not classified in any way, the one and only knowledge, about work methods used in the past, has got a worker performing a given operation – assuming the previous performance of a particular operation was made by him. The **key elements** included in category *documentation,* with a list of the possibilities of using tacit knowledge contained there, are shown in Table 2.

Table 2 – The key elements of documentation category

No.	Elements of documentation category	Possibilities of using tacit knowledge
1	Person who conduct the research	Person performing the test has got **wide knowledge** about: – the way of performing particular tasks, – disruptions appearing in process flow, – possible causes of the observed disruptions.
2	Date of performed research	It is possible, during analysis of data obtained from the research, to refer this information to the **conditions** in the studied workstation for the duration of the test.
3	Revisions of the document	The list of all implemented changes is a knowledge about: – processes performed in the past, – disruptions eliminated in the past, – the value of the parameters at which the disruptions occurred.
4	Person responsible for compliance standard	Person responsible for standard's abidance/ approval has got **knowledge** about: – occurring standard deviations, – deviations frequency, – possible deviations causes.

Source: self study

The results of analysis of the other identified and the most significant area, which is **information about process,** show that the share of information about *work methods* is the biggest, at the level of 49 %. This type of information is crucial for the needs of organizational production knowledge. The reason

is that they refer to detailed information about performed tasks and the way of their realization, as well as necessary time to execute them. They contain basic information necessary to the process improvement.

For the other factor, *basic characteristics of the process*, the share is about 20 %. Categories which share of information about process does not exceed 10 % are *workstation* (2 %) and *product* (7 %). These ones allow to identify a workstation or a manufactured product as they refer to basic information like the name of a workstation or a product. Share of each category in the information about the process are presented in Figure 5.

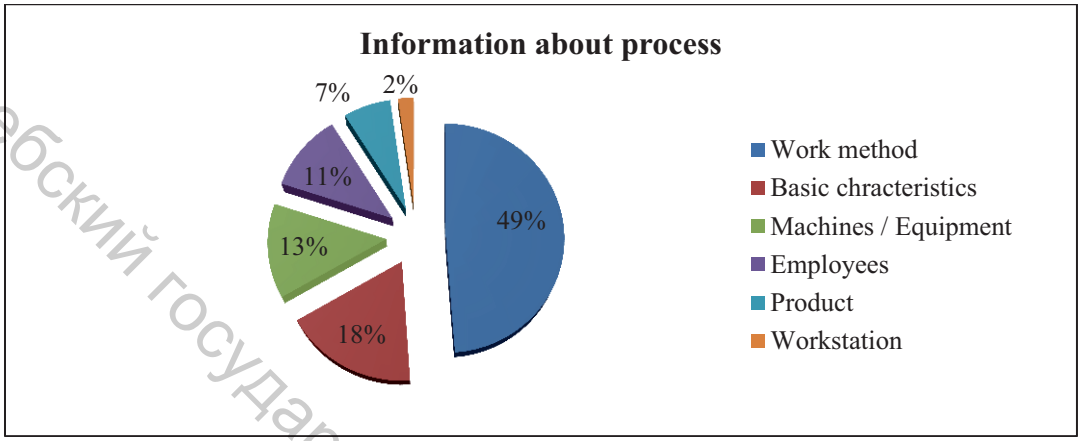

Figure 5 – Share of categories in the information about process

Source: self study

Based on obtained results, in-depth analysis of **work methods category** was done, due to its significant share in information about process areas. Elements of this category contain the greatest amount of particular information about execution of analyzed process, which are difficult to access or even impossible to obtain from other sources (i.e. related documents). Very often the only one carrier of knowledge derived from this information is the employee directly performing particular tasks. The selected **key elements** included in category w*ork methods*, with a list of the possibilities of using tacit knowledge contained there, is shown in Table 3.

Table 3 – The key elements of work methods category

No.	Elements of work methods category	Possibilities of using tacit knowledge
1	Manual Time	Both types of information allow to **balance** the duration of the tasks performed by the worker and machines in a way assuming, that employee will never wait for the end of the machine work. **Waiting is an obvious waste** for organization, which should be eliminated in the first place.
2	Machine Time	
3	Frequency of tasks repetition	The frequency of repetitions of the performing operation influences on the employee **safety level** as well as manufactured **products quality**. Apparently, the more tasks the employee performs, the more proficiency becomes (the positive effect). However, after exceeding the permitted number of repetitions, the repetitive work occurs, which leads to monotony - employee mental strain could cause loss of attention, which in turn increases the possibilities of an accident or incorrect performance of a task (manufacturing a failure product).
4	Workflow diagram	Workflow visualization reveals **possible disturbances of the process flow**, which are difficult to identify in the process of text information analyzing, such as crossing the workers road.
5	VA and NVA tasks' division	Identification of tasks, which from the customer perspective create value, allows to eliminate **unnecessary movements** performed by the employee, which leads to productivity growth.

Source: self study

Conclusion

The results of research show that there are two main areas of production knowledge: **general information** and **information about the process,** where the second one has the significant share, which indicates its importance. To the production process execution and improvement needs, that situation is required. Results confirm that a great deal of categories, which are the most imperative, are the ones connected with **information about the process**. Seeing that production process needs specific information about realization of manufacturing processes, a large share of detailed information about: work methods, basic characteristics of the process, employees, product and workstation, verify the utility of standardized work as a operational and improving tool.

Regarding production knowledge management, the role of standardized work is seen mainly as a method of **identification and codification of tacit knowledge**. The studies show the wide range of using standardized work documentation as a tool which carries information about tacit knowledge. It is worth notice, that manufacturing companies are particularly exposed to the risk of knowledge loss at the individual level. Front line operators are knowledge carriers having vastest knowledge of operations performed in a workplace and of proper operation of machines they work with. This very aspect is pointed out by Massaki Imai, an author of Kaizen, which uses involvement of all people and their knowledge of relevant problems to streamline operations within the organization [Imai, 2006]. Acquisition and codification of knowledge from workers prevent any loss of tacit knowledge by the organization, which is essential for manufacturing organizations since the rebuilding of such knowledge is a long lasting and not always feasible process. To acquire and codify knowledge, suitable methods and tools must be used. As an effect of this research the authors notice standardized work as playing an essential role here, nevertheless in-depth research in that field should be conducted in the future.

Literatury references

1. Davenport T. H., Prusak L., Working knowledge: how organizations manage what they know, Boston, Mass.: Harvard Business School Press, 2000.
2. Dennis P., Lean Production Simplified, New York: Productivity Press, 2002
3. Feld W., Lean Manufacturing. Tools, Techniques and How To Use Them, Boca Raton: The St. Lucie Press, 2007
4. Imai M., Gemba Kaizen: A Commonsense Low-Cost Approach to Management, Warsaw: MT Biznes, 2006
5. Kąkol U., Production knowledge management methods in lean organizations, [in] Computer Integrated Management, OW PTZP: Opole, 2010.
6. Liker J.K., Meier D. „The Toyota Way. Fieldbook", New York: McGraw – Hill, 2006
7. Nonaka I., Takeuchi H., The knowledge-creating company: how Japanese companies create the dynamics of innovation, New York; Oxford: Oxford University Press, 1995
8. Peszek A, The Construction of Knowledge Management System in Manufacturing Enterprises, [in] Enterprise Management No. 2/2009
9. Perechuda K. (ed), Knowledge Management in the Enterprise, Warsaw: PWN, 2005.
10. Probst G., Raub S., Romhardt K., Managing Knowledge: Building Blocks for Success, Krakow: Economics Publishing House, 2002.