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Krzysztof Chojnacki
ZAP Rachunkowość Sp. z o.o.
e-mail:kchojnacki@zapr.pl

Ewa Walaszczyk
Wroclaw University of Economics and Business
e-mail:ewa.walaszczyk@ue.wroc.pl
ORCID: 0000-0002-9119-2727

Aleksandra Markowska
Wroclaw University of Economics and Business
e-mail:aleksandra.markowska@ue.wroc.pl
ORCID: 0000-0002-4550-4224

Marcin Hernes
Wroclaw University of Economics and Business
e-mail:marcin.hernes@ue.wroc.pl
ORCID: 0000-0002-3832-8154

Marcin Fojcik
Western Norway University of Applied Sciences
e-mail: marcin.fojcik@hvl.no
ORCID: 0000-0002-8109-2175

SMART WORK – PRODUCTION TASKS MANAGEMENT SYSTEM

SMART WORK – SYSTEM ZARZĄDZANIA ZADANIAMI PRODUKCYJNYMI

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Abstract: The intensive development of Enterprise Resource Planning (ERP) is caused by huge competition on the production market and thus the need to optimize costs, efficiency and production time. However, the integration problem is still unresolved. One of the main problems is related to monitoring the realisation of production. In many ERP systems, this issue is very weakly performed. Data from different sub-systems are not fully integrated, therefore the process of decision-making is very difficult. The main purpose of the research described in this paper was to develop a prototype of a module for the settlement of production tasks in an integrated ERP-class system. The problems related to the module of the settlement of tasks of production workers, and online presentation of employee performance and machine condition was analysed.

Keywords: Enterprise Resource Planning (ERP), production tasks management, system integration.

Streszczenie: Intensywny rozwój ERP spowodowany jest ogromną konkurencją na rynku produkcyjnym, a co za tym idzie – koniecznością optymalizacji kosztów, wydajności i czasu produkcji. Jednak problem integracji procesów biznesowych jest nadal otwarty. Jedną z głównych trudności jest monitorowanie realizacji produkcji. W wielu systemach ERP problem ten jest uwzględniany w bardzo małym stopniu. Dane z różnych podsystemów nie są w pełni zintegrowane, dlatego podejmowanie decyzji jest bardzo trudne. Głównym celem badań opisanych w artykule jest opracowanie prototypu modułu do rozliczania zadań produkcyjnych w zintegrowanym systemie klasy ERP. Przeanalizowano problem związany z modułem rozliczania zadań pracowników produkcyjnych oraz prezentacją *online* wydajności pracowników i stanu maszyn.

Słowa kluczowe: systemy klasy ERP, zarządzanie zadaniami produkcyjnymi, integracja systemów.

1. Introduction

The intensive development of ERP is caused by huge competition on the production market and thus the need to optimize costs, efficiency and production time. However, the integration problem is still unresolved. One of the main issues is related to monitoring the realisation of production (Adamczak, 2016). In many ERP systems, this is very weakly performed. Data from different sub-systems are not fully integrated, therefore decision-making is very difficult (Hernes & Bytniewski, 2017).

The main purpose of the research described in this paper was to develop a prototype of a module for the settlement of production tasks in an integrated ERP-class system. The problems related to the module of the settlement of the tasks of production workers, and the online presentation of employee performance and machine condition was analysed. As yet, the production market does not have standardised ERP solutions, and machine manufacturers do not facilitate the production management tasks by creating their own systems integrated with the machines. With extensive machine parks, comprehensive solutions are necessary, i.e. one system supported by AI, into which each new device can be introduced. This article attempts to present such a solution with server integration. The research is based on system modelling methodology. The project's assumption was indicated in the first step. Next, the module development was performed. The discussion of the results and conclusions was presented in the final step. The article presents the results of the application research, therefore it has an industrial character.

2. Background

Traditionally, a task is considered a commitment with a specific time and location and may involve other participants or resources (Refanidis & Alexiadis, 2011). Each task may be divided and assigned in parts to several participants or devices, and generate large amounts of data (De, Golubkov, Klimentov, Potekhin, & Vaniachine 2014; Kłos, 2016). Nowadays, when basically every device is equipped with sensors and software and is interconnected with other devices and their users through the Internet of Things, the problem is even bigger (IoT) (Malik & Kim, 2021; Zanella et al., 2022). Today this means creating an efficient task management system that would gather all data connected to the task, and enable planning task realisation and accounting for the realised tasks, especially in production.

De et al. (2014) described the design of software that translated the company's general production tasks into workflows in over a hundred company sites all over the world. When the number of production tasks exceeds one million, and each task contains hundreds or thousands of jobs, the managing system must be adequately efficient. The authors presented the requirements, design parameters, basics of the object model and concrete solutions used in building the system and its components.

The increasing volume of new products regularly entering the market, forces manufacturers to increase efficiency in the planning and managing of production systems. Mylnikov presented the problem of production scheduling and production volume planning in relation to the projects' flow and characteristics (Mylnikov, 2021).

Gao et al. (2021) used machine learning to improve a task management system in designing high-performance materials as it requires high-throughput calculations and simulations. Machine learning was used to densify the output data, reducing the amount of calculation and accelerating high throughput calculations.

The use of an artificial neural network to predict machine utilisation in an assembly line was presented by Malik & Kim (2021). The mechanism was to help in improving the product quality and customer satisfaction based on learnings from past trends. The use of the system aimed to increase the efficiency of the resources' operation. The task management mechanism was evaluated based on multiple scenario simulations and performance analysis. The comparison analysis showed that the proposed task management system significantly improved the machine utilisation rate.

Tasks management systems are used not only in production. There are many different tasks to manage in everyday life, which need an application to schedule them in time and space. As reported by Refanidis & Alexiadis (2011), many tools with a variety of functions might be used as a personal task management system.

The recent development of the area of smart home resulted in the need to manage home devices and their optimal interaction. The smart home management system prioritises devices selected by the user, recommends optimal settings and the use of other devices associated with the selected device. The system is expected to provide users with increased convenience and more efficient task management (Kerang, Lee, & Jung, 2017).

Tasks management systems may also be used in administration. Network administration requires such a system to provide help in decision-making and the monitoring of task realisation (Silveira et al., 2022). In the administration of services, e.g. healthcare, a tasks management system helps assign staff tasks, optimize workflow, and allocate resources (Pachamanova, Glover, Li, Docktor, & Gujral, 2021).

3. Main project assumptions

The industrial research concerned the software platform, and the study of possible IT technology solutions. The target stage was to develop a prototype application for configuring and accounting production tasks. The developed prototypes were then tested and launched.

The research and development problems concerned the module for accounting for the tasks of production employees and the online presentation of employee performance, as well as the state of the machines. It was assumed that the module would be based on production workers performing tasks planned in the ERP on machines resulting from the main production plan.

The production plan is a list of production orders with planned start and end dates. The order contains, among other things, information on the number of pieces that should be made for a given product. Each product has a predefined composition and technological processes of the product and sub-assemblies (parts).

The system performs the supervision over machines and operations by realising the following assumptions:

1. Each product has a process in several versions (several processes).
2. Process – printed on the document circulation card (list of operations with codes). In the process definition the authors allowed for the operation preparation time and unit production time per piece.
3. The window of registration of the execution of operations on the production shows the start time (actual).
4. After performing x pieces of an operation, the worker registers stop and gives the quantity performed.
5. Online performance evaluation shown on the website (on TV or PC) allows the supervisor to intervene immediately. The colour and percentage of performance shows the online performance record of the worker. For a given PC/

TV (IP) in the production department, the machine numbers are defined to show on this IP address.

6. The machine status is the result of reporting machine failures, tools and other definable causes of downtime in the operation record window.

7. The machine status (as well as the quantity performed) is also read directly from the machines by the ZOPCConnector module from the Smart Work2B package.

8. The OEE chart window shows an online chart of OEE parameters for selected machines.

9. The window shows the status of the machines and also the failures downtime, failure time, return to work.

10. The Production Progress window shows how much time is left to perform an operation.

11. The Machine Performance window shows the online performance of the machines.

12. The Machines/Leaders window shows the online performance of the machines assigned to the machine's leader.

13. Machine schedule (available capacity).

14. Plan, execute and settle repair costs for machines.

15. Preparation and dynamic task queuing for workstation and machine.

16. There are several windows, reports and tables showing employee performance for any period for selected orders, products, and details.

17. List of ERP system windows for the implementation and supervision of job cards.

4. Module's development

As part of the research, prototypes of the following sub-modules were developed:

1. RCP application to register employee attendance – cooperating with ERP. The app is based on Maria_DB and developed in C# language as a stand-alone Windows application. Its purpose is to register employees using RFID codes or barcodes. The app is configurable and works by caching the collected data. Data storage in a fixed location of the database occurs after detecting the possibility of sending data over the network

2. The registration of operation execution portal. It provides the ability to record the execution of a technological operation and the post-measurement defined for that operation. The operation and the 2D code containing a link to the portal is generated in ERP. On the basis of a single scan the authors gained access to production operations and quality control parameters (measurements recorded during operation registration). The registration of task execution and measurements is carried by scanning a 2D code from the label of the process flow sheet (Figure 1).

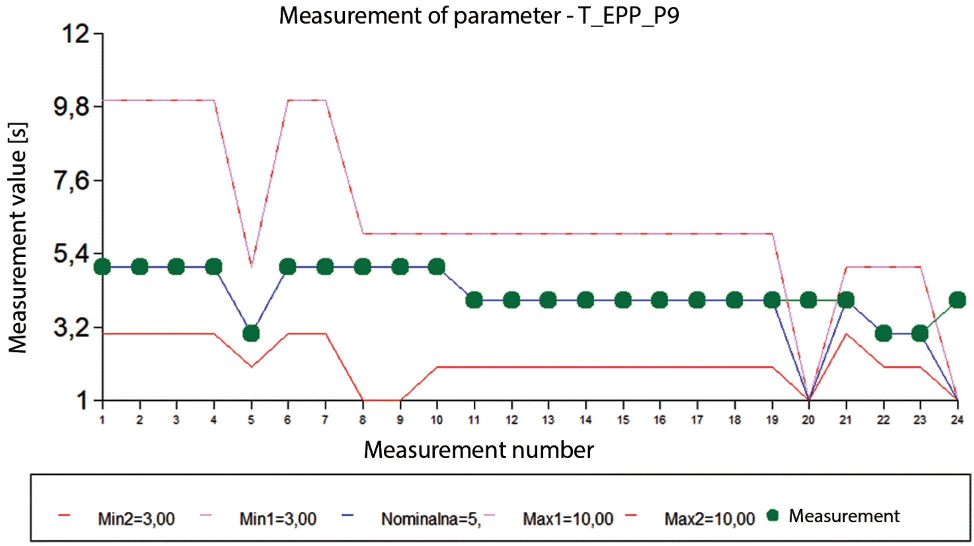

Fig. 1. An example of the measures of parameters

Source: self elaboration (screenshot).

Web pages adapt to screen size and can work on smart phones as well as small PCs and tablets, but the amount of information required cannot be accommodated on small screens; information on a small screen requires scrolling and remains unclear. Nowadays the techniques of programming for user interface (GUI) in browsers are highly developed, and there are many tools supporting this technology. The global popularity of the GUI browser (thin client) is so great that there are companies that provide tools to automate the transfer of GUI to the browser from regular windowed applications; this is why in further actions the study focused on creating applications in 3-layer technology. For workers in the production process, a larger range of information (including attachment files) is needed, which is difficult to fit on a tiny screen. Operating a smartphone during production work is cumbersome.

3. ZOPCConnector. It is a service type app and is used to download data from various sources. The test app ZOPCConnector, which is used to download data from the machines to the ERP database, was accepted positively. It allows using the data in an app supervising the working time of machines and controlling their failures. The operation of the app is based on configurable parameters and settings contained in the designated dictionaries of the ERP system:

- Server OPC_DA,
- Server OPC_UA,
- Server OPC_SQL.

The software consists of two components:

- service ZOPCConnectorSmartWork,
- a window app for configuring and viewing data acquired during operation.

The class diagram used in building the ZOPCConnector app is presented in Figure 2.

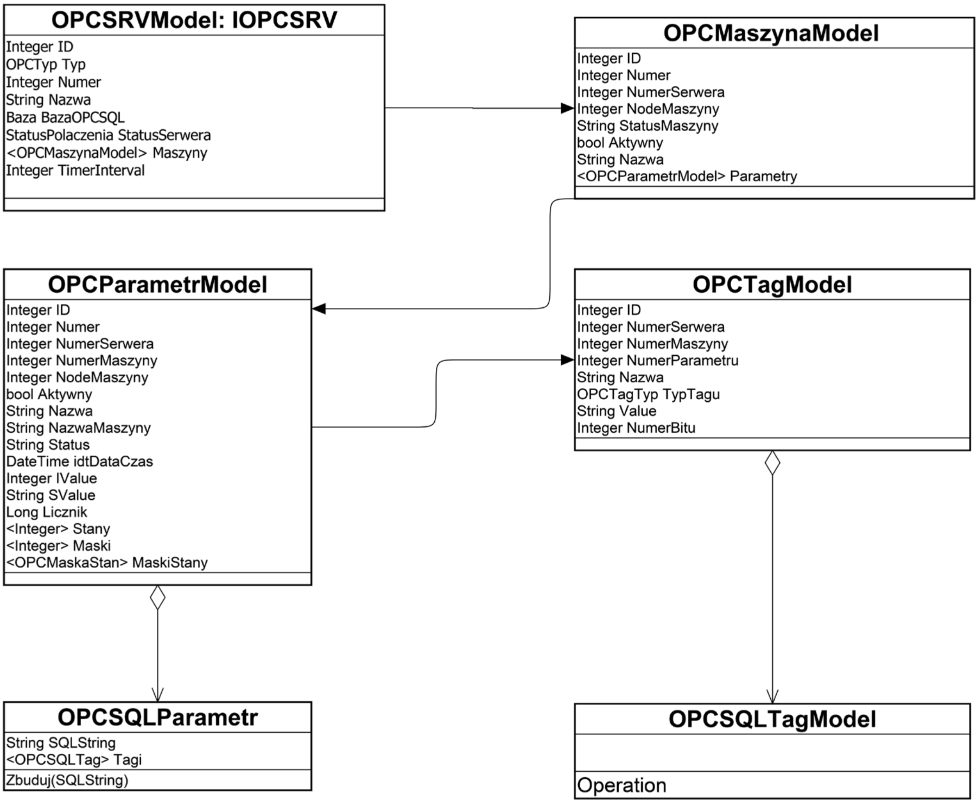

Fig. 2. The class diagram used in building the ZOPCConnector

Source: self elaboration.

In order to run the ZOPCConnector, a connection to the ERP and OPC Servers must be configured. It is most significant to provide online status information directly where it is needed in the ERP.

5. Discussion

The main advantage of the developed approach is online delivery of information on machine health directly to where it is needed in ERP, shown on the window of the Windows app at the supervisor's and manager's Smart TV in the production department. In addition, the ERP software reacts to the status of the machines with configurable alerts and notifies the appropriate personnel from production supervision and maintenance. In this solution, the authors included online information about the performance of an employee for the work started with a given detail on the machine. The purpose of using the information obtained from the machines is to increase the efficiency of industrial plants by the online monitoring of the condition of the machines, increasing the quality of products, optimising the use of machines and human resources, and reducing the consumption of energy and materials. To make this possible, it is necessary to precisely determine the production capacity, analyse the technical condition of the machines, material and the finished product flow, then select the data that have a direct impact on the efficiency, and implement solutions to improve it, observe the results and introduce further improvements. The problem is that most machine manufacturers have their own solutions, and have already tried to provide information on how to retrieve data from machine controls in the form of either their own database documentation, or a list of tags and parameters for a particular machine. The data lists and how they were retrieved had to be well documented. Each manufacturer had their own solutions, each of which required different software for data acquisition. In a standard enterprise after several years of operation, there are dozens of different machines and many controllers in these machines. An attempt to systematise the way of providing data for external applications was made by machine control manufacturers using OPC-DA and OPC-UA servers.

The evaluation of worker, workload, and machine performance is one of the primary functions of the system in manufacturing. The prototype of the developed module provides a comparison of the machining time included in the technology to the actual machine execution time.

6. Conclusions

Within empirical research, the authors managed to build a prototype of a module that configures and accounts for production tasks. The prototype has universal hallmarks, and can be used in several types of machines, configurations and types. It also offers the possibility to adjust servers and define a broad spectrum of data from the machine to the main ERP systems. The production management system is a necessity nowadays, since there are many possible data to follow. The data are used to optimise the production on many levels (such as savings, quality, and efficiency). The developed solution allows for improving the integration of ERP systems. The main limitation of the research was the lack of the prediction of a production tasks schedule, therefore future research can be related to developing sub-module based on machine learning for the prediction the production tasks schedule.

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