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THE IMPACT OF IMPLEMENTING A PROPRIETARY IT SOLUTION ON THE EFFECTIVENESS OF THE EMPLOYEE EVALUATION PROCESS IN AN INDUSTRIAL ENTERPRISE

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Purpose: The aim of this study was to assess the possibilities of improving the production management process in a manufacturing enterprise by implementing a dedicated IT solution aimed at assessing employee performance.
Design/methodology/approach: The study used methods of analyzing literature sources and quantitative research using observations of the duration of the selected employee assessment process before and after the implemented improvements.
Findings: As a result of the research results, the results with correct parameters were obtained in the result of the author's application in the Python programming language.
Social implications: The analysis carried out may show that the process of implementing new solutions concerns not only the production process, but also areas related to human resources management.
Originality/value: Due to the growing Industry 4.0, there is a need for methods that not only influence the development of the system, but also quantitatively assess their impact on operational performance – especially in the field of monitoring work in a time-based environment.
Keywords: Industry 4.0, enterprise management, programming languages.
Category of the paper: Case study.

1. Introduction

Through the centuries, man has formed new skills and methods for managing, evaluating the effectiveness and verifying the quality of the fruits of his own or others' labor. Up to a certain point in history, this was done on pieces of paper. However, in the age of expanding industry, mankind has begun and continues to adapt, miniaturize and standardize the

transmission of information. The goal is clear - to produce more products and satisfy more customers, while minimizing time and cost consumption (Sweigart, 2019).

In order to achieve the most essential business concepts, man evolved in an industrial environment, creating successive versions of the idea of industry, starting with Industry 1.0, where mechanization through the power of water and steam assisted man, relieving his physical burden while also helping to increase productivity. This was followed by Industry 2.0, whose domain was the electrification of machines, moving later to Industry 3.0, where computers allowed the automation of all production processes. Today, as humanity, we are developing knowledge within the solutions of Industry 4.0. Its principles have been very clearly and lucidly defined. An enterprise that can be honestly pinned a badge with this term is characterized by the following terms: the Internet, robotization and artificial intelligence (Fricke, Schoeneberger, 2015). The development of this concept absolutely includes deeper concepts like big data, simulation, systems integration or Internet of things (Cecelja, 2002; Majstorovic et al., 2020).

Programming is inherent and essential to the success of most of the previously mentioned concepts. The existence of a number of programming languages allows for some flexibility and should be treated as tools, the appropriate selection of which is crucial for solving problems (McKinney, 2022; dos Santos et al., 2018).

Despite the growing interest in the use of information technology and solutions based on the concept of Industry 4.0 in production management, the literature still lacks empirical analyses of the use of dedicated computer applications that integrate with IoT systems in the context of automating and improving processes for evaluating employee performance (Zywiolek, 2021; Serror, 2020).

Existing research focuses mainly on technological aspects, such as data acquisition from equipment or the overall efficiency of production systems, often overlooking practical applications in the area of human resource management at the operational level.

Thus, there is an emerging need for research that not only presents proprietary approaches to automating selected production processes, but also enables quantitative assessment of the impact of these solutions on operational efficiency - especially in terms of evaluating and monitoring personnel performance over time. This aligns with broader findings from recent research on Industry 4.0 and 5.0 transformations, where optimization through advanced technologies, including simulation, digital twins, and mathematical programming, enhances production control and integrates human-centric design principles (Guerrero et al., 2025).

The purpose of this study was to assess the possibility of improving the production management process in a manufacturing company by implementing a dedicated IT solution. The subject of the analysis was the effectiveness of implementing a computer application designed for a specific manufacturing process, with integration with Internet of Things (IoT) technology for data acquisition from manufacturing equipment. The study aimed to determine the potential of data processing to automate the process of evaluating employee performance

on a monthly basis. The study presented a proprietary solution developed in Python, working with Microsoft Excel software and the company's existing IT infrastructure, to automate the process of production data extraction and analysis. The empirical part includes a comparative analysis of the results obtained before and after the implementation of the described system in the context of the efficiency of the evaluation process.

2. Computer software in production management

Data is a permanent fixture in today's industry. It ensures the achievement of a satisfactory degree of management, the efficiency of production and decision-making processes, and provides the foundation for the competitiveness of the company in fields such as marketing and development strategies (Guerrero, 2019). The use of software makes it possible to automate repetitive and monotonous activities performed as part of the daily work of personnel in organizations. It also makes it possible to effectively reduce time-consuming calculations that employees, managing production processes or product quality, are obliged to do. The use of computer software is guaranteed to measurably increase the efficiency of processes, contributing to the identification of problems. Such conditions, create room for further waste elimination or continuous optimization (Scholten, 2009). Studies have highlighted that sustainable optimization approaches in production control, supported by tools such as Python, MATLAB, or simulation platforms, can measurably improve system efficiency and resilience in line with Industry 5.0 objectives (Guerrero, et al., 2025). By using or implementing software to support production processes, it becomes possible to achieve effects such as (Syreyshchikova, 2020):

- Reduce downtime.
- Reducing waste and defective products.
- Reducing lead times.

The most common management programs in companies include ERP systems, whose capabilities are customized according to the customer's requirements. Examples of such programs are primarily SAP, QAD, Oracle ERP or Comarch ERP and Symphony, which are present on the Polish market. These programs are very complex and require appropriate financial backing on the part of the company. Implementation of such software, in an environment unprepared in terms of organization and processes, can cause significant irregularities, and as a result, the improvements in selected parameters intended by the authors will not be achieved (Williams, 2008; Al-Amin, 2023). Spreadsheets, entrenched within the widespread availability of Microsoft services and commercial solutions, and more specifically Excel software, are used much more frequently and effectively to control processes, make decisions and record events. The main advantage is the open system, which allows users to

acquire knowledge and customize the sheets to meet the needs of both the process and the entire enterprise with functions that facilitate calculations, charting, data analysis. And if needed, users are able to expand the program's capabilities by using add-ons and programming their own functions or macros using Microsoft's proprietary VBA language (Fricke, Schoeneberger, 2015; Jelen, Syrstad, 2019).

Developing in-house computer software in manufacturing companies is, even in the era of Industry 4.0, a challenge for executives. Companies strongly rely on providing an existing solution or a ready-made environment to then customize their organization under the purchased software. This comes at a cost due to the lack of appropriate staff skills, but as time progresses, an increasing number of software developers are betting on open source policies. This involves allowing users to extend the functionality of the software to suit their own needs. There are also applications that allow users to add features by using programming languages such as Python or C++ or the syntax of a given software's environment. An example is the aforementioned Excel, which allows the creation of macros and functions in VBA (visual basic for applications) language, greatly expanding the spectrum of Excel spreadsheet capabilities (Winston, 2019; Alexander, Walkenbach, 2018).

In recent years, due to the increased demand for processing and analyzing large amounts of data, attempts to synergize programming elements into the daily processes occurring in a company have gained popularity. Industry 3.0 and 4.0 devices, with their capabilities derived from the number of sensors and recorders, acquire data in real time or on call. However, raw data, unconnected by any algorithms and processing logic, such as for the purpose of generating KPIs, is useless. The result of these obstacles is a palpable increase in interest in solutions that use the computational abilities of computers to a much greater extent than Excel sheets would be able to do. The ideal combination is a symbiosis of these two environments, as software written in Python is able to quickly process and filter data (Johansson, 2015; Khan, 2023). But still, for the sake of readability, the data should figure in such a form that it can be presented in a form that is friendly to every employee of the company. The solution is to create software whose main foundation remains in utilization of Excel files (Zumstein, 2021).

The selection of software is very often dictated by factors such as the size of the company, the budget, the qualifications of the workforce or the goals of the organization (Motiwalla, Thompson, 2011). It is important to tailor the selected software to meet any or all of the above criteria. Also, it is necessary to plan and take into account the potential growth of the enterprise over the years (Morawiec, Soltysik-Piorunkiewicz, 2023). When choosing software, it is also necessary to consider its positive value in the context of existing or alternative ideas (Bytniewski, 2020). For example, Table 1 shows a comparison of some criteria and differences in this aspect, between ERP and Microsoft Excel systems.

Table 1.
Differences between Excel and ERP systems (Wallace, Kremzar, 2001)

	Excel	ERP
Process automation	Automation is a complex process that depends on the skills of the user and the structure of the data, with which the company works.	Process automation is seamless because the ERP system bundles all aspects of the company into one environment.
Knowledge acquisition / Training / Affordability	Extensive system, but accessible to users who have no experience because there is a large body of knowledge on the Internet.	High threshold for entry, often only possible thanks to training or working with a particular software company.
Security	Little to none data security	The data is most often encrypted and can only be read by the program.

During the implementation of software in the enterprise, there may be problems arising from a smooth transition from one software to a new one with maintenance, employee training or process continuity, (Motiwalla, Thompson, 2011; Bytniewski, 2020).

3. Methods

The production facility reviewed is engaged in the production of automotive vehicle assembly components in the automotive industry. Staffing is 12 office workers and 60 production workers. Due to high demands from contractors, the analyzed production plant has been obliged to implement internal procedures for the monthly evaluation of the productivity and quality of the work of its employees. Data, downloaded via a database access panel from a computer connected to the local IoT network, is used for this process. In order to evaluate operator performance, the person performing the analysis is required to download files from the database in Excel format. Then, he or she manually sets the appropriate filters and operations under the specified criteria in the downloaded files in MS Excel, in order to develop a report for each employee individually. Due to the fact that the described process is characterized by a high level of complexity, the proposed solution involved writing an application in Python, using existing libraries, which are ready-made operational functions created for this programming language.

In the study, a three-stage methodology was carried out to identify the current state in terms of the efficiency of the work carried out, implement the improvement solution and analyze the results obtained:

Stage I - Diagnosis of the existing state

In the first stage, a detailed analysis of the employee performance appraisal process in place to date was conducted. The focus was on identifying time-intensive activities and repetitive manual operations. The time-consuming nature of the process and the complexity of the necessary steps involved in data preparation, verification and analysis were also assessed.

Stage II - Implementation of the IT solution

Based on the results of the analysis, a dedicated solution was designed and implemented in the form of a computer application, written in the Python programming language. The proposed solution, was designed to increase the efficiency of ongoing work related to the evaluation of employees by simplifying the activities required to be performed by the person in charge.

Stage III - Comparative analysis and statistical inference

The last stage involved a comparative analysis of the efficiency of the process before and after the implementation of the proposed solution. Particular attention was paid to the average execution time of the performance evaluation operations, as well as the number of steps required to obtain the final result. In order to assess whether the observed difference in task completion time was statistically significant, a Student's t-test was used for two independent samples. The purpose of the statistical analysis was to determine whether the implementation of computer software contributed significantly to improving the efficiency of the employee evaluation process.

$$t = \frac{x_1 - x_2}{\sqrt{\frac{(x_1 - 1)sd_1^2 + (n_2 - 1)sd_2^2}{n_1 + n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \tag{1}$$

where:

x_1, x_2 – average in the first and second sample,

n_1, n_2 – abundance in the first and second sample,

sd_1^2, sd_2^2 – variances in the first and second sample.

Hypotheses:

$$H_0 : \mu_1 = \mu_2, \qquad H_1 : \mu_1 \neq \mu_2, \tag{2}$$

where:

$\mu 1, \mu 2$ – averages of the studied variable in the first and second populations.

The assumed significance level α for each of the analyses performed was 0.05.

4. Results and discussion

As part of the activities carried out to determine the duration of operations carried out as part of the employee evaluation process, according to the adopted methodology, task execution times were measured in the work environment before the optimization changes were implemented. The sample was conducted on 50 independent observations of the execution of a full evaluation cycle for one employee. The average time for an employee to complete an activity was 310 seconds.

As a result of the observations, it was also found that in order to carry out 50 independent evaluations of employees in the existing version of the procedure, the person in charge of the task had to perform a total of 304 operational steps in Microsoft Excel. The number of operations was determined by analyzing each execution of the process, with repetitive activities recorded as separate operational units. The high number of manual operations indicates that the process is significantly time-consuming and prone to human error, which warranted optimization measures.

The proposed solution involved writing an application in Python, using ready-made libraries, which are functions, created for ease of programming. The software loads the report files given by the user, then, the appropriate parameters are asked, with the help of which the algorithm shown in Figure 1 extracts the data and consolidates the selected information in individual files for each employee in Excel format.

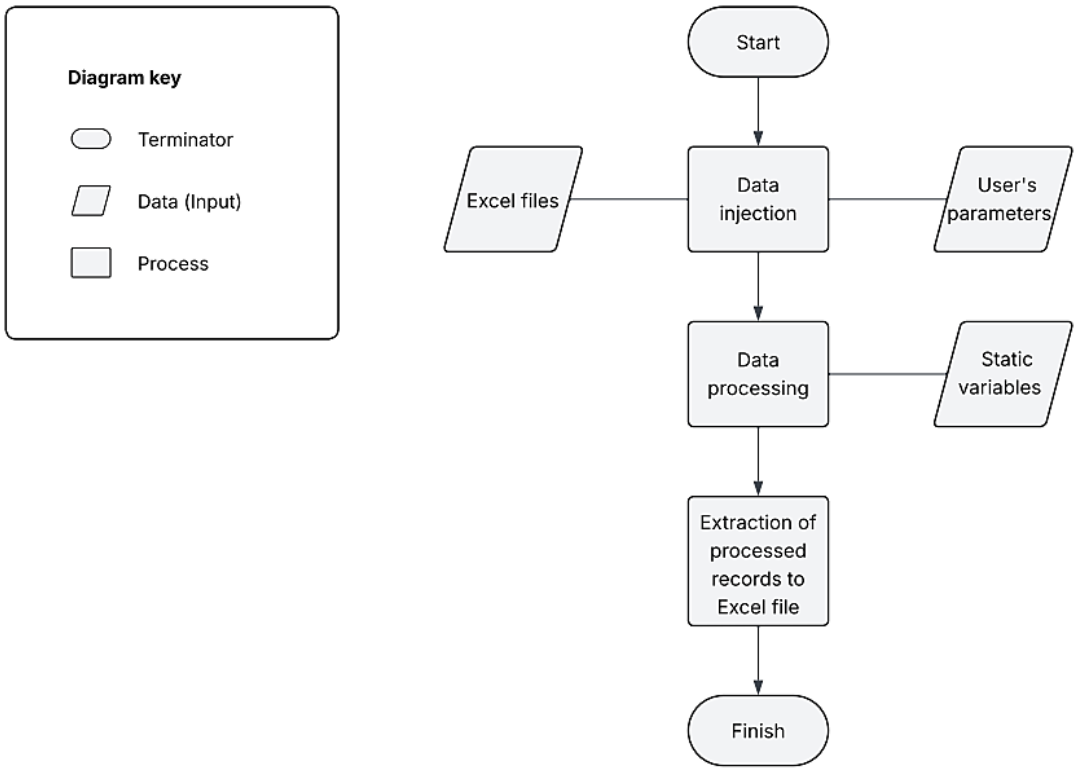

Figure 1. Diagram of how the computer application works.

As part of the research and implementation work carried out, a Python language application was developed and implemented, using available libraries containing ready-made functions designed for data processing and Excel file handling (such as pandas, openpyxl or os). The implemented software allowed automatic loading of reports provided by the user, and then - after specifying the appropriate input parameters - performed data extraction according to the adopted logic of operation. The process of operation of the application is shown schematically in Figure 1.

The extracted data was then grouped by employee assignment, and finally saved as individual Excel files, containing only the information that applied to a particular employee. This resulted not only in greater transparency, but also in significant automation and a reduction in the time required to complete the employee evaluation process.

In the last stage, an observation was carried out to determine the duration of the employee evaluation process after the implementation of the task automation application. The measurement was made on an analogous sample of 50 independent implementations of the process to ensure comparability of results. As a result of the analysis, it was found that the average execution time for a single evaluation was reduced to 162 seconds, a significant improvement in efficiency over the original version of the procedure (310 seconds). The study found that there were significant differences in the duration of the evaluation process compared to the state before the implementation of improvements ($p > a$), Figure 2.

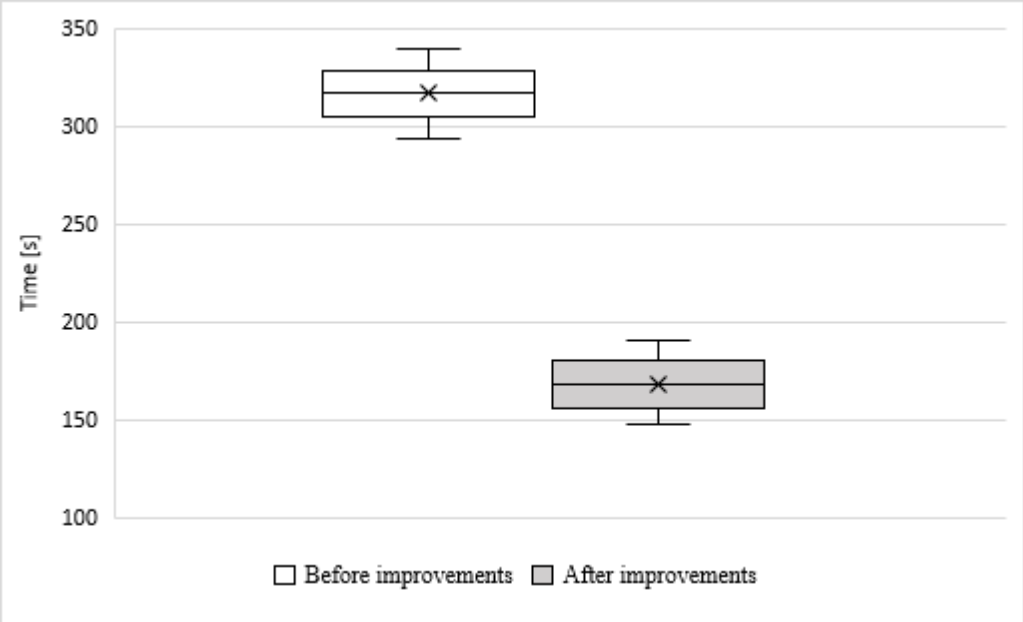

Figure 2. The time intensity of the process before and after the implementation of the improvement.

Next, an observation was made on the number of activities required to be carried out by the person conducting the personnel evaluation process, before and after the improvements, Figure 3.

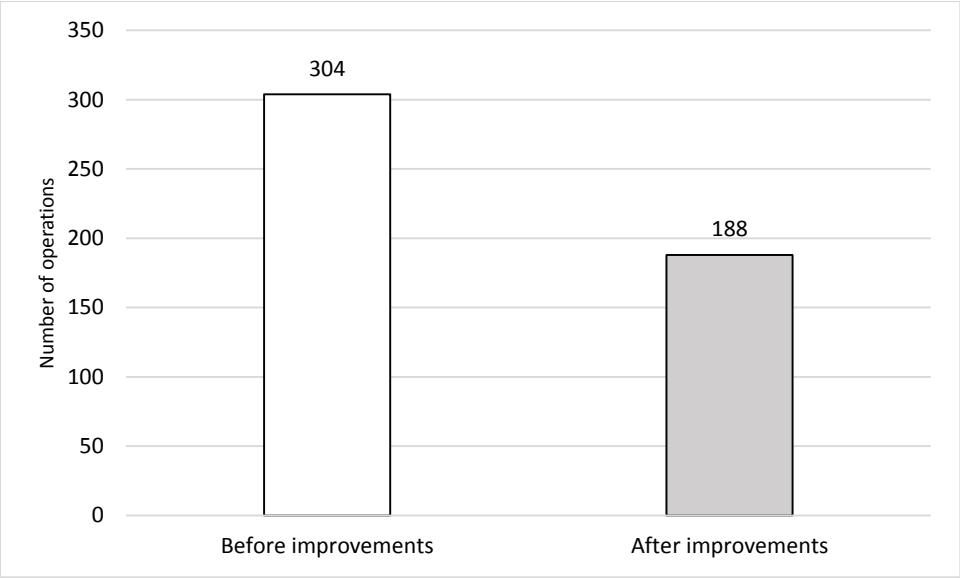

Figure 3. The number of improvements before and after implementation of the enhancement.

The observations showed a reduction in the number of activities required for the evaluation process after the implementation of the designed enhancement application. The analysis conducted on a group of 50 observations showed that the number of required activities was reduced from 304 to 188, which corresponds to a reduction of about 38.2%.

It should be noted, however, that the data used in this analysis originate from a single manufacturing facility, classifying this study as a case study. While this methodology allows for an in-depth examination of the specific context and characteristics of the enterprise in question, it does not permit the formulation of generalized conclusions or a definitive rule confirming the positive impact of implementing dedicated applications on the analyzed processes.

Nevertheless, the literature offers numerous examples demonstrating the beneficial effects of implementing proprietary solutions in the form of customized digital tools on various areas of industrial activity, both in terms of optimizing production processes and improving quality assessment indicators (Dymora, Paszkiewicz, 2020; Zhang, Chen, 2024; Wahjudi et al., 2024). These observations are consistent with the results obtained in the present case study, further supporting the validity of the conclusions drawn.

Summary

Based on the analysis of a case study conducted at a manufacturing company, results were obtained indicating significant opportunities to optimize the employee performance appraisal process through the use of a dedicated IT solution. The study included the identification of limitations present in the evaluation procedure used so far, which was characterized by

significant time-consumption and a large share of manual operations performed in a Microsoft Excel spreadsheet environment.

An analysis of 50 independent implementations of the assessment process showed that the average time to perform a single assessment was 310 seconds, and the total number of operational activities reached 304. In response to the identified problems, an application created in Python language was developed and implemented, using popular libraries for data processing and automation of work with Excel files.

The implemented solution made it possible to automatically load, process and organize production data, as well as record it in the form of individual reports for each employee. A benchmarking analysis carried out after the implementation of the application - also on a sample of 50 cases - showed a significant improvement in efficiency: the average evaluation time was reduced to 162 seconds (by 47.7%), and the number of operations required to perform the evaluation was reduced to 188 (a decrease of 38.2%). These results confirm the effectiveness of the developed tool in supporting HR processes, reducing the risk of errors and increasing the level of automation and data transparency.

The obtained research results, although derived from a single manufacturing facility and based on a limited sample, indicate a tangible potential for improving the analyzed process as a result of implementing a dedicated application developed in a programming language tailored to the specific needs of the enterprise. Notably, the observed improvements concerned not only areas directly related to production or quality control but also other aspects of the plant's operations. This confirms the broad applicability of supportive solutions, regardless of the specific area of the company's activities.

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