Low-code platform for automating business processes in manufacturing

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Abstract: The low-code platform enables quick generation and delivery of business applications with minimum effort to write in a coding language and requires the least possible effort for the installation and configuration of environments, and training and implementation. With a rapidly growing number of companies, the use of low-code solutions can be a significant step forward in creating essential business applications. This paper describes the use of the Aurea BPM low-code platform for automating business processes in manufacturing.

Keywords: Low-code platform, Aurea BPM, manufacturing, business processes, process automation.

1. INTRODUCTION

The low-code platform is a set of tools for programmers and non-programmers. It enables quick generation and delivery of business applications with minimum effort to write in a coding language and requires the least possible effort for the installation and configuration of environments, and training and implementation. With a rapidly growing number of companies, the use of low-code solutions can be a significant step forward in creating essential business applications. This is, so far, the fastest and probably also the cheapest method of developing software. Businesses need to change at a rate that can keep up with competitors, vendors, and the modern consumer's fleeting stream of impatient desires.

Low-Code Development Platforms (LCDP) are based on graphical user interface in designing the application as opposed to hard-coded programming techniques. The feature of LCDP focuses on the development of the following:

- Databases,
- Business processes,
- User interface (web-based applications).

Low-Code Programming technique is derived from fourth generation programming (4GL) ideology along with the concepts of Rapid Application Development (RAD). Low-Code Programming enables the programmer to spend less time thinking about the syntax of the code and to put more emphasis on designing the aesthetics and functionality of the application, so reducing the amount of time spent on troubleshooting and implementing. The idea of Low-code, which was introduced in 2011, is considered to be a novel and cutting-edge concept in the field of programming.

The approaches that created the Low-Code Programming are as follows:

- Model-driven software development approach
- Rapid application development
- Automatic code generation
- Visual programming

It is estimated that there are about 275,000 unfilled vacancies in the ICT sector in the EU, and by 2020 this shortage will reach 1 million. In Poland, the deficit of employees in the IT industry is estimated at around 50,000 people. According to the research company Gartner, by 2021, the demand for information systems will increase five times faster than the ability to provide them by IT departments, because the number of employees is not growing at a sufficient pace. This situation affects the timeliness of software delivery. In addition, modern IT solutions are not based on standard systems. Business is increasingly using customized solutions. Low-code platforms allow you to create applications without coding, while increasing the speed of introducing changes.

The global low-code platform providers are: Salesforce, Microsoft PowerApps, Mendix, Google App Maker, TrackVia, and Appian. In the Polish market, few companies offer low-code platforms. But these solutions are mainly built on existing European or American technologies by adding customized elements and modules.

The low-code platform for automating business processes in manufacturing is a difficult and demanding challenge that let to solution for many research and technological problems. It also required basic, applied, diagnostic, verification and heuristic research.

2. LOW-CODE PLATFORM

Rhett Ramos, the Regional Director for Allegro MicroSystems' IT operations, states that nowadays, in a field defined by tight margins and intense cost competition, organizations constantly need to be at the forefront of innovative automation to stay competitive and operate as efficiently as possible.

From reducing the costs associated with labour and maintenance to ensuring a higher net yield of manufactured goods via quality improvements, automation is key to running a profitable factory today.

Unfortunately for many factory managers automation is not the foreground issue. For many companies, it requires them to step into an entirely new world of development and data mastery and tackle completely new challenges like:

- Acquiring and paying for expert development skills,
- Understanding user experience to create intuitive applications,
- Manually maintaining applications and automated process to ensure minimal downtime.

Those technical and development challenges were the reason why companies did not decide to automate processes. It changed when the new option has emerged that can simplify all those challenges and give even those with the most limited development experience the chance to create automated applications and systems. This new possibility is the low-code platform.

Generating applications based on business process diagrams requires a specific modelling method. There are some, more complex, structures that can be drawn in BPMN diagrams, which are not suitable for automation. Therefore, a process diagram should be prepared in such a way that any request in the process is uniquely identified as a collection of screen forms, attachments and user actions. In this way, after assigning the contractor to the task, we provide him with the necessary information and tools for its execution.

There are tools for preparing business process diagrams in a way described above. One of them is designed and developed by the author. This is the Aurea BPM System. The comparison with the existing software of that kind has been presented by Waszkowski Robert and Kowalski Arkadiusz in the paper "Comparative analysis of Business Process Management frameworks" published in 2017.

Properly prepared process diagrams are not enough to generate applications for handling tasks. The appropriately modelled process data are equally important. Based on data models, screen forms and user interface elements are created.

The whole definition of the process allowing for the automatic generation of applications to support business process executions is complemented by 'actions'. Actions are divided into standard ones, i.e. those that are performed for all tasks in any processes, and individualized actions - specific for a particular task in a given process.
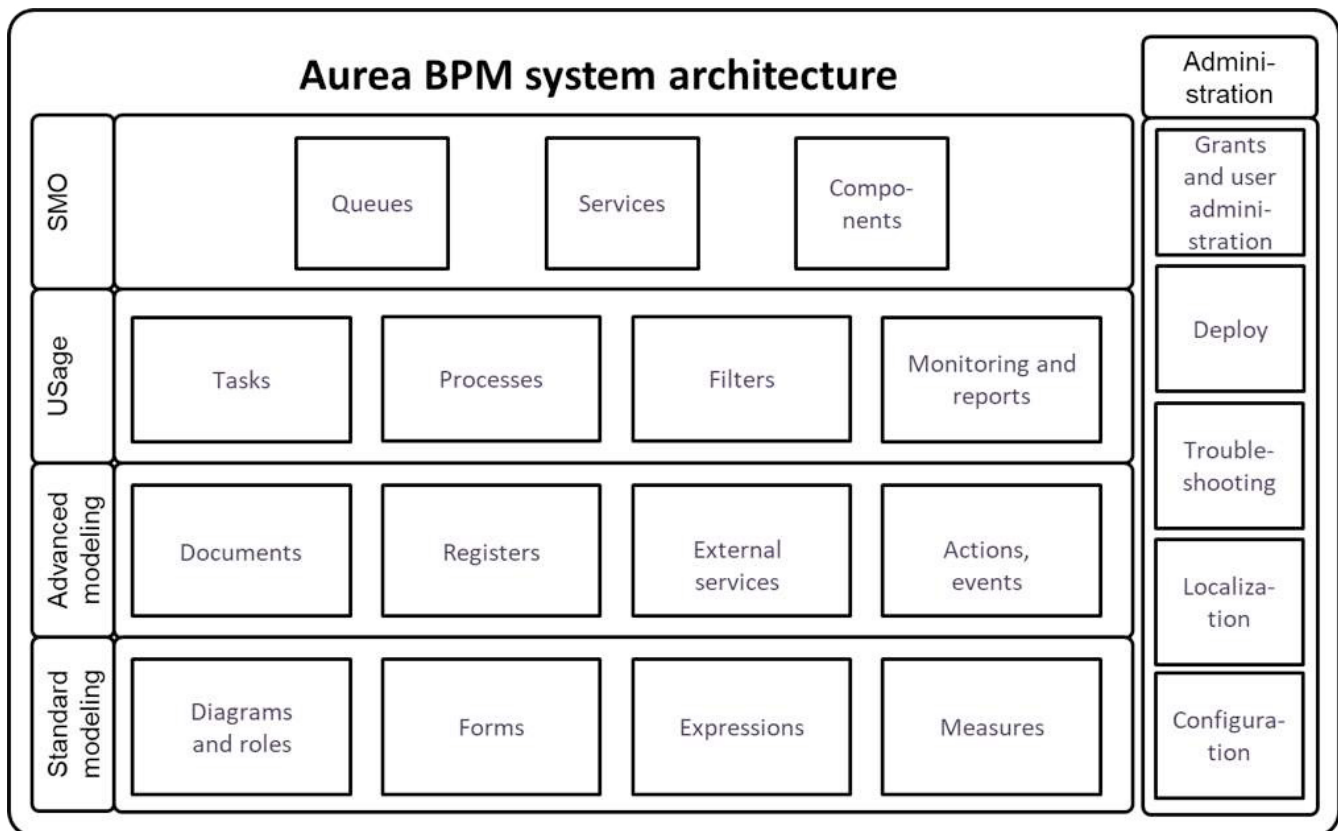
The system architecture is shown in Figure 1.

Fig. 1. Aurea BPM system architecture. Source: own elaboration.

Aurea BPM user interface modules generation algorithms are able to prepare an application on different levels of complexity, from a simple workflow to a complex solution containing databases, user and client dashboards, content management, task automation, load balancing, mobile interface, business monitoring, post action review, process simulation.

Thanks to the combined runtime and modelling architecture it is possible to de-sign and execute business processes using an integrated solution with a coherent user interface all by a web

browser. Any changes in process models influences the way it is executed and presented to end users. Business process model is integrated with the application. Any changes in the model are equal with changes in the system. Both process modelling, the usage and system administration are conducted in one integrated framework.

Process diagrams are converted into working web applications. For each task in a given business process the

system generates corresponding form for data entry as well as a set of data needed to execute the task. The set of data consists of both relational or XML data and different types of files as attachments.

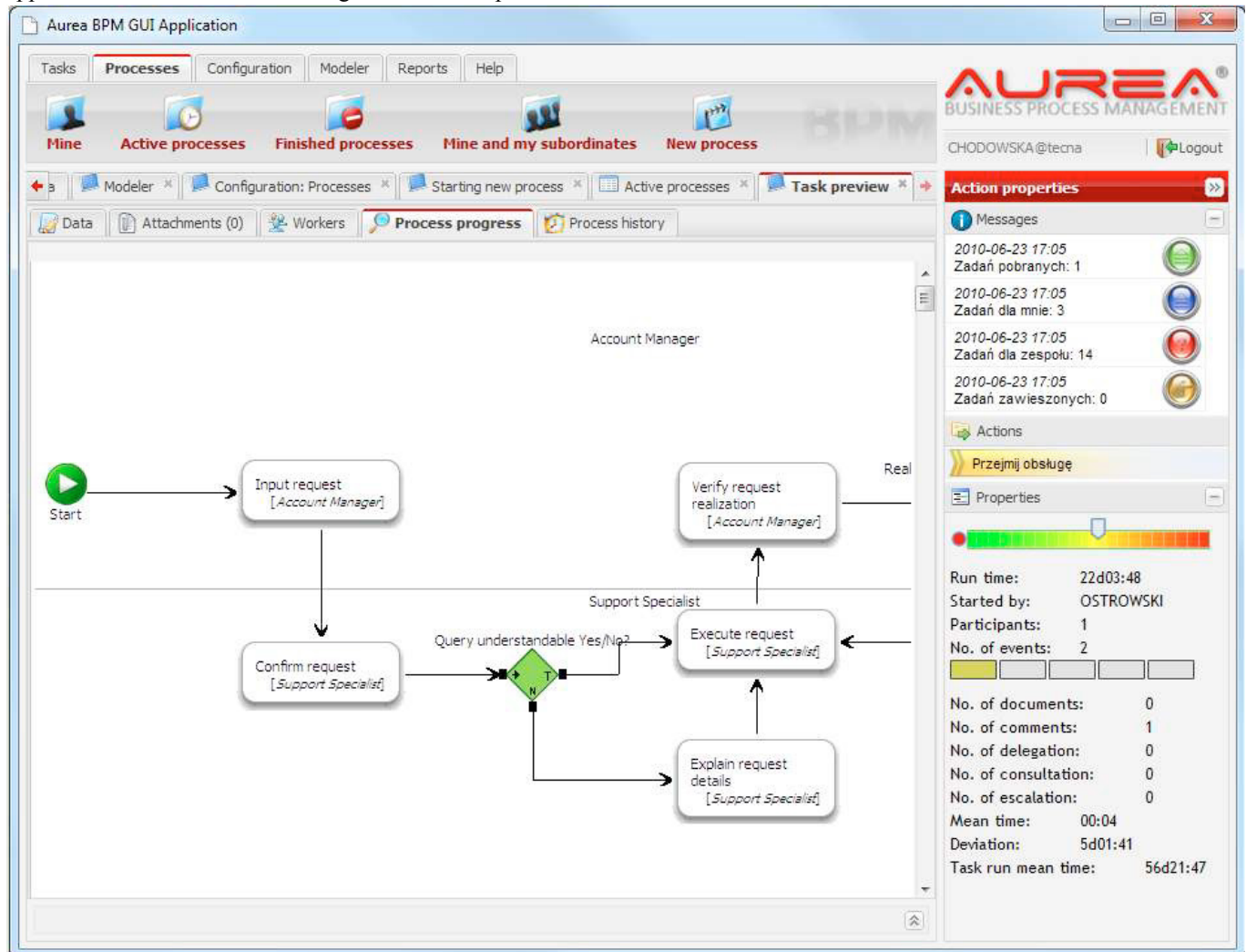Figure 2 presents the view of the tool with the business process being modelled.

Fig. 2. Sample business process as being prepared in Aurea BPM modeler. Source: own elaboration.

Business Process Management system Aurea BPM is a tool that provides extensive support for modelling, automation, managing and optimizing business processes.

Aurea BPM system works in Microsoft Windows, Linux, Unix environments with any application server and Web server and uses the Oracle database management system. Aurea was built using the following technologies: Google Web Toolkit, Oracle PL / SQL, AJAX, RPC.

Integrated management of enterprise processes

The designing, operating and control of all business processes takes place in one central, integrated repository. The target

groups of users: the departments of organization and management, operational and IT divisions and financial investigators, all work in an integrated environment. This allows fully integrated management of enterprise processes.

Remote access

The technology provides system users with access to repository resources from anywhere, simply using a web browser. The system works on most available platforms, operating systems and hardware, and may be supported by a variety of Web browsers (Internet Explorer, Firefox, Mozilla, Safari and Opera).

Security

The security subsystem protects data from unauthorized access. Access to the system is controlled at several levels, from the database objects through the application server and ending with the application itself. The system can operate both in an open Internet network as well as in a secure internal corporate network.

Reliability

The use of verified information technology provides Aurea BPM with adequate reliability. Moreover, the measure has a built-in exception logging subsystem. It facilitates identification and solving any problems.

Reports

Aurea BPM system operates on the basis of a relational database, Oracle. At the same time, all the events associated with process execution are recorded (process start and stop time, the paths of delegations, opinions and escalation, etc.) In this way, beyond the standard reports available in the system, you can build ad-hoc reports using tools based on SQL or specialized tools in OLAP class.

Business process modelling

Aurea Business Process Modeler is a visual modelling tool that provides support for the Business Process Modelling Notation (BPMN). Authorized users define new and modify existing business processes.

Business process execution

The Aurea Process Execution Engine module is responsible for executing business processes defined in the Aurea Business Process Modeler. While starting a process of a particular type the system automatically generates a new instance of the process, transfers tasks to appropriate users completing their task list. Overall the Aurea Process Execution Engine collects process data which gives the ability to analyse, measure and optimize business processes.

Collecting statistics and reports

The Aurea Business Activity Monitoring component is a set of predefined reports on the status of processes. The tool is intended for process owners, managers and other users. Reports are loaded by data collected by the Aurea Process Execution Engine module. Thanks to the use of transparent relational data structures, there is also the possibility of setting up ad-hoc reports using other available tools that support SQL.

User interface

System users use the Aurea User Portal module. The user interface not only displays the user task list, but also presents information on the currently executed processes and shows the process history of already finished processes.

System administration

For system administration Aurea provides the Aurea Admin Portal. This component allows you to create new business processes, create new versions of existing processes, create users and manage their rights, track the execution of current processes and finish processes.

Sample production processes

Three actors are involved in the "recovery process": production department (DP), maintenance department (DT) and quality department (DQ). Following, there are presented the details of each of the activities the recovery process is composed of. When reporting a failure, the reporting person (machine operator) determines the type of failure: mechanical, electrical, other, which should be understood as: type of failure unknown or simultaneous occurrence of mechanical and electrical failure). After a failure has been recovered, the DT responsible for recovery shall send the information to the DP. The production department runs a series of tests on a given machine to confirm the effectiveness of the repairs carried out. After the test series, the quality department (DQ) performs quality assessment of the defined product parameters. If the product meets the requirements, DQ approves DP production. The production department sends the information concerning the launch of the production to the planning department (DPP). In case of a negative quality assessment, the quality department (DJ) will forward the information to the technical department (DT) expecting repairs to be completed correctly. The new process model is shown in figure 3.

After the operator has reported a failure, the recovery task can be accomplished in two ways: by using own resources (DT) or external resources (external service). In the first option, there is possibility of the lack of necessary resources for task execution, e.g. lack of parts. In such a case, the Procurement Department (DZ) will be asked to purchase and deliver those parts and, upon delivery, work is continued until it is completed. In most cases, all the resources necessary to eliminate the failure will be available and the task will take place in one time. In the second scenario, the task is transferred to an external company that takes over the entire process until the task is completed. Irrespective of the option selected, the flow of information across departments is an important part of the process, as the date of recovery can affect the tasks performed by other departments: DP – Production Department, DPP – Planning Department. In the model described, if a failure has not been recovered within 1 (or 2) hours after notification, the departments indicated must take corrective action. After that time, the relevant information reaches the DP and DPP departments. The DPP

department is taking steps to implement the procedures for changing the production plans, and the DP department, depending on the level of execution of the production order

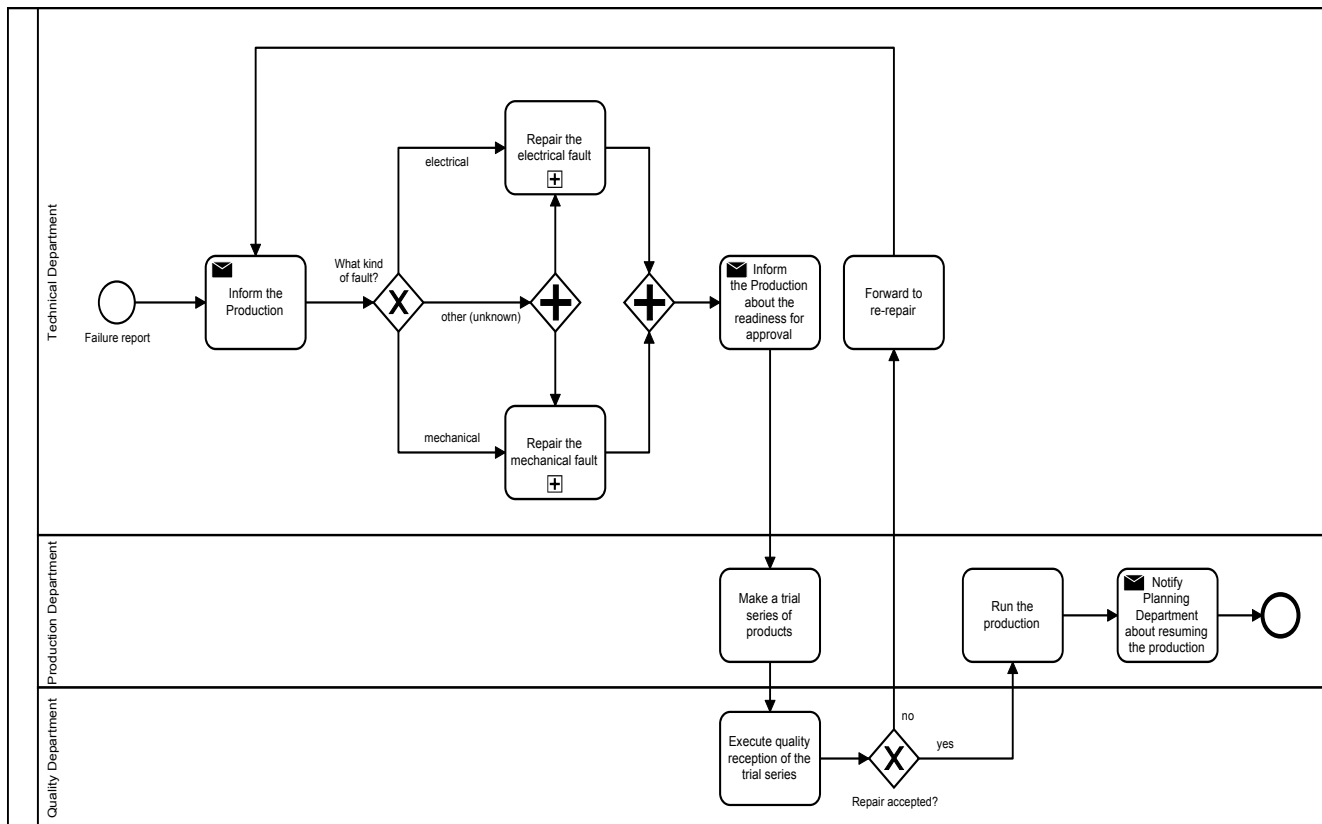(85% or 95%), is preparing to execute the next order (setups, replenishing, ...).

Fig. 3. BPMN diagram of the Recovery Process. *Source: own elaboration.*

rocess execution is the next stage. In this stage, proposed process was evaluated experimentally in a web environment. This was done by performing the following tasks: data modeling, generation of forms and definition of business rules and participants. The data model contains all the information required in the process and how they relate to the entities. To perform the simulation management of the maintenance process, the following information was required: problem description; its location; phone; e-mail, comments on the requested service; analysis of received data; observations on the need for correction of a request; technician name that will perform the service; check on the need of material request, etc.

3. CONCLUSIONS

The low-code platform Aurea BPM developed as the result of my research and development work is in line with current market demand. Experts see great potential for the development of such solutions. The basic reason for this is the lack of programmers and increasing requirements as to the scope and frequency of changes introduced in IT systems. Manual coding is time-consuming and labor-intensive. In the

case of low-code platforms, these obstacles disappear because programming is not necessary to build applications.

In 2017 Joe McKendrick (an analyst at Unisphere Research, a recognized analytical centre that is part of Information Today, Inc. researches the market in the field of information technology) developed a report on the development of applications by non-programmers, titled "The Rise of the Empowered Citizen Developer: Is IT Possible Without IT". This report shows that the main problem of business departments is the long waiting time for delivery of a business application to end-users and the long waiting time for requested data and reports. This leads to situations in which so-called "Citizen Development" takes place de-facto in business departments on its own, and with the use of common office platforms. More serious and responsible engagement of people who create such applications, and equipping them with appropriate tools, will certainly lead to the faster and better creation of business applications. Such a situation may take place, among others, due to shortening the path of transferring requirements from business departments to IT departments, and thus reducing the risk of errors and misunderstandings.

Using low-code platforms for automating business processes in manufacturing is a new and innovate approach. It can significantly reduce cost and time of implementing, developing and maintaining processes. Furthermore, due to a new possibility to utilize company's internal human resources for analytical and development work, the results of the work would better meet the real needs of business.

The rapid development of low-code platforms proves an increase in the demand for such tools. Gartner Inc., an independent analytical and research company specializing in the issues of strategic use of technology and technology management, predicts in the report of 2018 that the size of the low-code tools market will increase from $4.3 billion in 2018 to $21.2 billion in 2021. That is why the solution I have developed is very important from the point of view of providing the right tools for companies on the Polish and European market.

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