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Proposal for automation and its digitization for the selected manufacturing company

Erik Varjú

Technical University of Kosice, Faculty of Mechanical Engineering, Institute of Management, Industrial and Digital Engineering, Komenskeho park 9, 042 00 Kosice, Slovak Republic, EU,
erik.varju@tuke.sk (corresponding author)

Juraj Kováč

Technical University of Kosice, Faculty of Mechanical Engineering, Institute of Management, Industrial and Digital Engineering, Komenskeho park 9, 042 00 Kosice, Slovak Republic, EU,
juraj.kovac@tuke.sk

Jozef Trojan

Technical University of Kosice, Faculty of Mechanical Engineering, Institute of Management, Industrial and Digital Engineering, Komenskeho park 9, 042 00 Kosice, Slovak Republic, EU,
jozef.trojan@tuke.sk

Ján Kopec

Technical University of Kosice, Faculty of Mechanical Engineering, Institute of Management, Industrial and Digital Engineering, Komenskeho park 9, 042 00 Kosice, Slovak Republic, EU,
jan.kopec@tuke.sk

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Abstract: This article examines a selected manufacturing company, where an analysis of the current production layout was conducted. The primary objective of this study was to propose an automation solution to enhance the efficiency of the production process. The proposed automation system incorporates handling robots and roller conveyors to streamline material transportation from the warehouse to the production area. The implementation of this system aims to eliminate production downtime and ensure a continuous and efficient workflow. Article outlines the purpose of automation implementation, along with the necessary investment requirements. Additionally, the study provides a comprehensive evaluation of the proposed solution, highlighting both the advantages and potential challenges of automation.

1 Introduction

In today's manufacturing industry, there is a growing demand for increased efficiency, faster production processes, and the reduction of downtime. Automation and digitization have become key factors in ensuring competitiveness and optimizing workflow. This article presents a proposal for an automated system in a selected manufacturing company, focusing on improving material flow within the production process.

Currently, material is transported manually using workers and transport carts, which slows down production and leads to unnecessary delays. The proposed solution involves implementing conveyor belts and an automated control system at each workstation. Workers will be able to request specific semi-finished materials from the storage facility through a digital system. The warehouse will be organized into shelves based on different material types, such as bar stock, sheet metal, and other semi-finished products. A robotic system will process the request and transport the required materials using a roller conveyor to the designated production department, where workers will receive them.

The primary objective of this automation is to accelerate material flow and reduce inefficiencies in production. Initially, the company was unsure about the investment required for automation and was mainly interested in understanding how it would improve material flow. After evaluating the potential benefits, the company determined a feasible investment amount. This article focuses on the 3D visualization of material transport within the production process as part of the proposed automation strategy.

2 Analysis of the current state of the halls and machines

The current state of the production layout was initially illustrated using Microsoft Visio. This software is designed for creating various diagrams, including floor plans. In this software, it is possible to create flowcharts, organizational charts, building plans, floor plans, data flow diagrams, process flow diagrams, business process modeling, swimlane diagrams, 3D maps, and many others. Microsoft Visio can be used to create both simple and complex diagrams. It offers a wide range of built-in shapes, objects,

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and templates that we can work with. Within this program, we created a floor layout of the plant with machines and also provided precise dimensions [1].

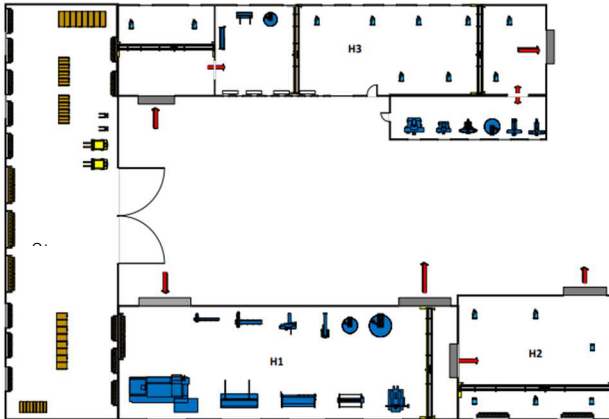


Figure 1 Hall layout

Using the Factory Design program, we created a 3D model of the enterprise where we will be implementing automation. The halls are represented with 3D models of machines. We illustrated the halls in this way to have a better visualization before implementing automation.

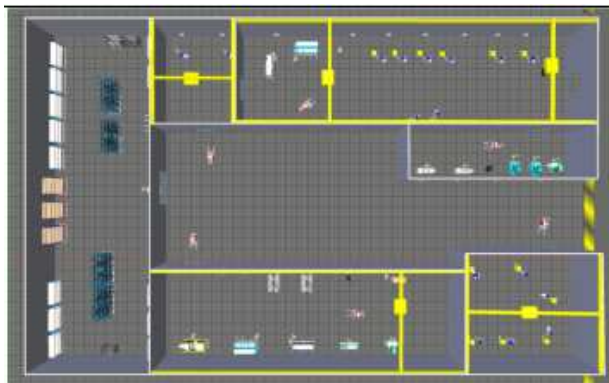


Figure 2 3D visual view from above of the current state

In the company where we have decided to implement production automation, there is a slow flow of production materials and semi-finished products into production. This causes downtime at the workplaces, and there is always a wait for the materials to arrive at the specific production department. Labor and various types of transport carts are required for the transportation of materials through production. In this enterprise, we have decided to automate production by introducing handling robots and roller conveyors that lead from the warehouse to both halls. The material from the warehouse will be placed on the conveyor by the robots and subsequently sent to the specific production department. The goal of this automation is to prevent downtime in production and ensure its smooth operation [2].

The purpose of implementing this automation was primarily to prevent production downtimes that occurred due to the slow flow of materials into production. Currently, materials are being moved at the workplace using manual labor and transport carts.

The automation of production will proceed in such a way that each workstation will have a control center where workers will enter requests into the warehouse for the semi-finished products needed at that specific production workstation. In the warehouse, shelves will be divided according to specific types of materials, for example, there will be a shelf for bar materials, a shelf for sheet materials, and various other semi-finished products. The robot will receive the information entered into the warehouse and will use a roller conveyor to send the specified materials and semi-finished products to the specific production department, where workers will collect them.

In this implementation of automation, our primary goal is to accelerate the material flow. At the beginning, the company was unsure of how much it wanted to invest in this automation; it primarily wanted to see how the material flow into production would be addressed and whether it would benefit their business. Subsequently, it indicated how much it was willing to invest in it. Therefore, in this work, we focused on the 3D visualization of the material transfer to production [3].

3 Proposed automation and digitization solution

To enhance efficiency and eliminate production downtime, the proposed automation and digitization solution focuses on optimizing material handling within the selected manufacturing company. The current manual transportation of materials using workers and transport carts slows down production and introduces inefficiencies. The new system aims to streamline this process by implementing handling robots, roller conveyors, and a digital request system that automates material flow from the warehouse to production stations [4].

Implementation of Handling Robots and Roller Conveyors

The proposed automation will introduce handling robots that will be responsible for picking and placing materials, reducing the need for manual labor in material transport. These robots will operate in the warehouse, retrieving materials from designated shelves and placing them onto roller conveyors, which will then deliver them to specific production workstations. This approach will ensure a continuous flow of materials and eliminate delays caused by manual handling [6].

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Figure 3 Proposed manipulation Robot Motoman ES165D-100 [5]

The picture above shows a 3D representation of a manipulative robot that can grab materials from the shelves and subsequently sends it via a roller conveyor to the designated production department [6].

Digital Request System for Material Handling

Each workstation will be equipped with a digital request system, allowing workers to input the type and quantity of materials needed. The request will be processed by the central control system, which will then instruct the warehouse robots to retrieve and transport the required materials. The warehouse will be structured with categorized storage racks, such as sections for bar stock, sheet metal, and other semi-finished products, enabling efficient material selection and retrieval [7].

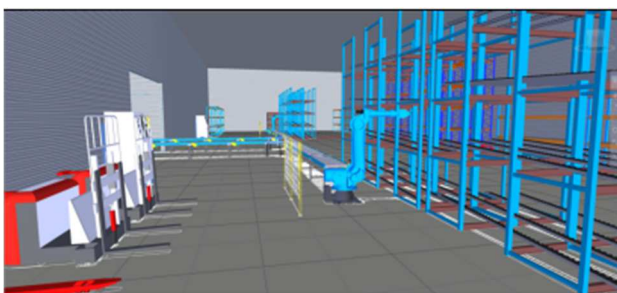


Figure 4 Warehouse robot retrieving required materials

Integration with the Existing Production System

To ensure seamless operation, the automation system will be integrated with the company's existing production management software. This integration will enable real-time tracking of material movement, inventory updates, and predictive restocking, ensuring that materials are always available when needed. The system will also generate analytical data to further optimize the production workflow over time [8].

Expected Outcomes

The implementation of automation and digitization in material handling is expected to bring several benefits, including [8]:

- faster material flow, reducing production delays
- minimized manual labor, allowing workers to focus on core production tasks
- reduced material handling errors, ensuring accuracy in production
- improved inventory management, preventing material shortages and overstocking
- enhanced production efficiency, leading to increased overall productivity

4 Investment and implementation strategy

In the company are two employees designated for loading, unloading, and transporting materials and semi-finished products. The average salary of these workers is 900 euros per month. The company employs two additional employees who assist in transportation and loading. The average salary of these employees is 700 euros per month. Approximately 400 euros are spent monthly on diesel for the transport vehicles.

If we were to implement automation in the company, where these four employees would no longer be necessary and no funds would be spent on transport carts, approximately 3,600 euros would be saved monthly. Annually, this amounts to 43,200 euros.

According to the company's internal analyses, estimated downtimes due to low material flow efficiency in production exceed 10% annually. This efficiency, in terms of employee time utilization, is primarily related to wages and personnel costs. The company's financial statement from 2019 indicates that personnel costs amounted to 189,572 euros. Considering the 10% time losses, this inefficiency costs the company 18,957 euros annually.

The absence of automation in the company results in estimated annual losses of 62,157 euros. The company clarified that roller conveyors could also be manufactured in-house, as they have previously engaged in the production of similar conveyors. This implies that the introduction of conveyors would be somewhat less expensive for the company.

Table 1 The cost of making 1-meter of conveyor

Production of a 1-meter conveyor	Cost
Material for 1-meter of conveyor	160€
Components	90€
Work	150€
Other costs (energy, overhead costs)	30€
Total	430€

The construction of 1 meter of a roller conveyor would cost €430. Since we need to produce 200 meters of conveyor, the total amount would be €86,000. To this

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amount, it is necessary to add the technology required for driving the conveyor, which would cost approximately €25,000. Therefore, if the conveyor were manufactured in the given company, its production would cost approximately €111,000.

As mentioned above, the Motoman ES165D-100 (Figure 3) is an advanced robot focused on machine operation and material handling with a payload of 100 kg and a reach of 3010 mm. The Motoman ES165D-100 is equipped with the DX100 controller. New industrial robotics with components range from 40,000 to 65,000 euros. After adding application-specific peripherals for production, the robotic system costs between 83,000 and 125,000 euros. The purchase of such a robot would cost up to 100,000 euros, including the relevant components. The company would be willing to invest 200,000 euros in automation. The implementation of automation would overall cost approximately 211,000 euros.

The implementation of this automation has more positive aspects than negative ones. The main intention was to accelerate the material flow, which has been achieved with the introduction of this automation, and the investments made by the company are more or less in line with the approximate costs required for this automation. Since the company would save 62,157 euros annually with the implementation of this automation, the amount of the implemented automation, which is approximately 211,000 euros, is acceptable for the company. Additionally, the payback period is very favorable for the company.

5 Conclusion

The primary objective of this study was to implement automation to enhance the efficiency of the production process, with a particular focus on optimizing material flow. The proposed automation strategy, outlined in the third section of this study, involved the optimization of intra-facility material transport through the implementation of roller conveyors, significantly improving inter-operational logistics and reducing production delays.

A detailed financial assessment was conducted to evaluate the economic feasibility of this automation initiative. The total investment required for the acquisition of inter-operational transport systems amounted to €211,000, while the projected annual cost savings resulting from automation were estimated at €62,157. Based on this analysis, the payback period for the investment is approximately three years and four months, which is considered highly favorable for the company.

Beyond financial savings, the introduction of automation also led to a reduction in labor requirements for

material handling and eliminated production downtime caused by delays in the delivery of raw materials and semi-finished products. By streamlining material flow and ensuring direct delivery to designated workstations, the proposed solution enhances overall production efficiency and minimizes operational disruptions.

The findings of this study indicate that the proposed automation strategy offers substantial benefits to the company, both in terms of economic return and operational effectiveness.

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Review process

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