WHETHER TO IMPLEMENT ROBOTIC SOLUTIONS IN LEAN INDUSTRIAL SYSTEMS: A DECISION BASED ON FINANCIAL INDICATORS

Nastasija Nikolic [1] [ORCID 0000-0002-2235-1712], Carlo Caiazzo [1] [ORCID 0009-0007-2761-7886], Marko Djapan [1] [ORCID 0000-0002-8016-8422], Ivan Macuzic [1] [ORCID 0000-0001-6153-6456], Djordje Milojevic [1], Aleksandra Jovicic[1]

[1] University of Kragujevac, Faculty of Engineering, Department of Production Engineering, Serbia

Abstract: *The successful finalization of the project is crucial for every organization, regardless of whether its operations are structured according to Lean principles or not. Industry 4.0 enabled the implementation of robotic solutions that significantly contributed to business improvement. In every company decisions should be based on the fact. Financial indicators represent only one of the criteria that should be followed when deciding on projects in a company. This study examined financial metrics following the implementation of a robotic solution in a particular company. According to the analysis, all of the indicators examined are above the minimum acceptable level. The break-even point, profitability index, and net present value were examined.*

Key words: *Robotics, Lean industrial systems, financial indicators, Industry 4.0*

1. INTRODUCTION

Today there is a need for continuous improvement of performance. For that reason, companies are enrolling on different projects. Those projects can refer to technical innovations, product innovations, manufacturing improvements, etc. One of the biggest problems refers to the potential failure of the project. Every company's main concerns in realizing the project refer to time and cost.

Industry 4.0 affects the fact that the main focus in improving a company's business is the improvement of technology. In general, Industry 4.0 is widely accepted because of its automation and enhanced computing capacity (Gualtieri, Rauch, & Vidoni, 2021). Automation is very important for Industry 4.0. Automation enables quality improvement of performance related to manufacturing.

For Industry 4.0 automation is of exceptional importance. Robotics represent one of the elements of Industry 4.0 which is suitable for improving the implementation of various processes in the company. Robots can perform simple pick-and-place activities and far more complex ones that include cutting, receiving and delivering welding… Today, the implementation of robotic solutions extends to various industries, from agriculture, through metal processing, to the pharmaceutical industry. Robots can repeat a large number of operations, can perform activities in collaboration with humans, or can be used for other solutions. The implementation of robots allows workers to focus on more creative tasks that enable productivity improvement and company growth.

The purpose of industrial robots can be linked to achieving enviable results when it comes to errors, defects, and downtimes, and accordingly, they are suitable for leading in Lean industrial systems. In this way, by investing in robotics, Lean industrial systems can realize better results when it comes to investment return time (Oztemel & Gursev, 2020).

Robotics is a technology that enables the performing of different tasks in the industry. Robotics can be used for continuous minimization of costs thereby also increasing productivity. Today, companies are reviewing the possibilities of applying robotics to improve further operations (Chen, et. al., 2021). Robots are transforming the market thanks to their rapid development and the possibility of combining them with different devices.

The application of advanced robotics can be seen as a significant project. In this sense, it is very important to implement robotic solutions in the foreseen period and with predefined costs. Also, as in other cases, the implementation of robotic solutions must have its justification.

In this sense, this paper deals with the research on the financial effects of the implementation of robotic solutions.

2. METHODS

Regardless of the industry within which a company operates, the performance of the entire production process must be continually improved due to the ongoing rise in competitiveness and the current economic climate. If the company has a well-established position, it also has to change strategies to keep it (Porter , 2004).
The fourth industrial revolution has made it possible for many industries to use cutting-edge robotic solutions. Advanced robotic solutions can significantly improve various manufacturers' productivity and efficiency if properly implemented. In previous research, Return on Investment is observed, and in this paper, research is upgraded by analyzing the net present value, internal rate of return and profitability index. Those financial indicators are analyzed in the company engaged in the production of construction equipment. The company operates in accordance with Lean principles, showing a commitment to improving operations, processes and procedures.
Analyzing financial indicators is critical in directing the organization toward Lean principles such as waste reduction and operational excellence. Net present value, internal rate of return and profitability index provide measurable insights into the Lean principles' effectiveness. Those indicators support the financial stability of the company. In addition to financial sustainability, it provides the feedback of commitment to continuous improvement and customer value creation. The decision was made to implement the robot for the welding activity after taking into account the significant amount of time that the worker allocates to performing necessary non-value-added activities. Also, more of the third of the cycle time is expenditure on welding preparation. In the case of robot welding, switching from one execution position to another is done much more quickly than in the case of manual welding. Additionally, piece manipulation is considerably quicker.
The financial indicators examined in the case study are summarized below.

2.1 Net Present Value (NPV)

Net present value can be calculated as the sum of the present values of incoming and outgoing cash (Gaspars-Wieloch, 2017). NPV indicate if the project will result in profit or loss. The difference between discounted inflows and outflows represents NPV. The formula for the NPV is:

$$NPV = \sum_{k=0}^{n} \frac{NCF_k}{(1+i)^k} \tag{1}$$

Where:
NCFk – net cash flow generated in year k
k – Number of periods
i – Discount rate
A higher Net Present Value indicates which project is better to choose. If Net Present Value is positive, it indicates that the project is acceptable. The discount rate is based on the ratio of owned and borrowed funds, risk, interest rates, inflation rate, financial policy and other factors. To assess the efficiency of the investment, a decision can be made based on the weighted average cost of capital (WACC), which is calculated as:

$$WACC = \frac{E}{E+D} * R_E + \frac{D}{E+D} * R_D * (I - T) \tag{2}$$

Where:
E – Equity
D – Debt
RE – Cost of Equity
RD – Cost of Debt
T – Tax
NPV determine the present value of all the future cash flows. Cash inflows and cash outflows are discounted when NPV is calculated. A project is worthwhile if a project's financial return is bigger than the

investment (Archer & Ghasemzadeh, 1999). The discount rate that is used reflects the risk of the project (Arshad, 2012).
Decisions made based on the NPV should be as follows:

Table 1: NPV decision-based

	Decision
NPV > 0	Investment is eligible for consideration
NPV < 0	The investment will result in financial losses
NPV = 0	There must be an additional interpretation

NPV is one of the main tools for industrial investment evaluation (Magni, 2015). When one company is considering a lot of different projects, NPV can be used for ranking them. The main advantages of using NPV are consideration of money value in time, enabling comparison of different projects by their duration, and the possibility to use NPV even when the rate of return varies over the course of a project. On the other side, the main disadvantage of NPV is a number of steps which include estimation. During the project, a lot of changes can happen and influence NPV significantly. Also, it is not appropriate to compare different sizes of projects.

2.2 Profitability Index (PI)

The ratio of discounted benefits to discounted costs is known as the profitability index (PI) (Grau, 2012). PI is an evaluation tool that has a wide real-life application. The PI can be used for comparing similar investments that are considered. PI is one of the many methods available to determine the effectiveness of a proposed investment. The PI formula is:

$$PI = 1 + \frac{NPV}{I_0} \tag{3}$$

Where I_0 refer to the initial investment.
The profitability index can be used in different cases, for short or long-term decisions making. Also, it can be used in the case of the positive net present value of projects in order to compare some of them. It is very useful when economic resources are scarce (Al-Rikabi, 2021). In general, the profitability index represents the relationship between the benefits and costs of the project. Since any value below 1.0 would imply that the project's present value (PV) is less than the initial investment, a profitability index of 1.0 is logically the lowest acceptable measure on the index. The main advantages of PI refer to providing information on whether an investment will increase company value or decrease, it aids in selecting the project when allocating capital and considers all project cash flows. On the other side, the main disadvantage of the PI is that it may always provide the best decision when it is used for the estimation of mutual projects.

Table 2: PI indications

	Indication
PI > 1	Anticipated discounted cash inflows exceed discounted cash outflows
PI < 1	The outflow deficit exceeds the discounted inflow deficit
PI = 1	Any positive or negative result from the project is minimal

If the PI is greater than 0, a project should be taken into consideration. If the PI is less than 0, a project should be rejected. In the case that PI is equal to 0, there is indifference about this project.

2.2 Breakeven Point (BEP)

By comparing an asset's market price to its initial cost, the breakeven point for a trade or investment can be identified. The breakeven point is reached when the two prices are equal.

The formula for the breakeven point in units is:

$$BEP = \frac{FC}{CMPU} = \frac{FC}{SPPU - VCPU} \tag{4}$$

Where:
BEP – Break Even Point
FC – Fixed Cost
CMPU – Contribution Margin per Unit
SPPU – Selling Price per Unit
VCPU – Variable Cost per Unit
In Figure 1 breakeven point is graphically presented.

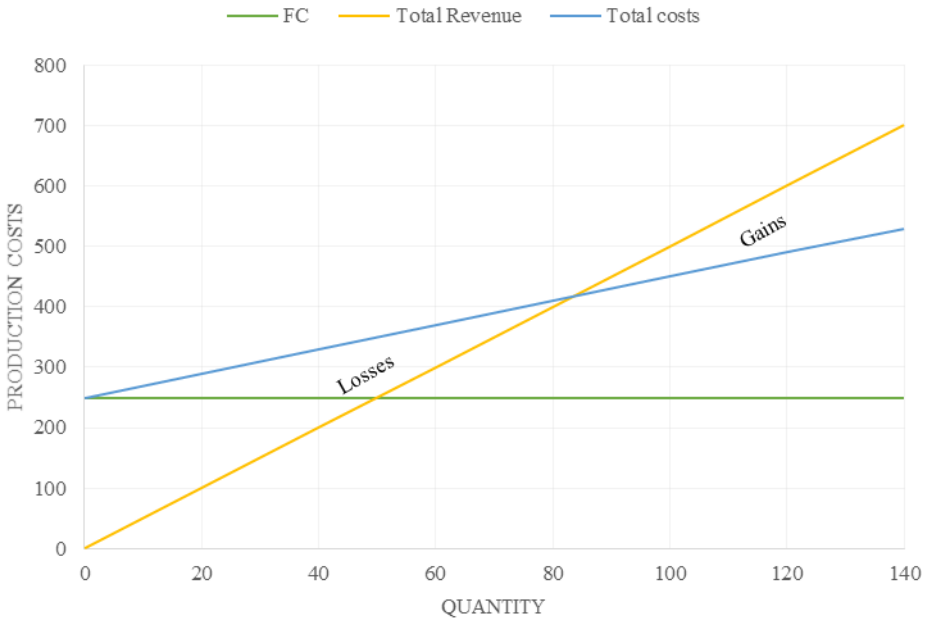

Figure 1: Breakeven point

As can be seen from Figure 1, the breakeven point is the production level at which revenues are equal to expenses. Below the breakeven point, the company realizes a loss, while above this point, a profit is realized. The breakeven point is the point at which the company makes neither a loss nor a profit. The breakeven point may also be worth calculating:

$$BEP = \frac{FC}{CMPU} * SPPU = \frac{FC}{SPPU - VCPU} * SPPU \tag{5}$$

Equation (4) represents the breakeven point in units and equation (5) represents the breakeven point in sales value. In this case, the breakeven point is the level of sales where total revenue and total costs are equal. In accounting terms, it primarily refers to the production level at which revenue will equal the production costs. A breakeven point indicates the elements of trading that must be met in order to avoid a loss of an initial investment in a business or project. The main benefits of calculating the breakeven point are fact-based decision-making, revealing costs that have not been anticipated and obtaining funding from investors.

3. CASE STUDY

This work is considering financial indicators in implementing the robot cell in the manual cell place. The company should be able to make some decisions on the projects from the obtained financial indicators.

Financial indicators are not the only indicators that should be analyzed. In the next research, quality and safety indicators will be analyzed. As it is defined in the previous research (Nikolic et. al., 2022), the process of deciding on project implementation consists of five steps:

- Value stream mapping
- Choosing the cell to be replaced
- Choose of robot
- Predicting future statement
- Making decisions based on KPIs

The research was done in a company engaged in the production of construction equipment. In the observed company it is conducted that implementing of robotic cell in the place of a manual cell would contribute to the process improvement in multiple ways. In the case of the implementation of the robot cycle time is reduced from 126:20 to 96:17. This research is analyzing NPV, PI and breakeven point in order to overview the effects that the company will realize in the case of implementing a robotic solution instead of a manual workstation. NPV can be described in one sentence as today's value of invested cash. The most important about NPV is the discount rate which is affected by inflation. If NPV is positive it means that today one euro is worth more than one euro in the future. There will be 60 periods included in the calculation. In Table 1 it is presented Net Present Value, cash inflows, cash outflows, as well as discounted inflows and outflows. The cash inflows include revenue increases and cost savings while cash outflows include initial investments, operating and training costs, maintenance costs and financial costs related to the project part invested from the loan.

Table 3: NPV

Year	0	1	2	3	4	Total
Inflows	121.500	243.000	243.000	263.250	263.250	
Outflows	310.000	20.000	20.000	20.000	20.000	
Discounted inflows	121.500	194.400	173.571	167.675	149.574	**806.720**
Discounted outflows	310.000	16.000	14.285	12.738	11.363	**364.386**
Cumulative	121.500	**315.900**	**489.471**	657.146	806.720	

Using the NPV function, it can be seen that the difference between the present value of cash inflows and outflows over a period of five years is 442.334 euros. As NPV is higher than 0 euros, it indicates the profitability of the project. WACC for this project is 12%. The return period is 2,34 years. The profitability index is 2,21. The profitability index is greater than 1.0, which is the index's lowest acceptable measure. In the next table, the breakeven point is presented, as well as data that are necessary for the calculation of this indicator

Table 4: BEP

	Manual workstation	Robotic workstation
Quantity	90	120
Product price	600	600
Sales revenue	54.000	72.000
Variable costs per unit	420	400
Total variable costs	37.800	48.000
Fixed costs	9.800	8.500
Profit	**9.600**	**18.200**
Breakeven point	**54**	**43**

In Table 3, the breakeven point in the case of the manual workstation and in the case of installing the robotic workstation can be seen. The breakeven point for a manual workstation is 54, whereas, for a robotic workstation, it is 43. This indicates that the company begins to realize a profit after 54 pieces, or 43 pieces of the sold product. As a result, the company starts to realize profit earlier than in the case of a manual workstation.

4. CONCLUSIONS

Industry 4.0 enable the implementation of various solutions that contribute to the improvement of companies' operations. Regardless of advanced technologies, it is important for each individual company that the decision to invest in such solutions is adequate. Due to the high costs of some solutions, it is necessary for companies to determine how the investment will contribute to business improvement in the future and whether this improvement will meet management expectations and market demands. Given that the price of such solutions is often the biggest problem, this paper deals with the implementation of robotic solutions and examines the impact on financial indicators in case of implementation. The company in which the implementation of the robotic solution was examined deals with the production of construction equipment. The business of this company is based on Lean principles. In the previous research, a manual workstation, which should be replaced with a robot, was identified. Financial indicators that are observed in this case are NPV, PI and breakeven point.

The NPV in the case of implementation of the robot in the place of the manual workstation is 442.334 euros. This is in accordance with the theoretically defined assumption that it is necessary for the NPV to be greater than 0. When it comes to the PI, it is 2.21, while the investment return period is 2, 34 years.

The breakeven point for a robotic workstation is 43, or 54 for a manual workstation. This points to the fact that by implementing a robotic solution and saving on costs, the company will start generating profits earlier.

On the basis of all analyzed financial indicators, the conclusion is that a robotic solution should be installed instead of a manual workstation. The invested funds will be returned in an adequate period of time, the value of the capital will increase and a larger profit will be generated thanks to the difference in the costs that will be realized.

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