Krzysztof Stall* https://orcid.org/0009-0000-6539-4846
Interdisciplinary Doctoral School, Technical University of Lodz
e-mail: krzysztof.stall@dokt.p.lodz.pl

Grzegorz Kruk** https://orcid.org/0009-0003-2999-3034
University of Banking of Gdansk
e-mail: grzegorz.kruk@mmrgroup.pl

The impact of technological innovation on employee retention in enterprises: a case study of quality control

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This article examines the impact of technological innovations on employee retention in the manufacturing sectors, focusing on a case study of quality control. It considers how technology, by reducing the monotony of manual labor and increasing efficiency, can enhance employee experiences. The authors explore the application of innovative technology in the context of quality control, highlighting the challenges associated with its implementation, such as safety, costs, and the need for employee training. The article emphasizes how the proper use of technology can lead to increased job satisfaction, reduced employee turnover, and improved productivity, by presenting the case of a company that has successfully implemented technologies into its quality control processes. The authors note that the effective implementation of technological innovations requires a strategic approach that considers both technological and human aspects.

Keywords: technological innovation, automation, employee retention, reducing monotony, job satisfaction, quality control

* Krzysztof Stall – a PhD candidate at the Technical University of Lodz, Interdisciplinary Doctoral School, Faculty of Organization and Management. He is the general director of a production and commercial company (MMR Group Sp. z o. o.) and co-owner of an accounting and tax company (Kowalska & Stall Sp. z o. o.). His research areas include management, logistics, supply chain management, innovation, printing industry, quality and quality control. He is the author of articles in academic journals.

** Grzegorz Kruk – a graduate of the WSB University in Gdańsk. His research areas include economics and finance, psychology, mathematics. He is the author of many articles in academic journals.

Introduction

In the face of rapidly advancing digitization and digital transformation, organizations worldwide are confronted with the continuous challenge of retaining and motivating employees. Particularly in production-oriented sectors, monotonous manual tasks are often a source of low job satisfaction, leading to a high turnover rate among employees (Stankiewicz, 2006: 56–57). In a study commissioned by KPMG titled “Keeping us up at night, the big issues facing business leaders in 2023”, as many as 77% of surveyed enterprises stated that acquiring, retaining, and upskilling employees to meet a more digital future is the biggest challenge of the current times. Interestingly, only 7% declared from a societal perspective that leaving a job due to the introduction of new or breakthrough technologies was a reason, and 4% of respondents considered IoT to be a threat to their job security (KPMG, 2023: 4–6). Significantly, enterprises are seeking ways to enhance employee experiences and increase their engagement, where technological innovations can play a key role in this process.

This article focuses on how technological innovations can assist companies in reducing the monotony of manual labor, through a case study in quality control. Quality control has always been a critical element of the production process, requiring intensive involvement and attention from employees. Thus, it is an area where technological innovations can have a significant impact by automating routine tasks and enhancing process efficiency. Instances of professional burnout caused by verbal or even financial penalization of employees for quality oversights are frequently heard. Many researchers agree that technological innovations can improve job satisfaction, both by reducing monotony and by enhancing a sense of efficiency and competency. However, the practical application of technology is a complex process that requires careful planning and implementation. Key questions here relate to how enterprises can successfully implement technological innovations to increase employee engagement and retention (Oczkowska, 2019: 27).

The aim of the authors is to provide practical guidance for managers and decision-makers seeking ways to leverage technology to improve quality of life in the workplace. In the theoretical part of the article, the issues related to quality control are discussed, emphasizing fundamental concepts and methods of their parameterization, essential for the existence of enterprises in a competitive market. The literature-based connection between technological innovations and job satisfaction is highlighted, with particular attention to the monotony of manual labor. Potential challenges and adversities associated with the implementation of innovations, such as security issues, data privacy, costs, and the need for employee training, are identified.

The article presents a case study of a Polish enterprise in the precision machining and steel finishing sector. Here, from the perspective of quality control, appropriate comparative indicators of the work of operators performing the studied phenomenon over one year, monitored by the existing management system in the enterprise, are set against the subsequent year of work post-automation implementation and data collected from it. Considering the above, the article aims to fill a gap in the literature on the application of technological innovation in the context of employee retention in production sectors. The authors hope that their insights will be valuable for both researchers and practitioners aiming to improve employee experiences and operational efficiency through technology.

Innovation, quality control and job satisfaction: problematics

Over recent decades, technology has gained a significant place in the workplace, contributing to changes in the nature of work and impacting employee experiences. Specifically, technological innovations play a crucial role in reducing the monotony of manual labor, which in turn affects job satisfaction and employee retention (Sikora, Uziębło, 2013: 351–363).

According to J.R. Hackman and G.R. Oldham's (1980) job theory, job satisfaction is strongly linked to five characteristics of work: skill variety, task identity, task significance, autonomy, and feedback (Hackman, Oldham, 1980: 161). Technological innovations can impact these characteristics in various ways. For instance, automation can decrease the monotony of manual labor by reducing the need for repetitive tasks, which may in turn increase skill variety and employee autonomy.

Studies have shown that technology and innovation can also contribute to enhancing employees' sense of efficiency and competency, key factors in job satisfaction (Crovini, Santoro, Ossola, 2021: 1086–1087). For example, in a case study by H. Sun and P. Zhang (2006), the results indicated that the application of advanced information technologies in quality control can help reduce job monotony, enhance efficiency, and ultimately improve job satisfaction (Sun, Zhang, 2006: 53–78).

Currently, innovation is defined as a unique approach to technological, managerial, economic, scientific, and social challenges, and is a major catalyst for transformation in the business world and society (Kraśnicka, 2018: 10–45). Although often analyzed from a technological or financial perspective, its scope is also expanding to potential benefits from new products or services that may increase their functionality. It's also important to consider the impact of innovative management methods on optimizing various aspects of enterprise activity. However, it's crucial to note that these analyses often overlook a key aspect – the human factor. Hence, all technical and economic analyses might be secondary if not linked with the human aspect, which can limit their effectiveness. Even the most optimal implementation plan of innovations, from a technological or economic standpoint, may encounter resistance if it neglects aspects related to enterprise activities, which are crucial for the effective implementation of innovative processes.

We also observe revolutionary changes in the work environment, where humans are supplemented or replaced by applications, machines, and robots. This trend, associated with automation and artificial intelligence, accelerated significantly during the COVID-19 pandemic in 2020–2022, leading to further digitization of society. Recent research, including that of D. Nam, J. Lee, and H. Lee (2019), confirms that employee adaptation of innovations enables organizations to overcome performance gaps and exploit new opportunities, especially in areas of advanced technology (Nam, Lee, Lee, 2019: 413–422). However, the introduction of innovation technologies is not a panacea for all work-related problems. Studies by J. Bijańska and K. Wodarski (2020) suggest that although new technology or innovation can increase job satisfaction by reducing monotony, it can also lead to concerns about job security, technology-related stress, and information overload (Bijańska, Wodarski, 2020: 203–204). Moreover, technological innovations may require changes in work organization, which can be challenging to achieve. For example, implementing technology may require training and support for employees to effectively use new systems and tools (Wesson, Gogus, 2005: 1018–1026). Therefore, a balanced approach to introducing technological innovations is crucial, taking into account both potential benefits and challenges related to employee retention in the enterprise. The concept of scientific quality management, focusing on measurement techniques, has developed effective methods for solving problems primarily in production but also related to work organization and employees themselves. A primary indicator creating a set of possible measurements is Key Performance Indicators (KPIs), which enable the verification of the conformity of enterprises' functioning with the assumptions for the production process (Parmenter, 2010: 16). In another publication, D. Parmenter identifies seven key attributes that effectively developed KPIs should have (Parmenter, 2015: 37–38):

1. Non-financial nature – these indicators should not be expressed in financial terms.
2. Understandability – the indicators must be clear and comprehensible to employees to facilitate appropriate adjustments in their actions.
3. Regular measurement: regular, preferably daily, measurement is essential for these indicators.
4. Coordination and management control – company management should coordinate and maintain control over these indicators.
5. Impact on organizational success – the indicators play a significant role in influencing organizational achievements.
6. Positive impact on efficiency – the indicators have a beneficial effect on various aspects that contribute to the organization's efficiency.
7. Use in defining tasks – these indicators are instrumental in defining tasks for both teams and individual employees.

Thus, a subset of KPIs includes all indicators that enable continuous evaluation and optimization of enterprise achievements, and also extend the range of knowledge (Grycuk, 2010: 28, 31). KPIs are designed to support managers in defining and achieving operational and strategic goals. According to P. Drucker, the ability to measure something allows for its effective management. However, KPIs do not cover all forms of data measurement but focus on key indicators for the organization, providing reliable results reflecting the actual state of the enterprise (Grabowska, 2017: 106–107). These indicators, consistent with the ISO 22400 standard, are characterized by a complex hierarchical structure and complicated internal relationships that are interconnected. According to the standard, we can distinguish three levels of KPI subsets:

1. Level of direct indicators – arising, for example, from the production process schedule, and actual, i.e., measured at the production position.
2. Level of basic indicators – resulting from the efficiency of the production system, its maintenance, and the quality of manufactured products, calculated based on direct data.
3. Level of complex indicators – located at the highest level of the hierarchy, calculated on basic indicators.

Tightly linked to hard KPI indicators are the assumptions of Six Sigma, where the basic assumption is to achieve production correctness at the level of 99.997%. The remaining 0.003% represents 6σ, or six times the value of deviation from the achieved maximum indicator. Such high quality of offered products translates into a noticeable increase in enterprise competitiveness, resulting in improved profitability (Eckes, 2010: 15–16). The literature offers many definitions focusing on Six Sigma. According to J.R. Evans and W.M. Lindsay, it is an approach to streamlining business processes, aimed at identifying and eliminating causes of defects and errors, shortening cycle time, and reducing operational costs while increasing efficiency to better meet customer expectations (Evans, Lindsay, 2005: 24–25). J. Antony describes Six Sigma as a systematic research methodology, providing employees with statistical and non-statistical tools necessary to understand critical processes and products for achieving operational and business excellence. Other researchers, like J.E. Brady and T.T. Allen, assert that Six Sigma is an approach based on statistical techniques, organized and systematic, aimed at reducing the defect rate. Considering the above, Six Sigma defines a certain production standard necessary in current times, and KPI is an integral tool for striving for excellence in quality management. Other related methods, similar to KPIs, such as the DMAIC cycle defined by W.E. Deming, systematize the improvement process, introducing a certain rigor in its implementation. This five-stage process, known as the Deming cycle, includes (Gołębiowski, 2011: 135–136):

1. Defining the problem – identifying the problem, identifying the process requiring project implementation, designating critical quality characteristics,
2. Measuring – measuring the process and establishing and verifying the measurement system to obtain the necessary data,
3. Analyzing – analyzing collected data to identify key factors affecting the previously defined critical feature,
4. Improving – actions aimed at bringing detected elements to required values.
5. Controlling – monitoring the constancy of implemented improvements.

The choice of appropriate KPIs and the adoption of the Six Sigma philosophy was closely linked to the character of the process in the case study of the analyzed enterprise, where the primary goal is to achieve efficiency and generate greater profits. However, even with the proper application of these tools and efforts to introduce innovative solutions, resistance is often encountered from employees who may be reluctant to change and new working methods.

Challenges associated with implementing innovations and data security

Despite the numerous benefits of implementing advanced technologies like automation, artificial intelligence (AI), and machine learning, there are also several challenges that enterprises must overcome to fully utilize these opportunities. Among these challenges, the most significant are data security, data privacy, costs, and the need for employee training. Data security is one of the key challenges associated with implementing new technologies. Technologies such as AI and machine learning often rely on collecting and analyzing large amounts of data, which may contain sensitive information about customers or employees. In the event of data loss or improper technical use in accordance with the General Data Protection Regulation (GDPR) (Ustawa z dnia 10 maja 2018 r. o ochronie danych osobowych, Dz.U. 2018, poz. 1000, p. 42), this information can be at risk, leading to serious legal and reputational consequences for the enterprise. Data privacy is another serious challenge. Many AI and machine learning technologies are entirely based on the analysis of personal data, which can raise privacy concerns among employees and customers. Organizations must ensure they have appropriate privacy protection mechanisms in place, such as data anonymization and strong data access policies (Tene, Polonetsky, 2012: 63).

The costs of implementing and maintaining new technologies are also a significant factor. In addition to the direct costs of purchasing and installing technology, organizations must also consider expenses such as system maintenance and software updates. For some businesses, especially smaller firms and startups, these costs can be substantial. Ultimately, the undeniable need for employee training typically poses a key challenge, especially for employees who remember the early days of the enterprise. Transitioning to new technologies often requires employees to acquire new skills and adapt to new ways of working. Although advanced technologies can bring significant benefits to organizations and employees, implementing these technologies requires careful planning and management to meet these challenges. When implementing new technologies, enterprises must understand that employees may initially be resistant to change, especially if they fear losing their jobs to automation (Brynjolfsson, McAfee, 2014: 187–188).

Equally important is for companies to understand and consider the needs, expectations, and concerns of their employees. As shown in a study by P. Cappelli and

J.R. Keller (2013), employees are more inclined to accept and use new technologies if they feel that they have been presented with facts that potentially increase profitability and that the innovation will serve to improve their work experiences, rather than for monitoring or replacing them with machines (Cappelli, Keller, 2013). As a result, companies that want to successfully implement technological innovation must approach this process in an employee-oriented manner, involving these same employees in the decision-making process and considering their needs and expectations.

Employee retention factors and the influence of technological innovation in minimizing monotony in the workplace – a quality control case study

The objective of the conducted empirical study was to determine the reasons for the high turnover of quality control operator positions at the examined enterprise before the introduction of an automation system. The study was based on the company's documentation over a full year of the operators' work and for a full year of operation of the new robotic arm.

The enterprise, specializing in precision machining and steel finishing, faced quality issues related to measuring the thickness of the final product, which is a stainless steel plate impregnated with a rubber film. The measurement of the applied coating, which provides adhesive properties for further processing, typically varies in thickness measured in microns. It needs to be categorized into areas of minimum thickness (160μm), acceptable for fulfilling its adhesive qualities, and areas of maximum thickness (190μm) suitable for further processing by the end customer. Stainless steel formats coated with a rubberizing agent are used for further precision processing by the end customer, therefore the exact values must meet the ISO 2808 standard for measuring the thickness of dry coating plates. This standard specifies the thickness of the coating or its distance between the coating surface and the substrate surface as appropriate. However, it reserves that in practice it does not have an optimally smooth coating or smooth substrate, which significantly affects the measurement results. The discussed enterprise did not pay much attention to the ISO regulations, assuming that if it has tools dedicated to ISO 2808, it meets its criteria. The company was also unaware that the standard specifies and describes more methods for measuring the thickness of dry coatings. Moreover, regular audits according to DMAIC were not conducted, only simple data compilations. In the case of ISO 2808, the measurement methods of the same physical phenomenon are divided into subgroups and labeled A, B, C, and D, where the standard describes them in seven basic sections of measurement methods (ISO 2808, 2019: 5–33):

Measuring the thickness (ISO Standard 2808:2019) of dry coating:

1. Mechanical measurement method:
   - Method 4A – Based on thickness difference,

- Method 4B – Depth gauge,
- Method 4C – Surface profile scanning.

2. Gravimetric measurement method:
   - Method 5 – Based on mass difference.
3. Optical measurement method:
   - Method 6A – Cross-section,
   - Method 6B – Wedge cutting.
4. Magnetic measurement method:
   - Method 7A – Removable magnetic device,
   - Method 7B – Device using magnetic flux,
   - Method 7C – Device using magnetic induction,
   - Method 7D – Device using eddy currents.
5. Radiological measurement method:
   - Method 8 – Backscatter radiation method.
6. Photothermal measurement method:
   - Method 9 – Measurement using thermal properties.
7. Acoustic measurement method:
   - Method 10 – Ultrasonic thickness gauge.

The examined enterprise equipped its two operators with a manual coating thickness measuring device for mechanical measurement. This handheld device had a probe for measuring non-magnetic coating on a magnetic substrate. Management established a piece-rate bonus system where operators were paid 5 groszy gross (Polish pennies) per measured plate and deducted 10 groszy gross for each received complaint. These conditions were introduced in the bonus regulations. The operator's task included marking the package with the operator's symbols and the measured thickness within three tolerances: a) 160–170 μm b) 171–180 μm c) 181–190 μm Incoming complaints, amounting to 7.08% of the total deliveries according to the end customer's report, concerned extreme values, where the end customer also measured values according to ISO 2808. It was still profitable for the enterprise to replace defective plates, and employees were penalized by deduction of bonuses for inaccurate measurements, assuming that the measurements were not done precisely. The position for measuring the final product experienced frequent turnover. Employees complained about:

- an unfair bonus system (trying to prove that the claimed goods were within tolerance),
- monotonous measurement system in five places – on the edges and in the middle of the plate,
- professional burnout, lack of job rotation,
- no career development or promotion path,
- low management level – lack of motivation,
- lack of training or new technical solutions that could improve measurement quality.

The board of management of the studied enterprise decided to conduct an audit through an external company specializing in Six Sigma and lean production. An examination of the ISO 9001:2008 standard was conducted, from the quality manual to processes and workstations. Auditors met with the strategic customer of the studied enterprise to analyze which measuring devices they used according to ISO 2808. The audit led to the following conclusions for making changes:

- There was a discrepancy in the actual use of measuring devices. The studied enterprise used coating thickness measuring devices with mechanical measurement method 4A, while the end customer scanned the surface with mechanical measurement method 4C. The differences were minor, but the roughness of the rubberized film surface did not always match in the same measuring points. This was corrected in the production process along with the implementation of analytical sensors to collect data to examine the efficiency and quality of operators' work.
- The bonus system, in the auditors' assessment, was unfair to the operator who was more diligent in measurements. Although he rationed the plates within the measurement range, measuring them longer (6.143 seconds compared to the other operator's 4.805 seconds), he only earned 1,256.2 Polish Zlotys (gross) more annually, generating 14,730 fewer plate complaints compared to the other operator. The difference in the number of measured plates between Operator No. 1 and No. 2 is only 4336 in favor of operator No. 1 (see: tab. 1 and 2). The need to install sensors on measuring devices, primarily measuring the time of operators' work, allowed for the calculation of OEE (Overall Equipment Effectiveness) according to figure No. 1.

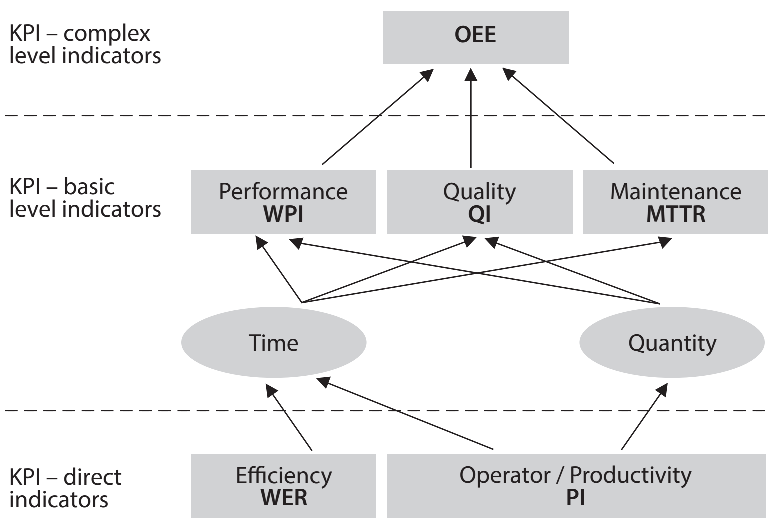

Fig.1. The three levels of KPI

Source: Own work based on: Ishaq Bhatti, Awan, Razaq, 2014: 312–314.

The mathematical formulas for the key performance indicators (KPIs) mentioned are as follows:

(WER) Work Efficiency Ratio – measures what percentage of available work time is actually used for productive work, with a greater emphasis on the aspect of labor rather than equipment usage. The formula is:

$$\text{WER} = \left(\frac{\text{Productive Time}}{\text{Total Work Time}}\right) \times 100\%,$$

where Productive Time is the number of hours (or other time units) in which employees actually perform productive tasks, and Total Work Time is the total number of hours (or other time units) available for work, including both productive and non-productive time (e.g. breaks, downtime).

(PI) Productivity Index – is a measure that assesses how effectively an organization uses its resources to produce goods or provide services. A higher index indicates that a larger quantity of products or services is produced per unit of time, indicating higher efficiency. The formula is:

$$\text{PI} = \frac{\text{Number of Produced Units}}{\text{Work Time}},$$

where Number of Produced Units is the total amount of goods or services produced in a given period, and Work Time is the total time spent producing these goods or providing these services in the same period.

(WPI) The Work Performance Index measures the value (typically expressed in monetary units) generated by an employee within a specified period. This can be useful for monitoring and enhancing work efficiency, planning human resources, as well as for assessing and comparing performance across different teams or departments within enterprise. The formula is represented as follows:

$$\text{WPI} = \frac{\text{Value of Produced Goods or Services}}{\text{Number of Employees/Poeple involved in the production or delivery process}},$$

where, the Value of Produced Goods or Services refers to the total value of all the goods or services produced or delivered by the company in a specified period, and Number of Employees/People involved corresponds to the number of employees or persons engaged in the production or delivery of those goods/services.

(QI) Quality Index – assesses the percentage of produced units that are free from defects and meet specific standards or quality requirements. A high QI indicates that the majority of produced units comply with the required standards, serving as an indicator of the effectiveness of production processes and quality control systems. The formula is as follows:

$$\text{QI} = \left(\frac{\text{Number of Good Units}}{\text{Total Number of Produced Units}}\right) \times 100\%$$

here, “Number of Good Units” refers to the quantity of produced units that satisfy specified quality criteria, and “Total Number of Produced Units” is the sum of all units produced during a given period, including both good and defective ones. The Quality Index is expressed as a percentage and is a key indicator in quality management systems, such as ISO 9001, where monitoring and continuous improvement of quality are the foundations of operational success. This index is also frequently used to analyze the effectiveness of changes in processes, technologies, or employee training.

(MTTR) Mean Time To Repair – the average repair time aids in understanding how long it takes for equipment to be repaired and restored to operational condition after a failure. This is crucial for planning production processes, minimizing downtime, and maximizing productivity. A short MTTR is desirable as it indicates efficient and rapid repair processes. The formula is presented as follows:

$$\text{MTTR} = \frac{\text{Total Repair Time in a Given Period}}{\text{Number of All Repairs in that Period}},$$

where “Total Repair Time in a Given Period” is the sum of the times spent on repairing equipment or systems during a specified time, and “Number of All Repairs in that Period” is the total number of repairs that took place in the same period. MTTR is typically measured in units of time such as minutes, hours, or days. Low MTTR values suggest that repair systems are effective, which minimizes downtime and increases equipment availability. High MTTR values may indicate a need to improve repair processes, train maintenance personnel, or invest in better repair tools and technologies.

(OEE) Overall Equipment Effectiveness – is a universal metric for assessing how effectively resources (machines, equipment, work time) are utilized in the production process, taking into account factors such as machine availability, performance, and the quality of produced products. Therefore, although the literal translation of OEE is “Overall Equipment Effectiveness”, in practice, this indicator is often interpreted as a measure of the overall efficiency of production processes, combining three important elements of performance: availability, performance, and quality. The formula is as follows:

$$\text{OEE} = \left(\frac{\text{Availability} \times \text{Performance} \times \text{Quality}}{100^3}\right) \times 100\%$$

here, availability measures what portion of the planned production time the machine is actually available for use, performance assesses whether the machine operates at maximum possible speeds, and quality refers to the ratio of good products produced to the total number of products produced. Based on mathematical formulas and collected data, the OEE is determined (see: tab. 1 and 2), and conclusions are drawn:

Operator No. 1

- The Quality Index (QI) is relatively high, suggesting that the quality of work by operator No. 1 is satisfactory and the majority of the products produced meet quality standards. The average QI is 95.06%. This result likely contributed to the lack of response from the company's management to make changes,
- The Productivity Index (PI) averages 265.89 units per hour, which could be considered low productivity in relation to the operator's potential capabilities, considering the capacity of the equipment they operate with. This is influenced by the fact that the work time is relatively low (averaging 55.30 hours per month with a standard work schedule). Work monotony and frequent breaks were cited as the main reasons in interviews with operators,
- The Overall Equipment Effectiveness (OEE) indicates low efficiency, which may be a result of both low productivity and insufficient performance. The average OEE value is 55.86%, which is far from the desired values that should be close to 90–95% in well-managed production processes.
- Bonusing – assuming that the average PI is 265.89 units per hour and the average QI is 95.06%, it can be estimated that operator No. 1 generates a high quantity of pieces but also experiences a certain number of complaints. A high bonus may result from the large number of produced pieces, but the final effect is reduced by penalties for complaints, which is a demotivating and uncertain factor for the employee.

Operator No. 2

- The Quality Index (QI) is lower than that of operator No. 1, which may suggest that operator No. 2 produces more low-quality units. The average QI is 91.86%, indicating room for improvement in production quality.
- The Productivity Index (PI) for operator No. 2 is at a similar level to that of operator No. 1, averaging 265.89 units per hour. Like operator No. 1, this indicates low production efficiency, considering the available work time.
- The OEE for operator No. 2 is also low, with an average of 56.46%, pointing to the need for optimization of production processes and increased efficiency through faster and more accurate measurements.
- The work time for operator No. 2 is lower (averaging 49.25 hours per month), which could indicate insufficient use of work time or production downtime.

The data suggested that both operators have the potential to increase production efficiency, considering the relatively low Productivity Index (PI) and Overall Equipment Effectiveness (OEE). However, faced with the increasing demand for production and considering the monotony of the work performed, it was suggested either to rotate positions so that each production employee performs measurements, or to introduce a technological innovation in the form of a robotic measuring arm and modernization of the film application line. A line was designed to fit the film application process, which additionally polishes it. Laser triangulation sensors support the reading of the total coating thickness on plates made of stainless steel.

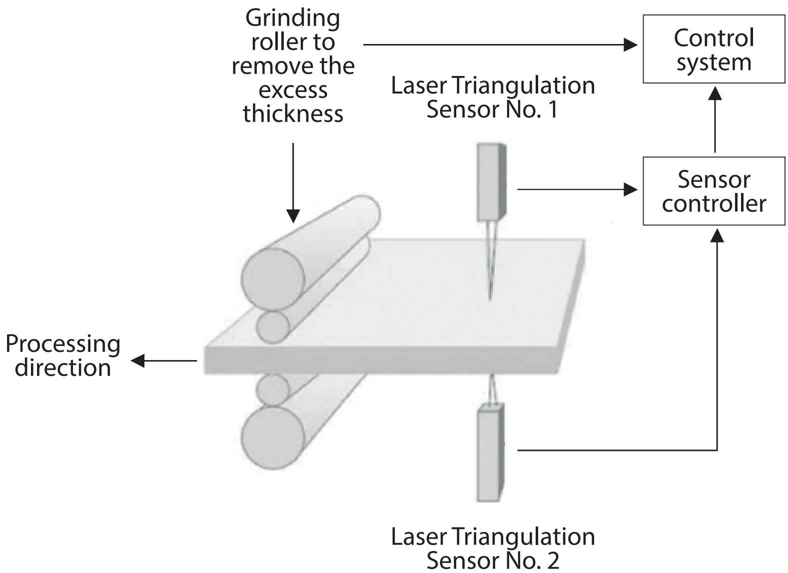

Fig. 2. Conventional diagram of laser triangulation sensor measurement application

Source: Own work.

A measuring device with a robotic arm was introduced into the workflow, which scans the surface in accordance with method 4C used by the external customer.

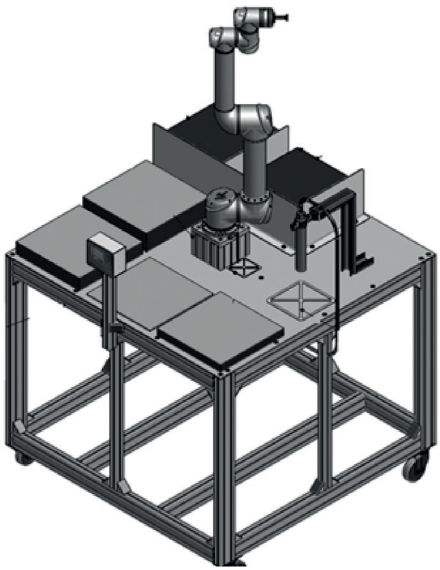

Fig. 3. Measuring device assessing formats after grinding (provided with permission from Cobotex company)

Source: Cobotex company

Tab. 1. Annual performance of operator no. 1 at the measurement station vs. number of complaints, with calculation of average measurement takt and KPI Source: Own work based on data from the studied enterprise.

Month	Quantity of Measurements	Quantity of Complaints	Measurement Takt (sec)	Actual Production Time (h)	Bonus in Polish Zlotys	PI	WER	QI	WPI in Polish Zlotys	MTTR (h)	OEE
January	35455	235	5.12	50.76	1749.25	250.00	30.21%	99.34%	349850	2.00	59.09%
February	42344	2349	4.85	60.21	1882.30	247.06	35.84%	94.74%	376460	2.00	70.57%
March	29503	541	8.52	71.10	1421.05	260.00	42.32%	98.20%	284210	2.50	49.17%
April	45921	3213	4.34	59.23	1974.75	250.00	35.26%	93.46%	394950	1.50	76.54%
May	39253	2100	5.23	60.08	1752.65	252.94	35.76%	94.92%	350530	2.00	65.42%
June	28233	3115	9.21	80.20	1100.15	271.43	47.74%	90.06%	220030	3.00	47.06%
July	51233	4120	3.94	60.58	2149.65	250.00	36.06%	92.56%	429930	1.25	85.39%
August	15255	2455	4.32	21.25	517.25	291.67	12.65%	86.14%	103450	3.50	25.43%
September	43432	1232	4.75	58.93	2048.40	244.44	35.08%	97.24%	409680	1.75	72.39%
October	35234	1545	6.15	62.83	1607.20	256.25	37.40%	95.80%	321440	2.75	58.72%
November	23123	333	9.32	60.72	1122.85	276.92	36.15%	98.58%	224570	2.50	38.54%
December	13211	45	4.82	17.75	656.05	340.00	10.56%	99.66%	131210	3.00	22.02%
Total/ Average	**402197**	**21283**	**5.88**	**55.30**	**17981.60**	**265.89**	**32.92%**	**95.06%**	**3596310**	**2.31**	**55.86%**

Source: Own work based on data from the studied enterprise.

Tab. 2. Annual performance of operator no. 2 at the measurement station vs. number of complaints, with calculation of average measurement takt and KPI

Month	Quantity of Measurements	Quantity of Complaints	Measurement Takt (sec)	Actual Production Time (h)	Bonus in Polish Zlotys	PI	WER	QI	WPI in Polish Zlotys	MTTR (h)	OEE
January	21455	342	4.12	24.95	1038.55	250.00	14.85%	98.43%	207710	2.00	35.76%
February	41141	4322	4.35	54.93	1624.85	247.06	32.70%	90.49%	324970	2.50	68.57%
March	38208	3233	5.31	61.13	1587.10	260.00	36.38%	92.20%	317420	2.25	63.68%
April	32445	4333	4.95	50.57	1188.95	250.00	30.10%	88.22%	237790	1.50	54.08%
May	41223	4560	5.36	68.17	1605.15	252.94	40.57%	90.04%	321030	2.00	68.71%
June	31440	3434	6.15	59.58	1228.60	271.43	35.46%	90.15%	245720	2.75	52.40%
July	47860	6322	3.45	51.92	1760.80	250.00	30.91%	88.33%	352160	1.75	79.77%
August	25340	2550	4.55	35.25	1012.00	291.67	20.98%	90.86%	202400	3.50	42.23%
September	46322	2330	4.86	65.68	2083.10	244.44	39.10%	95.21%	416620	1.50	77.20%
October	35234	2300	3.95	41.18	1531.70	256.25	24.51%	93.87%	306340	2.50	58.72%
November	24555	1432	7.15	51.61	1084.55	276.92	30.72%	94.49%	216910	3.00	40.93%
December	21310	855	4.23	26.04	980.00	340.00	15.50%	96.14%	196000	3.00	35.52%
Total/ Average	**406533**	**36013**	**4.87**	**49.25**	**1393.78**	**265.89**	**29.32%**	**91.86%**	**3345070**	**2.35**	**56.46%**

Source: Own work based on data from the studied enterprise.

As a result of these changes, a new production line was launched with triangulation sensors and a robotic arm, which underwent a year-long efficiency study in addition to the calculation of bonus payments. Changes were made in the context of retaining employees in the studied enterprise:

– The operators were separated. One was trained in the operation and monitoring of the grinding line for the applied rubberizing film, while the other was trained in collaborating with the measuring arm for operation, programming, and setting variable positions.
– The piecework and bonus system was changed to a bonus linked to the absence of downtime, continuity of line maintenance, quality of workplace cleanliness, and adherence to health and safety rules associated with the robot.
– A job rotation system was introduced to avoid the monotony of the same position or tasks.
– The introduction of automation stabilized the employee turnover situation.
– It increased satisfaction with innovative production solutions that support their tasks.
– It opened up career advancement opportunities within the company.
– It enhanced the company's prestige – it was no longer perceived as a poor employer.
– It impacted on the environmental aspect by minimizing post-production waste through a decrease in the number of complaints.
– It increased the company's production efficiency, which translated into the upskilling of employees operating more advanced systems.
– It minimized the amount of overtime, which was prevalent in the previous system.

Based on data from Table 3, the robotic arm produced 109,905 more formats in a year than the two operators performing these tasks manually. The number of complaints dropped from 57,296 to 35 formats. This allowed for savings and, in the short term, a return on investment.

Tab. 3: Annual performance of robotic measuring arm at the measurement station vs. number of complaints, with calculation of average measurement takt and KPI Source: Own work based on data from the studied enterprise.

Month	Quantity of Measure-ments	Quantity of Compla-ints	Measure-ment Takt (sec)	Actual Production Time (h)	PI	WER	QI	WPI in Polish Zlotys	MTTR (h)	OEE
January	71,440	11	3.15	62.52	1,143.00	37.21%	99.98%	642960	6.25	92.79%
February	68,455	2	3.40	64.65	1,059.00	38.48%	100.00%	616095	24.50	89.15%
March	68,450	5	3.17	60.28	1,136.00	35.88%	99.99%	616050	5.50	90.05%
April	70,300	2	3.15	61.51	1,143.00	36.62%	100.00%	632700	3.75	91.85%
May	78,240	0	3.02	65.63	1,192.00	39.07%	100.00%	704160	4.00	95.57%
June	79,200	0	3.01	66.22	1,196.00	39.42%	100.00%	712800	5.00	96.11%
July	68,300	0	3.23	61.28	1,115.00	36.48%	100.00%	614700	6.00	90.63%
August	78,500	12	2.85	62.16	1,263.00	37.00%	99.98%	706500	4.00	95.22%
September	79,250	0	2.99	65.82	1,204.00	39.18%	100.00%	713250	2.00	96.01%
October	82,200	0	2.97	67.82	1,212.00	40.37%	100.00%	739800	2.00	96.82%
November	92,000	2	3.01	76.92	1,196.00	45.79%	100.00%	828000	27.00	91.88%
December	85,300	1	3.15	74.64	1,143.00	44.43%	100.00%	767700	12.00	96.88%
Total/ Average	**918,635**	**35**	**2.50**	**65.79**	**1,166.70**	**39.16%**	**100.00%**	**8294715**	**8.50**	**93.58%**

Source: Own work based on data from the studied enterprise.

Summary

The focus of this article was an enterprise demonstrating how technological innovations can effectively enhance quality control processes while simultaneously increasing employee satisfaction and reducing turnover. A key element of this organization's success was its strategic focus on employee needs and an adaptive approach to implementing new technologies. Employee expectations were considered through the analysis of production efficiency using Key Performance Indicators (KPIs), while simultaneously recognizing and managing potential challenges and adversities arising from the implementation of changes. The foundation of the strategy was to maintain a balance between technology and the human factor. The execution of this strategy required employee retention management based on solid process foundations. The integration of technological innovations encompassed all aspects of the enterprise's operations, with retaining valuable employees through innovations becoming a key component of a dynamic management strategy. This approach reflects the concepts of thinkers like Peter Drucker, who emphasized the importance of innovation and entrepreneurship in creating business value, and Gary Hamel, who highlighted the need for continuous transformation of organizations in response to changing market conditions. The strategy is based on the premise that the continuous utilization and adaptation of internal and external resources within an organization allows for effective adaptation to changing market conditions, forming the foundation for building long-term competitive advantage.

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Streszczenie

Wpływ innowacji technologicznych na zatrzymanie pracowników w przedsiębiorstwach: studium przypadku kontroli jakości

Artykuł analizuje wpływ innowacji technologicznych na zatrzymanie pracowników w sektorach produkcyjnych, skupiając się na studium przypadku kontroli jakości. Rozważa, jak technologia, poprzez zmniejszenie monotonii pracy manualnej i zwiększenie efektywności, może poprawić doświadczenia pracowników. Autorzy badają zastosowanie innowacyjnej technologii w kontekście kontroli jakości, zwracając uwagę na wyzwania związane z ich wdrożeniem, takie jak bezpieczeństwo, koszty i potrzebę szkolenia pracowników. Artykuł podkreśla, jak poprawne wykorzystanie technologii może prowadzić do zwiększenia satysfakcji z pracy, obniżenia rotacji pracowników i poprawy wydajności, poprzez prezentację przypadku przedsiębiorstwa, która z powodzeniem wdrożyła technologie do swoich procesów kontroli jakości. Autorzy zaznaczają, że skuteczne wdrożenie innowacji technologicznych wymaga strategicznego podejścia, które uwzględnia zarówno technologiczne, jak i ludzkie aspekty. Niekiedy potrzebne jest wsparcie firm zewnętrznych aby przezwyciężyć przyzwyczajenia lub procesy jakie stoją naprzeciw zmianom.

Słowa kluczowe: innowacje technologiczne, automatyzacja, zatrzymanie pracowników, zmniejszanie monotonności, zadowolenie z pracy, kontrola jakości

O autorach

Krzysztof Stall – doktorant w zakresie nauk o zarządzaniu i jakości na Wydziale Organizacji i Zarządzania Politechniki Łódzkiej. Dyrektor generalny w firmie o profilu produkcyjno-handlowym (MMR Group Sp. z o.o.) oraz współwłaściciel firmy o profilu księgowo-podatkowym (Kowalska & Stall Sp. z o.o.). Dziedziny badawcze: zarządzanie, logistyka, zarządzanie łańcuchem dostaw, innowacyjność, przemysł drukarski, jakość i kontrola jakości. Autor artykułów w czasopismach naukowych.

Grzegorz Kruk – absolwent Wyższej Szkoły Bankowej w Gdańsku. Dziedziny badawcze: ekonomia i finanse, psychologia, matematyka. Autor wielu artykułów w czasopismach naukowych.