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The Operational Strategies of a Manufacturing Company: The Case of Italmetal

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Abstract: The article examines strategies to increase operational efficiency at Italmetal, a manufacturer of cold-stamped metal components for the automotive and household appliance sectors. The analysis identified key issues such as low overall equipment effectiveness (OEE), extended changeover times, and supply chain management inefficiencies. A combination of quantitative (KPI, OEE, backlog analysis) and qualitative (SWOT, benchmarking, interviews) methods was used to identify the primary sources of inefficiency. In response to the diagnosed challenges, a comprehensive improvement plan was implemented based on Lean Management, Six Sigma, Total Quality Management (TQM) and Business Process Reengineering approaches. Key actions include waste elimination, process standardisation, capacity planning, preventive maintenance and digital integration using IoT technologies and ERP systems. Particular emphasis was also placed on the development of human capital, systematic training and interdepartmental cooperation as the foundation for lasting organizational changes. The case study presents the implemented improvements in three strategic pillars: processes, human resources, and technology. The use of operational tools such as Power BI, Kanban and FIFO logistics supports real-time decision-making and contributes to increased efficiency. The results obtained indicate a significant improvement in productivity, quality and operational flexibility, allowing Italmetal to maintain its competitive advantage and ensure long-term, sustainable development.

Keywords: Lean Manufacturing, operational efficiency, Ishikawa, PDCA, digitalisation

1. Introduction

This article analyses strategies to enhance Italmetal's operational efficiency in cold metal stamping. The study investigates key challenges, such as low OEE, long setup times, and supply chain inefficiencies, affecting productivity and competitiveness. Using KPIs, SWOT, and Ishikawa analysis, the research identifies critical weaknesses and proposes improvement strategies based on Lean, Six Sigma, and digitalisation to optimize processes and resource management.

2. Operational Strategies – Theoretical Background

To improve organizational processes and product quality, various strategies are implemented.

Lean Thinking is a methodology that focuses on reducing waste and creating efficient, standardized processes at low cost. This strategy, derived from the Toyota Production System (TPS), aims to eliminate non-value-added activities, improve efficiency, and empower employees in the process of continuous improvement (Womack & Jones, 2003).

Six Sigma is a data-driven methodology that uses statistical tools to identify and minimize defects, errors, and variability in organizational processes. The primary goal is to improve overall performance by reducing variation and ensuring a stable, predictable process. This approach includes tools like DMAIC (Define, Measure, Analyse, Improve, Control) which allow for systematic process improvement (Antony, 2006).

Total Quality Management (TQM) is a comprehensive management approach aimed at improving quality at all levels of the organization. TQM focuses on continuous improvement, employee involvement, and meeting customer expectations. By monitoring and improving all production factors in alignment with customer needs and technical standards, TQM ensures that quality is built into every aspect of the product and service (Juran, 1999).

Quality Function Deployment (QFD) is a method used to design production processes that align directly with customer requirements. By incorporating the 'voice of the customer' into every stage of product development and manufacturing, QFD helps prevent the need for post-production adjustments and ensures the final product meets customer demands (Akao, 1990).

Business Process Reengineering (BPR) involves a radical redesign of business processes to achieve substantial improvements in cost, quality, and speed. BPR seeks to optimize processes by eliminating redundant steps and automating procedures. The approach is based on a deep understanding of the existing processes and a strategic focus on eliminating inefficiencies (Hammer & Champy, 1993).

Capacity Planning plays a vital role in optimizing resource availability to meet service-level agreements (SLAs) and production requirements. It involves determining the required resources for various processes, such as workforce, production tools, and equipment, to ensure efficient service delivery (Chase et al., 2006).

Inventory Management is another key strategy for resource optimisation. It involves minimising inventory costs while maintaining enough stock to meet customer demand. Approaches like Just-in-Time (JIT), Material Requirements Planning (MRP), and Economic Order Quantity (EOQ) are used to ensure efficient inventory control and minimise storage costs. JIT, in particular, seeks to reduce inventory by delivering materials only when needed in the production process, thus reducing waste (Heizer & Render, 2009).

Supply Chain Management (SCM) encompasses all activities involved in sourcing, production, and distribution. It ensures the timely and cost-effective delivery of products to customers. SCM can be divided into two main components: Supply Chain Planning and Supply Chain Execution. Supply Chain Planning involves activities such as sales forecasting, demand planning, production planning, and procurement. Supply Chain Execution focuses on the actual movement of materials, production processes, and the fulfilment of customer orders (Simchi-Levi et al., 2003).

The Theory of Constraints (TOC) emphasizes identifying and managing bottlenecks within a system to improve overall system performance. The TOC process includes five critical steps: identifying the constraint, exploiting it, subordinating everything to it, elevating it, and avoiding inertia. By focusing on the most limiting constraint, TOC helps organizations enhance their performance and maximise throughput (Balderstone & Mabin, 1998).

3. The Case Study

3.1 Performance Improvement Analysis

This analysis focuses on enhancing Italmetal's operational strategy and performance by identifying key challenges and proposing targeted improvements in processes, workforce skills, and technology adoption, aiming to prevent future profitability issues and support sustainable long-term growth.

The focus is on optimising business operations, with particular attention to three key areas: processes, people, and technology. Each area is examined and improved to achieve strategic objectives related to quality, speed, reliability, flexibility, and cost control:

- Processes – operational efficiency is enhanced through the introduction of lean methodologies, standardization of procedures, and automation of production flows. These interventions reduce waste, production times, and improve resource utilization.
- People – investment in training and skill development is essential to improve collaboration among teams and foster a continuous improvement work environment. Additionally, leadership and interdepartmental management will strengthen the organization's agility.
- Technology – the adoption of advanced technologies, such as the Internet of Things (IoT) and ERP software, will improve process monitoring and resource planning, enabling faster decisions and increasing the ability to respond to market demands.

This overall strategy aims to maximize productivity, improve quality, and reduce costs, enabling Italmetal to successfully face future challenges and sustain its growth in the long term.

3.2. Tools Used for Analysis

The case study employed a combination of qualitative and quantitative tools to analyse and improve business operations, with a particular focus on collecting and analysing both numerical and non-numerical data.

Quantitative Tools. Tools such as OEE (Overall Equipment Effectiveness) were used to assess the overall efficiency of machines and identify areas for improvement in terms of availability, performance, and quality. In addition, the FIFO (First In, First Out) system was applied to optimize inventory management, reducing waiting times and improving material turnover. The customer backlog was also analysed, serving as a crucial indicator to monitor delivery delays and optimise order management.

Qualitative Tools. The SWOT analysis was fundamental in identifying the strengths, weaknesses, opportunities, and threats related to business operations. This allowed for a focus on strategic areas for continuous improvement. Benchmarking was used to compare Italmetal's performance with that of key competitors and identify best practices that could be adopted to gain a competitive edge. Furthermore, financial analysis helped assess the economic sustainability of the proposed changes and monitor operating costs, enabling informed decisions regarding technological investments and resource allocation for improvements.

Interviews. Another important qualitative tool was the interviews conducted with production managers, operators, and department heads. These interviews provided direct insight into daily issues, perceived inefficiencies, and improvement opportunities that were not evident from the numerical data. The responses allowed for integrating previous analyses with real-world information, enriching the understanding of business dynamics and offering concrete suggestions for process optimisation.

Tool Evaluation. Each tool used was evaluated to ensure it was reliable, meaning it produced consistent results over time, valid, meaning it measured what it was intended to, and generalizable, so it could be applied at a company-wide level to identify trends and areas for improvement on a larger scale.

4. Analysis of the Company's Current Operations

Italmetal, part of the Girardini Group, has been operating in the Polish market since 2004. Located in Jelcz-Laskowice, the company manufactures metal components for the automotive and household appliance sectors, with a focus on cold stamping of steel.

Italmetal manages the entire production cycle, from customer order to final product delivery, through a structured and efficient organization.

Customer Order Management – Italmetal ensures high accuracy and responsiveness in order management through the integration of EDI (Electronic Data Interchange) systems and Microsoft Dynamics 365 (Microsoft, n.d.). These tools enable the exchange of automated data with customers, reducing errors and processing times. Advanced order management allows for real-time monitoring of production status and deliveries, enhancing customer satisfaction and service reliability.

Supplier Selection and Management – the company follows a structured process for supplier qualification and monitoring, evaluating them based on customer technical specifications or corporate strategies. Key parameters such as quality, on-time delivery, and cost competitiveness are analysed. Supplier relationships are managed through a collaborative and data-driven approach, ensuring operational continuity and minimising supply chain risks.

Supply Chain Management – Italmetal optimises the entire procurement and logistics management process by combining various digital tools and lean strategies:

- Production Planning: the Gantt software provides a visual and dynamic management of the production phases, ensuring the optimal allocation of resources and materials.
- Purchase Order Management: Microsoft Dynamics MRP (Nishad & Sahu, 2015) is used for managing purchasing agreements and call-off orders, ensuring a continuous flow of raw materials and components in line with production needs.
- Inventory Management: through JIT (Just-In-Time) and Kanban methodologies, the company maintains an optimal inventory level, avoiding excess stock with--out compromising production.
- Inventory Monitoring: with Power BI, Italmetal has access to real-time updated data on stock levels and material values, enabling quick and strategic decisions for resource optimisation.

Production Management – the production department is organized to ensure efficiency and operational continuity. Shift planning and material management are optimised to reduce machine downtime and maximize productivity. The adoption of digital tools for production monitoring enables constant performance control, supporting quick decisions aimed at continuous improvement.

HR Management – human capital is a strategic resource for Italmetal. The company fosters a work environment based on efficiency, safety, and inclusion, with continuous training programs aimed at enhancing employee skills. HR policies focus on talent development, employee motivation, and adherence to workplace safety standards.

Quality and Certifications – Italmetal operates under a rigorous IATF 16949 certified management system, specific to the automotive sector. The approach to quality is based on defect prevention, continuous process improvement, and constant monitoring of production performance.

Maintenance – the maintenance department uses a data-driven approach to ensure the reliability and operational continuity of the equipment. Performance monitoring is based on key KPIs such as OEE (Overall Equipment Effectiveness), MTBF (Mean Time Between Failures), and MTTR (Mean Time to Repair). The strategies adopted include:

- Routine Maintenance, to ensure the proper functioning of the equipment.
- Preventive Maintenance (Wu, 2011), based on periodic programmes to reduce the risk of equipment failures.
- Predictive Maintenance, based on the use of advanced technologies such as IoT sensors, real-time data analysis, and machine learning algorithms to continuously monitor the condition of machines. Data collected from sensors (e.g., vibration, temperature, pressure, etc.) are analysed to identify patterns or signals that may indicate potential malfunctions or excessive wear of components.
- TPM (Singh et al., 2013) (Total Productive Maintenance), to involve the entire team in the efficient management of machines.

5. Strategies for Improving Operational Performance

5.1. Interviews

Quality

1. Question 1 regarding the main quality objectives – the main quality objectives are customer satisfaction and reducing non-quality costs, with KPIs integrated into the PBSC. The IATF sets process regulations.
2. Question 2 regarding the alignment of objectives between those of the company and those of the department – the company's objectives align with its policy, mission, and strategy, covering sustainability, health and safety, information security, quality, environment, and ethics.
3. Question 3 regarding the main challenges of quality assurance – the company aims to reduce human error and customer claims by installing cameras for product verification and defects, along with adopting visual management, machine learning, and digitalisation.
4. Question 4 regarding the possibility of reducing waste and customer complaints – the strategy to reduce waste and complaints starts with product development and FMEA analysis. Technology for defect detection is planned, and if defects persist, the company negotiates compromises with customers due to technological limits.

Production

1. Question 1 regarding the main objectives of the department – maximising efficiency, ensuring quality, reducing waste and raw material consumption, increasing capacity, improving flexibility, ensuring health and safety, and staff development.
2. Question 2 regarding the alignment of objectives between those of the company and those of the department – achieving financial milestones, involving

production in strategy, setting SMART objectives, promoting collaboration, and fostering a culture of operational efficiency.
3. Question 3 regarding the possibility of reducing scraps and customer complaints – reducing scraps is a priority, with visual management tools like monitors showing instructions, and scrap reduction being a shared responsibility, not just the quality department's.

Maintenance

1. Question 1 regarding the responsibilities of the department – maintaining equipment for cold metal stamping, resolving failures quickly to minimize interruptions, and upgrading technology to improve productivity and quality. Regular preventive maintenance ensures efficiency and prevents unexpected issues.
2. Question 2 regarding the alignment of objectives between those of the company and those of the department – the goal is to minimize downtime and waste by ensuring presses are well-calibrated, preventing mold breakages and component failures, which improves product quality.
3. Question 3 regarding the continuous improvement of the department – maintenance uses weekly, monthly, and quarterly analyses, Pareto charts, and the PDCA cycle. Key indicators are MTTR and MTBF, with TPM methodology for equipment upkeep.

Logistic

1. Question 1 regarding the responsibilities of the department – the management includes inventory control, production and shipment planning, transportation optimization, warehouse organization, traceability systems, supplier and logistics partner management, and ensuring safety and compliance.
2. Question 2 regarding the integration of the department within the company – and its impact on overall operational efficiency.
3. Integrating the logistics department has improved supply chain synchronization, reduced costs, and enhanced collaboration, resulting in faster responses, shorter delivery times, and better overall performance.
4. Question 3 regarding the reduction of losses due to material flow – regular inventories, waste reduction, optimized transportation, minimized warehouse idle times, and RFID use in the Kanban warehouse are key practices for efficiency.

Management Board

1. Question 1 regarding how the board of directors monitors and evaluates company performance – key KPIs include financial performance, customer feedback, benchmarking, and measurable objectives. Regular performance helps create a culture where success is rewarded and underperformance addressed.

2. Question 2 regarding the KPIs used to monitor the company – KPIs, including those in the Balanced Scorecard and monthly income statement, are analysed monthly to address underperformance and track financial results.
3. Question 3 regarding initiatives to ensure the company's environmental and social sustainability – the company focuses on reducing its environmental impact through eco-friendly technologies, emissions reduction, recycling, and energy efficiency. It also prioritises employee health and safety and publishes annual sustainability reports on progress and challenges.
4. Question 4 regarding how these initiatives is communicated to stakeholders – the company publishes annual reports on sustainability progress and holds ISO 14001:2014 (environmental management) and ISO 45001:2018 (health and safety management) certifications.

5.2. Identification of Problems and Opportunities

In order to clearly highlight Italmetal's internal strengths and weaknesses, as well as external opportunities and threats, a SWOT analysis was conducted. This structured approach helps to identify the key factors affecting the company's operational performance and competitiveness.

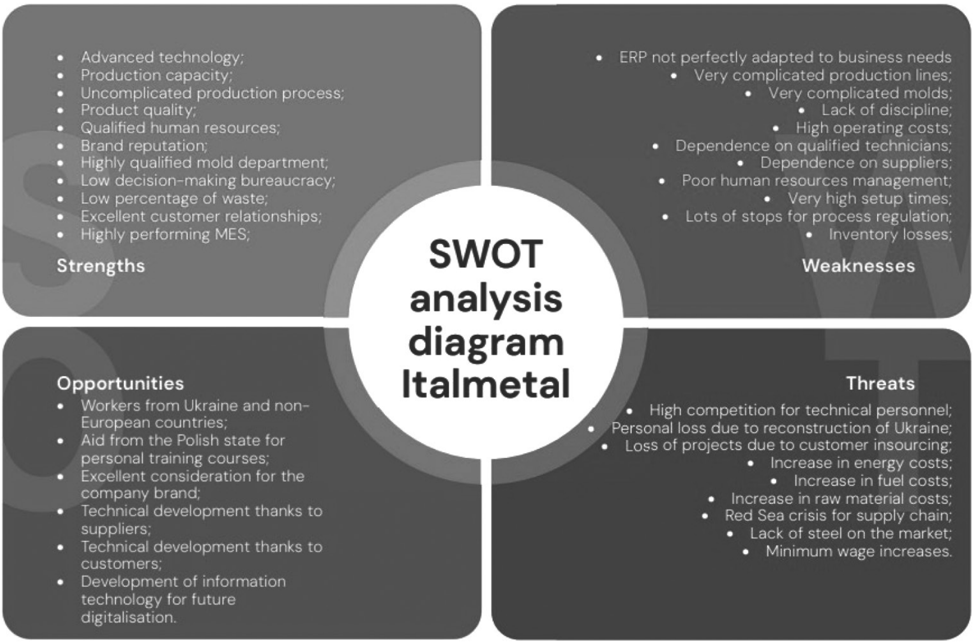

Fig. 1. SWOT analysis

Source: own elaboration.

While Fig. 1 summarises the findings, a short explanation is essential to contextualise the analysis and guide strategic decision-making. For this reason, each element of the SWOT is briefly discussed to better illustrate how it relates to current challenges and potential areas for improvement.

5.3. Selection of Improvement Strategies

The analysis will use the Ishikawa method and '5 Whys' to identify root causes. The SWOT analysis highlighted key weaknesses: low OEE, high setup times, difficulty in supplying materials, and complex machines.

Significant weakness: low OEE (Tab. 1)

Table 1. Low OEE analysis

Causes		Possible solutions
Material	Dimensions out of tolerance for the sheet	Automatic monitoring of sheet dimension and quality
	Thickness out of tolerance for the sheet	Automated material selection to ensure quality
	Poor quality of the sheet	Viso systems
Environment	Disorder on the line	Implement the 5S methodology to reduce disorder
	Noise	Improve lighting and noise levels on the line
	Insufficient lighting	
Methods	Preventive maintenance not performed on time	Implement predictive maintenance through the IoT
	Undefined processes	Standardise processes and automate operations
	Manual operations	
	Incorrect line setup	
Measurement	Finished product dimensions	Automatic checks for finished product dimensions and sheet measurement
	No automatic parameters check	
	No automatic checks for sheet dimensions	
Machine	No early warning system	Adopt predictive monitoring systems
	Incorrect lubrication	Automate lubrication processes and monitor tool conditions
	Tool anomalies	Adopt predictive monitoring systems
	Machine anomalies	
Men	No parameter checks	Continuous training and monitoring of critical parameters
	Manual operations	Automate manual operations
	Incorrect packaging	
	No detection of scrap	Introduction of Viso systems and machine learning

Source: own elaboration.

Italmetal's OEE is 68%, below the target of 70%, with efficiency losses due to raw material quality, manual operations, and equipment downtime. Automation through robotics, sensors, and vision systems could improve efficiency and reduce waste.

Significant Weakness: High Setup Times (Tab. 2)

Table 2. High setup times analysis

Causes		Possible solutions
Material	Dimensions out of tolerance for the sheet	Automatic monitoring of sheet dimensions and quality
	Thickness out of tolerance for the sheet	Automated material selection to ensure quality
	Poor quality of the sheet	Viso systems
Environment	Disorder on the line	Implement the 5S methodology to reduce disorder
	Noise	Improve lighting and noise levels on the line
	Insufficient lighting	
Methods	Mold change operations, undefined time	Standardise and automate the mold change process. Implement time tracking and establish standard changeover durations
	Unsuitable equipment	Invest in equipment suited for the mold change process
	Undefined internal and external activities	Define and document all internal and external activities
	Non-parallelized activities	Parallelise task where possible to reduce downtime and improve efficiency
Measurement	Machine parameters not updated	Implement automatic parameter updates and regular checks
	Operation times not respected	Establish clear time standards and monitor adherence
	Non-compliance with setup start time	Standardise setup times and enforce strict scheduling
	Performance of line after setup	Implement post-setup performance checks and continuous improvement
Machine	Unsuitable transfers	Optimize transfer methods and invest in appropriate equipment
	Unsuitable molds	Redesign and update molds to match production requirements

Causes		Possible solutions
	Unsuitable presses	Replace or upgrade presses to meet production standards
	Complexity of the machine	Simplify machine operations and invest in operator training
Men	No check of parameters	Implement automated parameter monitoring and regular checks
	Waiting time and unnecessary movements	Optimise workflow and layout to reduce waiting and unnecessary movement
	Manual operations	Automate repetitive tasks and improve processes
	Staff rotation	Establish a clear rotation schedule to balance workload and prevent fatigue
	Competence and training	Provide continuous training and skill development programme
	Teamwork efficiency	Promote collaboration and clear communication across teams
	Stress and tiredness	Implement regular breaks and stress management practices

Source: own elaboration.

The company's current setup time is 3 hours, with a target of 1 hour. High setup times are mainly due to the lack of 5S and SMED methodologies, staff discipline issues, and insufficient continuous improvement. Implementing Visual Management with monitors to guide staff and monitor timelines is a key strategy for improvement.

Significant Weakness: Difficulty in Supplying Materials (Tab. 3)

Table 3. Difficulty in supplying materials analysis

Causes		Possible solutions
Material	Lack of steel in the market	Diversify suppliers, negotiate long--term contracts, or explore alternative materials
	Poor quality of the sheet	Viso systems
Environment	Disorder in the warehouses	Implement the 5S methodology to reduce disorder
Methods	Inventory not properly carried out	Implement regular inventory audits and use barcode/RFID systems for tracking
	Operators do not unload materials from the warehouses (IT)	Assign clear responsibilities and improve communication with warehouse staff

Causes		Possible solutions
	ERP does not properly manage materials	Update or upgrade the ERP system to enhance material management capabilities
	Suppliers not well managed	Strengthen supplier relationships, establish clear performance metrics and conduct regular reviews
Measurement	Wrong material inventory	Regularly update inventory records and conduct accurate stock audits
	Suppliers not well evaluated	Implement a supplier evaluation system based on performance metrics and quality
	Wrong raw material budget	Review historical data and adjust the budget based on actual consumption and market trends
Machine	ERP not well calibrated	Recalibrate the ERP system and ensure it aligns with current processes
	Warehouse Wi-Fi not working	Upgrade the Wi-Fi infrastructure and perform regular maintenance
	Unsuitable scanners and PDAs	Replace outdated equipment with more efficient and reliable models
Men	Failure to comply with procedures	Conduct regular audits and reinforce adherence to procedures
	Errors in locating materials	Implement better inventory tracking systems and improve warehouse organization
	Short times for carrying out operations	Review and optimize workflows to allow sufficient time for tasks
	Lack of training	Provide regular training sessions and develop a continuous learning programme for employees

Source: own elaboration.

The company faces 20% stoppages due to supply shortages, aiming to reduce this to 15%. Challenges include steel shortages, poor ERP integration, and untrained personnel, leading to delays and inefficiencies. To address this, the company must optimize internal processes, update the ERP system, train staff, improve supplier relationships, and enhance inventory management for reliable material procurement and better performance.

Significant Weakness: Complex Machines (Tab. 4)

Table 4. Complex machine analysis Source: own elaboration

Causes		Possible solutions
Material	Materials that are not easy to put into production	Improve material handling processes and provide specific training for operators on handling challenging materials
Environment	Disorder on the line	Implement the 5S methodology to reduce disorder
	General discontent	Address concerns through open communication, feedback sessions, and improvement initiatives
Methods	Lack of clear instructions	Provide detailed and standardized work instructions for all tasks
	Creation of machines without involving technical operator	Involve technical operators early in the design and development phase of machines
	Production processes not fully defined	Define and document all production processes to ensure consistency and efficiency
Measurement	No evaluation of the complexity of the machine	Perform a thorough evaluation of machine complexity during the design phase. Evaluation to redesign the actual machine
	No assessment of the level of internal assistance from technicians	Regularly assess and document the level of internal technical support needed for operations
Machine	Machines built in steps	Implement a more streamlined machine design process to ensure smooth integration
	Parts of the line not perfectly interfaced	Improve the interface and communication between line components for better coordination
	Machines have no clear alarms	Install clear and intuitive alarm systems for quick issue identification
	Control panels are overloaded with commands	Simplify control panels by organizing and prioritizing commands for better usability
Men	Lack of skills and training	Implement regular training programmes and skill development initiatives
	Lack of availability of qualified manpower	Hire additional qualified staff or offer training to current employees
	Staff rotation	Establish a structured staff rotation system to ensure consistency and experience across roles
	Motivation and involvement	Foster a positive work culture, offer incentives, and involve employees in decision-making processes

Source: own elaboration.

The company faces 15% of stoppages due to machine complexity, aiming to reduce this to 10%. Challenges include the need for specialised skills and equipment for cold forming materials, low technician motivation, and lack of training and work instructions, leading to operational errors. The diverse origins of machinery also complicate production management. To address these issues, the company needs a strategic approach to improve recruitment, staff training, and motivation, while optimizing technologies and procedures. Continuous improvement is essential for long-term success.

6. Conclusions and recommendations

Italmetal faces key operational challenges, including low OEE, long setup times, material supply issues, and production line complexity. High setup times are exacerbated by the lack of methodologies like 5S and SMED, and personnel discipline. Introducing Visual Management can help improve setup processes and adherence to deadlines. Material supply issues are linked to market shortages and inefficient ERP integration, which can be addressed by optimising ERP systems, training staff, and enhancing inventory management.

Key recommendations for improvement include investing in machine learning, Visual Management, automation, IoT, and AI to reduce human error and drive Digital Transformation. By implementing these technologies, Italmetal can improve resource monitoring, optimise processes, and reduce waste and costs. These changes will enable the company to adapt to the fast-paced digital era and enhance its competitiveness in the market.

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Strategie operacyjne przedsiębiorstwa produkcyjnego: przypadek Italmetal

Streszczenie: W artykule autor analizuje strategie mające na celu zwiększenie efektywności operacyjnej przedsiębiorstwa Italmetal Sp. z o.o., producenta elementów metalowych tłoczonych na zimno dla sektora motoryzacyjnego oraz AGD. W toku analizy zidentyfikowano kluczowe problemy, takie jak niska ogólna efektywność wyposażenia (OEE), wydłużone czasy przezbrojeń oraz nieefektywności w zarządzaniu łańcuchem dostaw. Zastosowano połączenie metod ilościowych (KPI, OEE, analiza zaległości) oraz jakościowych (SWOT, benchmarking, wywiady) w celu identyfikacji podstawowych źródeł nieefektywności. W odpowiedzi na zdiagnozowane wyzwania wdrożono kompleksowy plan doskonalenia oparty na podejściach Lean Management, Six Sigma, Total Quality Management (TQM) oraz Business Process Reengineering. Kluczowe działania obejmują eliminację marnotrawstwa, standaryzację procesów, planowanie zdolności produkcyjnych, konserwację prewencyjną oraz integrację cyfrową z wykorzystaniem technologii IoT i systemów ERP. Szczególny nacisk położono również na rozwój kapitału ludzkiego, systematyczne szkolenia oraz współpracę międzydziałową jako fundament trwałych zmian organizacyjnych. Studium przypadku prezentuje wdrożone usprawnienia w trzech filarach strategicznych: procesach, zasobach ludzkich i technologiach. Wykorzystanie narzędzi operacyjnych, takich jak Power BI, Kanban oraz logistyka FIFO, wspiera podejmowanie decyzji w czasie rzeczywistym i przyczynia się do wzrostu efektywności. Uzyskane rezultaty wskazują na istotną poprawę produktywności, jakości oraz elastyczności operacyjnej, umożliwiając Italmetal utrzymanie przewagi konkurencyjnej oraz zapewnienie długofalowego, zrównoważonego rozwoju.

Słowa kluczowe: Lean Manufacturing, efektywność operacyjna, Ishikawa, PDCA, cyfryzacja