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Improving Manufacturing Efficiency and Resource Utilization Through OEE and Bottleneck Analysis at Belrise Industries Ltd

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Abstract **- This study examines manufacturing efficiency and resource utilisation at Belrise Industries Limited through an integrated assessment of Overall Equipment Effectiveness (OEE), cycle time, production capacity, and operational bottlenecks. Conducted as part of an on-the-job training project, the research focuses on the Press Shop, K17 BD and EA silencer lines, and CCB W610 robotic cells. A descriptive and analytical case-study approach was adopted, using shop-floor observations, cycle-time measurements, discussions with operators and supervisors, and company production, downtime, and quality records. The analysis evaluated equipment availability, performance, and quality, compared actual output with production targets, and identified constraints affecting operational efficiency. Results indicate that the K17 EA line achieved 252 parts against its target of 250, while the K17 BD line produced 219 parts against a target of 220. The CCB W610 line met its daily requirement of 250 parts despite variations in robotic cell cycle times. Major inefficiencies were associated with mechanical breakdowns, material and manpower shortages, sensor-related micro-stoppages, and suboptimal robot programming. Quality losses were comparatively limited. The study recommends preventive maintenance, improved material coordination, standardised work practices, and robotic cycle optimisation to strengthen productivity, resource utilisation, and continuous improvement in automotive component manufacturing across the selected production areas studied.**

Keywords - Overall Equipment Effectiveness, Bottleneck Analysis, Manufacturing Efficiency, Capacity Utilisation, Cycle Time, Automotive Industry.

I. INTRODUCTION

The project titled “Improving Overall Equipment Effectiveness (OEE) and Capacity Utilisation Through Bottleneck Analysis in the Automotive Manufacturing Industry” was carried out at Belrise Industries Limited as part of the On-the-Job Training (OJT) programme. This study focused on observing actual shop-floor manufacturing processes to evaluate how effectively machines, manpower, and resources are utilized across key operating areas such as the Press Shop, K17 BD and EA silencer lines, and CCB W610/M310 and CCB M110 operations. By gathering production records, conducting floor observations, and interacting with supervisors and operators, the study went beyond basic performance metrics to uncover the underlying causes of production losses and operational inefficiencies.

To systematically evaluate manufacturing performance, the project utilized core industrial engineering concepts including Overall Equipment Effectiveness (OEE), cycle time, and bottleneck analysis. OEE serves as a standard metric to measure equipment utilization by evaluating three critical dimensions: Availability, Performance, and Quality. Additionally, cycle-time analysis was employed to estimate actual production capacities against targeted goals, while bottleneck analysis targeted specific limitations—such as machine and robot breakdowns, material shortages, and welding or tapping issues—that restrict overall line output.

The primary purpose of this study was to identify practical opportunities for enhancing manufacturing productivity and equipment effectiveness at Belrise Industries. The specific objectives included analyzing the OEE of selected machines, measuring cycle times to estimate line capacity, diagnosing major production losses and bottlenecks, and proposing actionable measures to improve overall operational efficiency. Ultimately, the insights and recommendations derived from this study aim to support the company's continuous improvement

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goals and strengthen its competitive edge within the dynamic automotive component manufacturing sector.

II. LITERATURE REVIEW AND THEORITICAL BACKGROUND

A. Literature Review

The selected literature consistently supports OEE and bottleneck analysis as tools for improving manufacturing efficiency, equipment utilization, and resource management. Mncwango and Mdunge (2025) used DMAIC to identify material- and manpower-related downtime, while Zubair et al. (2021) linked low OEE to machine unavailability, malfunction, rework, and scrap. Tayal et al. (2020) improved automotive OEE through Pareto and fishbone analysis, and Singh et al. (2022) demonstrated that TPM improved performance in a metal industry. AlMashaqbeh and Hernandez (2024) identified speed losses and stoppages in plastic production, whereas Agustin et al. (2025) increased capacity by resolving a static-electricity bottleneck. Bhosale and Jadhav (2025) proposed real-time modified OEE, and Haddad et al. (2021) improved extrusion OEE using SMED. Barosz et al. (2020) applied OEE to compare human-operated and robotic lines. Zehra et al. (2024) integrated OEE with sustainability. Ng Corrales et al. (2020) reviewed OEE research systematically. Zhang and Feng (2021) developed a phased TPM model for SMEs. Ongbali et al. (2021) identified process capability, equipment failure, and material unavailability as major bottleneck factors. Di Luozzo et al. (2023) examined human factors, while Puvanasvaran et al. (2020) incorporated transportation and capacity balance. Chikwendu et al. (2020) optimized OEE factors statistically. Latsou et al. (2023), Subramaniyan et al. (2021), and Subramaniyan et al. (2020) addressed digital-twin, AI, and clustering-based bottleneck detection. Souza et al. (2020) extended OEE to healthcare. Together, these papers provide a strong methodological foundation for Belrise Industries Ltd. B. Mncwango & Zithobe Lisanda Mdunge, 2025 & 19 others.

B. Theoritical Background

The theoretical foundation of this study is grounded in Total Productive Maintenance (TPM), Lean Manufacturing, and continuous improvement frameworks. Originally introduced by Seiichi Nakajima, TPM aims to eliminate major equipment-related losses and maximize productivity through structured maintenance and operator involvement. A central metric within this framework is Overall Equipment Effectiveness (OEE), which evaluates equipment utilization through three critical dimensions: Availability, Performance, and Quality. By tracking the Six Big Losses—including equipment failures, setup delays, minor stoppages, reduced speeds, and defects—OEE highlights hidden sources of operational inefficiency.

To complement equipment-level metrics, the study integrates cycle time, capacity utilisation, and bottleneck analysis. Cycle time measures the duration required to complete a single production unit, directly influencing output capacity and line balancing. Capacity utilisation gauges how effectively available manufacturing resources are deployed. When workflows are constrained by slow machines, frequent breakdowns, or material shortages, bottleneck analysis identifies these limiting processes to guide targeted interventions.

Extensive literature emphasizes that while OEE provides a robust snapshot of machine performance, isolated metrics are insufficient to diagnose complex shop-floor issues. Recent studies highlight the value of data-driven approaches and Lean practices in optimizing manufacturing workflows. Consequently, this research bridges the identified gap by adopting an integrated conceptual framework that combines OEE measurement, cycle-time evaluation, and bottleneck identification. This multi-faceted approach enables a comprehensive root-cause analysis, ultimately driving higher operational efficiency and resource utilization in automotive component manufacturing.

III. MATERIALS AND METHODS

The study adopts a descriptive and analytical research design with a quantitative case-study approach to evaluate manufacturing performance at Belrise Industries Limited. Both primary and secondary data were utilized. Primary data was gathered through direct shop-floor and machine observations, cycle-time measurements, and discussions with operators and supervisors. Secondary data was obtained from company production records, OEE logs, downtime information, and quality reports. A purposive sampling technique was employed, focusing on specific sampling units and frames including the Press Shop (29 machines across seven tonnage categories), K17 BD and K17 EA silencer lines, and CCB W610 and M110 robotic cells. Data analysis incorporated OEE calculations (Availability × Performance × Quality), cycle-time and capacity evaluations, bottleneck identification, root-cause analysis of downtime and quality losses, and comparative benchmarking against targets.

Objectives of the Study:

The study was undertaken with the following objectives:

1. To analyse the Overall Equipment Effectiveness (OEE) of selected machines and production lines at Belrise Industries Limited.
2. To measure cycle time and evaluate the production capacity and capacity utilisation of selected manufacturing processes.
3. To identify major bottlenecks and production losses affecting machine and process performance.
4. To analyse the major causes of downtime, reduced performance, quality losses and other operational inefficiencies.
5. To recommend practical improvement measures for improving OEE, reducing bottlenecks and enhancing overall production efficiency.

IV. DATA ANALYSIS AND DICUSSION

Cycle Time Measurement and Production Capacity Estimation.

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TABLE I. OPERATIONAL CYCLE TIMES, HOURLY OUTPUT, AND DAILY PRODUCTION CAPACITY

Line / Machine Station K17 (BD) Line	Observed Cycle Time		
	3.00 min	**20**	**10.5**
K17 (EA) Line	2.50 min	24	10.5
CCB W610 (Robo Cell 1)	6.00 min	2.5	10.5
CCB W610 (Robo Cell 2)	5.90 min	2.5	10.5
CCB W610 (Robo Cell 3)	5.94 min	2.5	10.5
CCB W610 (Robo Cell 4)	5.48 min	2.5	10.5
K17 (BD) Line	3.00 min	20	10.5
K17 (EA) Line	2.50 min	24	10.5
CCB W610 (Robo Cell 1)	6.00 min	2.5	10.5
CCB W610 (Robo Cell 2)	5.90 min	2.5	10.5
CCB W610 (Robo Cell 3)	5.94 min	2.5	10.5

Cycle time measurements reveal balanced operational flows that closely align actual output with customer demand schedules. The K17 EA line recorded a fast 2.50-minute cycle time, producing 24 parts per hour and exceeding its shift target at 252 parts (100.80% achievement). The K17 BD line operated at a 3.00-minute cycle time, producing 219 parts against a 220-part target (99.55%). On the CCB W610 line, cycle times varied across the four robotic cells from 5.48 minutes (Cell 4) to 6.00 minutes (Cell 1). Despite these extended cell processing times, synchronized batch handling enabled the line to meet its 250-part daily requirement. Overall, processing speeds are capable of hitting current schedules, though minor variances in cell cycle times highlight opportunities for line balancing.

Evaluation of Operational Inefficiencies and Performance Drivers

TABLE II. **ROOT-CAUSE ANALYSIS OF AVAILABILITY, PERFORMANCE, AND QUALITY LOSSES**

Metric Category Availability Losses	Specific Loss Factor		
	Mechanical Breakdown	***Aging press components, lack of predictive maintenance***	***Press Shop (63T/80T) , K17 BD***
Availability Losses	Material & Labor Shortages	Delayed store-to-line replenishment , operator absenteeism	K17 BD Line
Performance Losses	Cycle Time Variations	Sub-optimal robot programming, improper operator motion	CCB W610 (Cell 1), K17 BD
Performance Losses	Micro-Stoppages	Sensor alignment errors, minor component misfeeds	K17 BD, 80T Press Group
Quality Losses	Dimensional Rejections	Tooling wear, blank thickness variations, weld spatter	Press Shop, K17 BD
Quality Losses	Rework & Touch-ups	Manual weld touch-ups, surface scratches	CCB Assembly Lines
Metric Category	**Specific Loss Factor**	**Root Causes Identified**	**Affected Work Areas**

Evaluating loss drivers shows that availability breakdowns and performance reductions cause the vast majority of efficiency losses, while quality remains consistently high. Availability losses stem primarily from mechanical failures in ageing 63T/80T presses and uncoordinated raw material transfers on the K17 BD line. Performance losses are predominantly caused by micro-stoppages, sensor alignment faults, and unstandardized operator movements during loading cycles. On the CCB W610 line, sub-optimal robot path programming at Cell 1 creates speed losses. Quality losses contribute the least to overall inefficiency, with rejection rates hovering around 3.00% across all lines, mainly caused by minor tool wear and manual weld reworks. Thus, intervention strategies must prioritize preventive maintenance and material flow over quality re-engineering.

V. DATA ANALYSIS AND DICUSSION

A. Findings

The analysis reveals that the selected manufacturing lines generally achieved their planned production volumes, although avoidable operational losses remained. The K17 EA line recorded a cycle time of 2.50 minutes and produced 252 parts against a target of 250, achieving 100.80 percent of its target. The K17 BD line operated at a cycle time of 3.00 minutes and

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produced 219 parts against a target of 220, achieving 99.55 percent. Across the four CCB W610 robotic cells, cycle times ranged from 5.48 to 6.00 minutes; nevertheless, coordinated batch handling enabled the line to meet its daily requirement of 250 parts. Availability losses were primarily linked to breakdowns in ageing 63T and 80T presses, delayed material replenishment, and operator absenteeism. Performance losses resulted from sensor alignment problems, component misfeeds, inconsistent operator movements, and inefficient robot path programming, particularly in CCB W610 Cell 1. Quality losses were less significant, with rejection rates reported at approximately 3 percent, mainly because of tooling wear, weld spatter, and rework. Overall, the findings indicate that equipment reliability, uninterrupted material flow, and improved cycle-time consistency offer more immediate opportunities for efficiency gains than major quality-process redesign. These patterns highlight the importance of integrating equipment performance monitoring with systematic bottleneck identification.

B. Conclusions

The study concludes that manufacturing efficiency at Belrise Industries Limited depends not only on the speed of individual machines but also on equipment availability, coordinated resource deployment, and balanced production flows. The K17 EA and BD lines operated close to their production targets, while the CCB W610 robotic operations demonstrated the ability to meet daily demand despite differences in cell cycle times. These results suggest that existing process capacity is broadly adequate for current schedules, but operational interruptions and inconsistent work practices constrain further efficiency improvements. Mechanical failures in older presses, material replenishment delays, minor stoppages, and suboptimal robot programming emerged as important areas requiring management attention. Since quality-related losses were relatively limited, improvement efforts should initially emphasise preventive maintenance, timely material availability, operator training, and cycle-time standardisation. Reviewing robot movements and applying systematic root-cause analysis can further support bottleneck reduction and line balancing. Regular monitoring of OEE components, downtime causes, and actual versus planned output would help managers prioritise corrective actions and evaluate their effectiveness. As the study covers selected production areas, its conclusions should not automatically be generalised to the entire plant. Overall, integrating OEE measurement with bottleneck and capacity analysis provides a basis for sustained operational improvement.

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REFERENCES

[1] Agustin, E., Marcello, D., Setiawan, M. F., & Diamond, M. V. (2025). Analisis bottleneck dan kapasitas mesin untuk meningkatkan efisiensi produksi cup plastik di PT “X”. Journal of Mechanical Engineering.

[2] AlMashaqbeh, S., & Hernandez, E. (2024). Evaluation and improvement of a plastic production system using integrated OEE methodology: A case study. Management Systems in Production Engineering.

[3] Barosz, P., Golda, G., & Kampa, A. (2020). Efficiency analysis of manufacturing line with industrial robots and human operators. Applied Sciences.

[4] Bhosale, P., & Jadhav, S. (2025). Uncovering the influence of operational factors on manufacturing efficiency with real time data. Scientific Reports.

[5] Chikwendu, O., Chima, A. S., & Edith, M. C. (2020). The optimization of overall equipment effectiveness factors in a pharmaceutical company. Heliyon.

[6] Di Luozzo, S., Starnoni, F., & Schiraldi, M. (2023). On the relationship between human factor and overall equipment effectiveness (OEE): An analysis through the adoption of analytic hierarchy process and ISO 22400. International Journal of Engineering Business and Management.

[7] Haddad, T., Shaheen, B., & Németh, I. (2021). Improving overall equipment effectiveness (OEE) of an extrusion machine using lean manufacturing approach. Manufacturing Technology.

[8] Latsou, C., Farsi, M., & Erkoyuncu, J. (2023). Digital twin-enabled automated anomaly detection and bottleneck identification in complex manufacturing systems using a multi-agent approach. Journal of Manufacturing Systems.

[9] Mncwango, B., & Mdunge, Z. L. (2025). Unravelling the root causes of low overall equipment effectiveness in the kit packing department: A Define–Measure–Analyze–Improve–Control approach. Processes.

[10] Ng Corrales, L. C. N., Lambán, M., Hernandez Korner, M. E., & Royo, J. (2020). Overall equipment effectiveness: Systematic literature review and overview of different approaches. Applied Sciences.

[11] Ongbali, S. O., Afolalu, S., Oyedepo, S., Aworinde, A., & Fajobi, M. A. (2021). A study on the factors causing bottleneck problems in the manufacturing industry using principal component analysis. Heliyon.

[12] Puvanasvaran, P., Teoh, Y. S., & Ito, T. (2020). Novel availability and performance ratio for internal transportation and manufacturing processes in job shop company. Journal of Industrial Engineering and Management.

[13] Singh, S., Agrawal, A., Sharma, D., Saini, V., Kumar, A., & Praveenkumar, S. (2022). Implementation of total productive maintenance approach: Improving overall equipment efficiency of a metal industry. Inventions.

[14] Souza, T. A., Vaccaro, G., & Lima, R. M. (2020). Operating room effectiveness: A lean health-care performance indicator. International Journal of Lean Six Sigma.

[15] Subramaniyan, M., Skoogh, A., Bokrantz, J., Sheikh, M. A., Thürer, M., & Chang, Q. (2021). Artificial intelligence for throughput bottleneck analysis—State-of-the-art and future directions. Journal of Manufacturing Systems.

[16] Subramaniyan, M., Skoogh, A., Muhammad, A., Bokrantz, J., Johansson, B., & Roser, C. (2020). A generic hierarchical clustering approach for detecting bottlenecks in manufacturing. Journal of Manufacturing Systems.

[17] Tayal, A., Kalsi, N. S., Gupta, M., Pimenov, D., Sarıkaya, M., & Pruncu, C. (2020). Effectiveness improvement in manufacturing industry: Trilogy study and open innovation dynamics. Journal of Open Innovation: Technology, Market, and Complexity.

[18] Xiang, Z. T., & Feng, C. J. (2021). Implementing total productive maintenance in a manufacturing small or medium-sized enterprise. Journal of Industrial Engineering and Management.

[19] Zehra, K., Mirjat, N. H., Shakih, S. A., Harijan, K., Kumar, L., & El Haj Assad, M. (2024). Optimizing auto manufacturing: A holistic approach integrating overall equipment effectiveness for enhanced efficiency and sustainability. Sustainability.

[20] Zubair, M., Maqsood, S., Habib, T., Jan, Q. M. U., Nadir, U., Waseem, M., & Yaseen, Q. (2021). Manufacturing productivity analysis by applying overall equipment effectiveness metric in a pharmaceutical industry. Cogent Engineering.

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