Published by :
https://www.ijert.org/
An International Peer-Reviewed Journal

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 12, UCBO - 2026

Optimization of Inward Quality Control Processes Using Lean Tools: A Case Study of an Automotive Component Manufacturer

Ajinkya Gaikwad
Student, MBA- Operations and Supply Chain Management,
School of Business,
Indira University,
Pune, India 41103
agaikwad3333@gmail.com

Dr. Manisha Maddel
Associate Professor & Guide, School of Business,
Indira University,
Pune, India-411033
manisha.maddel@indiraisbs.edu.in
ORCID: 0009-0008-1720-2959

Dr. Hetal Bhinde
Associate Dean Ph.D. Programs,
School of Business,
Indira University,
Pune, India-411033
hetalb19@gmail.com
ORCID: https://orcid.org/0000-0002-6435-5113

Abstract **- Effective material uptake and speedy quality clearance are essential to sustaining agile manufacturing, but operational disconnects between the physical manipulation of material and the digital tracking of enterprise often leave key supply chain holes. It has been pointed out in contemporary literature that in order to be transparent in the workplace, it is necessary to implement the principles of Lean manufacturing (muda: waiting, over-processing, and motion) alongside synchronized Enterprise Resource Planning (ERP) and built-in quality frameworks (TQM and PDCA). It is case study on the Inward Quality Inspection (IQC) workflow in the factory of Belrise Industries Ltd Chakan, Bhamboli. The main objective was to record the current receiving sequence, identify process delays and non-value added activities, identify systemic bottlenecks with the Lean and Root Cause analysis with 5 Why and develop an actionable and sequenced proposal for improvement. The method used was an applied and descriptive case study which was process-oriented and consisted of direct gemba observations of receiving, stores and quality hand-offs and a quantitative audit of the historical SAP Goods Receipt (GR) transactions in four purposively selected automotive component suppliers.**

The results confirm that the key constraint of the operations is informational latency, not inspection execution. An average of 3.0 days were found between receipt and posting to SAP (max 15.0 days for vendor BAPL), meaning that 25.5% of all transactions were above a 3 day threshold, causing the production planners to be blind and quality clearance to be stalled. Lean diagnoses found significant waiting waste, as well as over-processing caused by having to enter data into multiple paper registers, offline spreadsheets and core ERP screens, which increased the risk of data transcription errors and added 1.5 to 6.0 hours to the time it took to issue unplanned notifications. The study findings are that operational friction is caused by unstandardized hand-offs, lack of service level agreements (SLAs), and fragmented digital tools. In practice, management should establish a sub-4-hour GR posting SLA with visual aging boards, have cross-trained back-up operators, use a single scan-to-SAP workflow with barcode scanners, set up automated notifications that trigger the system every month, and institute monthly supplier performance scorecards.

Keywords - Lean Manufacturing, Inward Quality Inspection (IQC), SAP Goods Receipt (GR), Root Cause Analysis, Supply Chain Visibility.

I. INTRODUCTION

The expectations of the Indian automotive and auto-component manufacturing industry are very high with regard to Quality Compliance, Delivery timelines and material tracing during the entire manufacturing lifecycle. Tier 1 component suppliers are under increasing pressure to ensure seamless operations and business continuity, while simultaneously managing a complex supply chain. India's leading Tier-1 automotive component maker Belrise Industries Ltd. has operations in various engineering segments such as metal forming, polymer processing, suspension systems and e-mobility. In this high volume production environment, incoming raw materials and sub-components are inputs for critical, downstream production processes. So, the efficiency, reliability and precision of the Inward Quality Inspection (IQC) step, transcends the inspection desk to impact enterprise inventory visibility, production schedules and supplier performance monitoring.

Although incoming material verification is an important process in the strategic process, the incoming inspection operations are frequently facing operation bottlenecks, information delays and non-value adding activities. Inward Q.I has a dual operational duty not only to protect the manufacturing line from non conforming lots, but also to ensure that conforming materials are quickly verified, recorded and released to the manufacturing line to avoid a ‘starving' situation on the shop floor. There are often disconnects between the physical dock and digital system updates in practice. Artificial inventory blind spots and unnecessary shop-floor waiting are the result of arrivals of physical material before the SAP Goods Receipt (GR) posting, causing redundant manual logging, batch-traceability risks and

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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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delay between the different functional departments. To overcome these operational bottlenecks, one must think beyond the point of having to do manual checks and approach IQC as a data, integrated node within the entire supply chain.

This research paper aims to explore the current Inward Quality Inspection process at Belrise Industries Ltd, Chakan, Bhamboli on selected component for K17E, K17 B/D and Triumph vehicle platform. The study is based on Lean manufacturing concepts and using the RCA tools a systematic identification of process delays, operational waste (muda) and system disconnections between physical material handling and ERP transaction postings. It compares empirical transaction data with shop floor workflows to identify important performance indicators, including the biggest indicator of all: the gap between receipt and SAP posting, and supplier-specific differences. Finally, a phased implementation plan is proposed to achieve a practical solution to eliminate non-value added activities, to standardise inspection processes, to increase digital traceability and to improve supplier coordination without incurring too much operational overhead.

II. LITERATURE REVIEW AND THEORITICAL BACKGROUND

A. Literature Review

The closest study, An improvement of raw material incoming The most similar study, An improvement of raw material incoming inspection process by implementing Lean and IE techniques (2022), combines work study, ECRS, equipment changes and redesign of inspection level to reduce the incoming inspection process time. Yasarudin (2014) reviews automated optical inspection of supplier contamination defect. Bastos (2017) combines the concepts of supplier quality engineering with the lean performance indicators. A supplier-Kaizen model for an automobile parts company is proposed by Rusli, Jaffar and Ali (2013). Makua, Nleya, and Dewa (2023) adopt PDCA and built-in quality to minimize the occurrence of defects, scrap, rework and manpower for inspection. The study of PDCA, Poka-Yoke and TQM is done by Márquez-Figueroa et al. (2025) with 411 responses from maquiladora. Fleacă, Bujdoiu, and Severin (2025) use DMAIC with the incoming material inspection and traceability. To enhance the receiving-warehouse performance, Prayogo and Sutapa (2015) adopt 5S, layout, scheduling and FIFO. Jasti, Kota and Sangwan (2019) use the method of VSM and Kaizen in an auto-ancillary plant. Anuar and Mansor (2022) report flows from incoming to outgoing warehouses and significant amounts of waste were reduced, along with lead-time. In automobile components, Vinodh et al. (2015) present and apply current as well as future state VSM. Bhamu et al (2012) correlate VSM with quality, scrap, inventory, and lead time. The paper by Wiecha and Ćwikła (2019) is based on the implementation of SPC and CAQ in an automotive-parts supplier. Lean adoption and the tools that prove useful: Lean adoption is assessed by the authors of Lean, Lavios and Grzywa (2023) and they identify the following tools as useful: PDCA, Poka-Yoke, Andon, Kaizen, visual management, and 5S. Singla (2023) reports on the use of 5S and visual control in an automobile-parts manufacturing unit. Markulík et al. (2022) integrate Pareto, Ishikawa, 4W1H, process capability, microscopy and auditing. Knop (2022) uses Pareto-Lorenz, Ishikawa, and 5 Why to help analyze automotive hose defects. Sodkomkham and Chutima (2016) apply Lean Six Sigma and Kanban to decrease defects, lead time and inventories. A study by Manfredsson, Hilletofth and Reitsma (2019) focuses on supplier involvement with Lean training. Urban and Tochwin (2023) compare the implementation of Lean in three automotive companies, and stress the need for preparation, customization, and employee engagement.

B. Theoritical Background

This study's theoretical background combines principles of Lean Manufacturing, Quality Management Systems (QMS), and Enterprise Resource Planning (ERP) in automotive supply chains. Lean theory, often called the Toyota Production System, is a systematic process for maximising customer value by eliminating non-value added activities, commonly referred to as the TIMWOOD (Transportation, Inventory, Motion, Waiting, Over-processing, Over-production, and Defects). Waiting waste and over-processing are the most frequent structural barriers in inbound logistics and quality control, and may occur as queuing of waiting materials or unnecessary double handling of materials to be processed by clerks, adding to the operational lead time.

Complementing Lean, Total Quality Management (TQM) and the Plan-Do-Check-Act (PDCA) approach focus on built-in quality at the source, where incoming material verification is a seamless gateway and not a standalone process. Structured RCAs such as Ishikawa (Fishbone) diagrams and the 5-Why are critical to effective quality assurance as they focus on rooting out systemic method, manpower and technological deficiencies as opposed to superficial symptoms.

Modern manufacturing theory relates these philosophies of manufacturing to the flow of information in ERP. Operational synchronization is supported by digital integration, such as SAP ERP. Synchronizing the physical transportation of goods with real-time digital transaction records (Goods Receipt) is essential to eliminate informational lag, incorrect material requirements planning (MRP) and artificial buffer stocks. The key theoretical concept for end-to-end supply-chain visibility, traceability and agile flow is bridging physical receipt and digital systems by the use of automated identification tools (AI tools) such as barcodes and QR codes and integration of quality modules (SAP QM).

III. MATERIALS AND METHODS

A. Research Obejctives

A. Research Obejctives

In this study, an applied case research design with a non-experimental, process-oriented approach to the research is used that involves direct qualitative observations and descriptive quantitative analysis of transactional data. Primary operational learning was obtained through gemba visits to receive, stores, IQC and cross functional hand-offs and review of parallel documentation in paper, Excel, and enterprise platforms. Historical SAP Goods Receipt (GR) data for four suppliers were purposively selected and quantitative data were extracted. The analytical scope was limited to the transaction-level timestamps and the gap between the date when the material was physically available and the date when it was available in the digital system, measured by comparing the material document date with the posting date. Average and maximum receipts to posting time and percentage of transactions taking > 3 days were used for data

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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 12, UCBO - 2026

analysis. The Lean TIMWOOD waste taxonomy was used to categorize the qualitative process bottlenecks. Inefficiencies, record duplications and informational latencies were then identified using Ishikawa (Fishbone) diagrams and a 5-Why analysis to trace back to the core root causes. These findings directly inform an implementation matrix and actionable roadmap that aims to cut non-value added activities, to streamline material release, and enhance supplier quality oversight.

The analytical framework adopted was based on descriptive statistical methods such as mean delay, maximum observed delay and percentage of transactions exceeding a three-day threshold, and used them to set up operational baselines. Qualitative bottlenecks were classified following the waste classification of Lean TIMWOOD. To find the systemic failures of methods, manpower and technology, Ishikawa (Fishbone) diagrams and the 5-Why method were used for root-cause diagnostics. These results directly populated an objective-to-analysis linkage matrix transforming empirical process gaps into an actionable, phased roadmap concentrating on service level agreements, digital barcode scanning, and SAP Quality Management integration.

IV. DATA ANALYSIS AND DISCUSSION

Documenting and Analysing the Current Inward Quality Inspection Process Flow.

TABLE I. DOCUMENTING AND ANALYSING THE CURRENT INWARD QUALITY INSPECTION PROCESS FLOW

Paramter/ Operational Metric				
	Primary Activities Performed	***Hand-Off & Interface Points***	***Data & Information Media Used***	***Observed Process Friction / Bottlenecks***
Material Receiving	Gate entry check, vehicle offloading, physical count, challan verification	Security gate to Warehouse / Stores Receiving	Physical Delivery Challan, Gate Register (Paper)	Redundant manual logging; receipt exists physically without digital system presence
System Receipt (SAP GR)	Verification against Purchase Order, batch creation, Goods Receipt posting	Stores Receiving to Enterprise System (SAP)	SAP ERP (MIGO transaction), Material Document	Average 3.0-day posting latency; dependency on dedicated single-user terminals
Quality Inspection (IQC)	Lot sampling, visual checks, dimensional verification,testing against specs	Stores to Inward Quality Control (IQC) Team	Inspection Check-sheet, Drawing Specs, Excel Log	Informal notification delays (1–4 hours); parallel tracking across isolated systems
Documentation & Clearance	Recording inspection results, usage decision determination, tag application	IQC Inspector to Quality Manager / SAP QM	Paper Inspection Report, Local Excel Sheets, SAP	Triplicate data entry across paper, spreadsheets, and system; transcription error risk
Material Release & Transfer	Removing quality hold, physical transfer to production or finished stores	IQC to Stores / Production Planning	Physical Identification Tags, Verbal/Email alerts	Lag of 30 minutes to 2 hours between physical clearance and consumer departmental awareness

The current-state mapping show a sequence of material intake that is in a broken state, with asynchronic lifecycles between physical operations and digital operations. A material flow analysis across the five phases of operation (gate entry to final production release) highlights the technical quality checks that are done in a systematic manner but identify the significant friction points in the administrative hand-over. The main procedural challenge is the unloading of the shipments until system logging, where the shipments are in physical holding but not traceable across the enterprise. Moreover, exchange of information is highly dependent on informal and non-standardized communication channels and leads to cumulative delays of up to six hours only when considering the notification transitions. Multiple disconnected documentation media (hard-copy gate logs, off-line spreadsheets and core ERP screens), fragment operational attention, reduce the effectiveness of physical to digital alignment and establish that inefficiencies are largely as a result of organizational workflow handoffs, and not the actual inspection tasks.

TABLE II. LEAN TIMWOOD WASTE CLASSIFICATION AND ROOT-CAUSE ANALYSIS

Lean Dimension / Waste Category	**Table Column Head**		
	Direct Empirical Observation	***Root-cause pathway***	***Underlying Systemic Factor***
Waiting Waste	3.0-day average lag from physical unload to SAP Goods Receipt posting	Unclear posting Service Level Agreements (SLAs) and lack of time-bound escalation rules	Method / Management
Over-Processing Waste	Dual logging of consignment details: physical paper registers followed by SAP entry	Fragmented administrative procedures requiring paper trails alongside digital entry	Method
Defects / Error Risk	Manual keyboard input of	Absence of barcode/QR	Technology / Data Entry

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ISSN: 2278-0181
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Lean Dimension / Waste Category	Table Column Head		
	Direct Empirical Observation	*Root-cause pathway*	*Underlying Systemic Factor*
	alphanumeric material codes, lots, and counts	scanning hardware and digital automated capture devices	
Communication Waste	1–4 hour lag before IQC notification; 0.5–2 hour lag before production release.	**Total** reliance on informal calls, messaging, and intermittent physical visits.	Communication / Manpower
Inventory Waste	Material parked physically at unloading staging zones under untracked status	Single-user SAP terminal constraints; absence of secondary cross-trained operators	Manpower/ Organization

This is because the Synthesizing field observations through the Lean TIMWOOD framework and root cause logic shows that administrative and systemic disconnects lead to operational losses. The 5-Why analysis reveals that the cause of the waiting waste is not the lack of care by staff, but because there are no SLAs, data capture tools are not integrated, and tribal coordination is relied upon too heavily. Waste over-processing is embedded in the system, in the form of dual-documentation policies, requiring physical paper logging in addition to ERP data. Since technology has not yet developed to replace the manual desktop terminals, data entry errors are always a potential hazard. Importantly, these non-value added activities can cascade along the process: poor inbound communication de-starts initiation of IQC inspection, and non-automated release confirmations create inventory that remains un-moved. The inefficiencies are therefore a combination of architecture at method, tool and procedure level.

TABLE III. EVALUATING DELAYS, WAITING TIMES, AND NON-VALUE-ADDED ACTIVITIES

Supplier Name	*Adiru Enterprises*	*BAPL*	*Pankaj Enterprises*	*Shree Automotive*	*Overall Process*
Total Records Analyzed	18	37	25	18	98
Average Receipt-to-SAP Gap (Days)	2.1	4.4	2.4	1.7	3
Maximum Observed Delay (Days)	4	15	9	3	15
Records Exceeding 3-Day Threshold	5	16	4	0	25
Share of Delayed Records (>3 Days)	27.80%	43.20 %	16.00%	0.00%	25.50 %

The quantitative assessment of the SAP Goods Receipt transactions is used to determine the single most important non-value added waiting period in the facility as being the receipt-to-system posting lag. Materials in the whole sample have an average operational blind span of 3.0 days, with more than a quarter (25.5%) having a blind span of more than 3 days. There was significant spread in performance across the vendors – Shree Automotive was operating very disciplined with an average latency of 1.7 days and no vendor breaches at the threshold, while BAPL had a much higher variance of performance, ranging up to a peak of 15.0 days and an average of 4.4 days. Over 43% of BAPL's shipments breached the three-day benchmark. This mismatch indicates that the system postings are delayed, which artificially bumps up the inventory availability from the quality inspectors and production planners, leading to an artificial delivery panic because of information delay without physical delay.

TABLE IV. CURRENT STATE VERSUS PROPOSED FUTURE-STATE IMPROVEMENT TARGETS

Operational Parameter/ Metric	*Current Baseline Performance*	*Proposed future-state target*	*Project Intervention Mechanism*	*Implementation Complexity*	*Strategic Impact & Priority Rank*
Average Receipt-to-SAP Gap	3.0 days	< 4.0 hours	Formal receiving SLAs, visual aging indicators, and management escalations	Low	High (Rank 1)
Critical Vendor Peak Delay (BAPL)	15.0 days	Same-day / <4.0 hours	Vendor-specific inbound schedule smoothing and expediting protocols	Low	High (Rank 2)
Transactions Over 3 Days	25.5% (25 of 98 records)	< 2.0%	Daily aging alerts, cross-trained secondary SAP backup operators	Low	High (Rank 2)

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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 12, UCBO - 2026

Operational Parameter/ Metric	*Current Baseline Performance*	*Proposed future-state target*	*Project Intervention Mechanism*	*Implementation Complexity*	*Strategic Impact & Priority Rank*
Manual Data-Entry Touchpoints	2 distinct manual stages	1 scan-to-SAP event	Barcode / QR-code scanning implementation at receiving bays	Medium	Medium-High (Rank 5)

The comparative analysis is presented as a proposed modernization plan, with a transition from reactive, manual-handling to a standardized, digitally-integrated approach to receiving. Taking the time from 3.0 days to under 4 hours to receive the shipment to the sub-4 hour SLA eliminates the operational blind spot that previously held 25% of incoming shipments for more than 3 days. Administrative actions such as formal agreements with time limits, backups of data operators and monitoring of dock aging, are low complexity and have high impact without any software delays. Later stages include automated barcode scanning, standardized SAP Quality Management (QM) logging and automated system notifications based on business rules that reduce informational latency to less than 15 minutes. These recommendations, supported by monthly vendor compliance scorecards, directly tackle empirical challenges to inventory traceability, operational speed, and cross-functional accountability at the supply-quality interface.

V. FINDINGS, CONCLUSIONS AND SUGGESSIONS

A. FINDINGS

The investigation shows that informational delays in the inward quality inspection process and disjointed work flows are the main reasons for operational bottlenecks in the process, not the quality inspection itself. Analysis of 98 Goods Receipt transactions in SAP showed an average of 3.0 days between the time the physical goods arrived and the time they were entered in SAP, and a maximum of 15.0 days. More than a quarter (25.5%) of the shipments analysed went over the critical time limit of three days, leaving an operational blind spot that prevented both planning and quality teams from seeing inventory. The performance of the vendors was quite uneven and while Shree Automotive had the same performance with an average of 1.7 days with none of the consignment having threshold breaches, BAPL took an average of 4.4 days with 43.2% consignment experiencing severe delay in the process.

When the lean diagnostic mapping was done, waiting waste was identified as the main structural inefficiency and some significant over-processing and communication lag were observed. Multiple documentation processes were followed at administrative gate registers, in hard copy spreadsheets in the back office, and in the main ERP screens, resulting in non-value-added administrative tasks and higher risk of transcription errors when manually entering data. In addition, there were delays of 1.5–6.0 hours between informal notification hand-offs and quality teams starting inspection and releasing inventory to production stores. These gaps were institutional in nature, revealed by the Root Cause Analysis using the 5-Why method, which showed that there was no standardized time-bound service level agreements, limited cross trained user coverage, and disconnection of the digital infrastructure. Finally, the critical problem areas that need to be addressed include setting posting targets, introducing automated barcode scanning, linking quality records to SAP QM and introducing structured supplier score cards.

B. Conclusions

The study finds that operational delays in the inward quality inspection process at Belrise Industries Ltd. stem from lack of collaboration in information flow and administrative transfers, rather than from technical inspection failures. The average delay between receipt and posting to SAP was 3.0 days, with as many as 15.0 days for certain suppliers, and more than a quarter of shipments taking longer than three days. This information delay means that there is significant waiting waste, which separates physical stock from enterprise resource planning and delays quality checks. In addition, duplicate paper registers, spreadsheets and ERP screens create redundant processing of data and increase the risk of transcription errors due to manual data entry, and informal notifications add to clearance delays. The root cause analysis using the 5-Why method identified that the inefficiencies were not due to mistakes by the operators; it was because there is a lack of standardized service level agreements, insufficient cross-trained backup coverage and disjointed digital tools. Immediate operational stabilisation, therefore, is needed using strict posting SLAs and visual ageing controls, before being followed by the technology integration of automated barcode scanning, unified SAP Quality Management logging, automated system notifications and structured supplier scorecards to gain end-to-end process visibility, velocity and traceability to enable sustainable performance improvements..

C. Suggessions

Hawkins Cookers Limited will need to implement a staged collaborative plan to achieve tangible operational improvements across all stakeholders:

- For Management & IT: Replace paper based four copy challans with automated and API integrated ERP e-way bill digital signature and reduce administrative burden and truck turnaround at the security gates.
- Plant Logistics & Floor Workers: Use a digital vehicle-docking schedule to eliminate single forklift waiting times, deploy electric tugs along primary transport aisles to reduce physical strain and designate dedicated FIFO lanes to clear workspace clutter.
- For Quality Assurance & Operators: Implement a “first-off” inspection alert (Andon) for mobile devices, along with the IS 2500 Portal for digitization, to ensure consistent acceptance decisions and reduce press shop scrap.
- For Suppliers & Subcontractors: Track QR-coded bulk metal circles and intermediate trolleys and implement returnable, weatherproof plastic crates with closed-loop inventory visibility, fewer dents during transport and smooth material transfers..

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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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D. Implications

The study has implications for operational stakeholders of an organization, such as:

- Eliminating the 3.0-day posting blind spot means that Inward Quality Control (IQC) & Stores can generate lots of material immediately when a vehicle arrives, avoiding the material queues. The use of a single digital log instead of broken paper and spreadsheet records decreases the amount of paperwork and errors that can occur during transcription.
- Production Planning & Operations: Real-time system visibility of incoming inventory eliminates MRP signal distortion, reduces line-stoppage alarms and speeds up production staging with automated clearance notifications.
- Procurement & Plant Maintenance: Clear accountability from shift to shift when tracking transactions, from reactive firefighting to standardized, SLA-based workflows.
- Suppliers: Objectives vendor scorecards offer turnaround benchmarks in a clear way, encourage accurate, advance documentation, and promote supply partnerships that are collaborative and quality-at-the-source..

E. Future Scope of The Study

Several key technical and strategic dimensions are recommended for future research, to develop this operational study:

- Post-Implementation & Statistical Validation: Validate actual performance data after implementing the proposed sub-4-hour SLA, barcode scanning and SAP QM module to quantify the throughput increases, operational cost savings and statistical error reductions.
- 2. Scope Expansion & Generalizability: Cross Plant Benchmarking across a wide variety of materials classes, commodity types and multi tier supplier chains.
- 3. Advanced Digital Technologies: Incorporating Industry 4.0 innovations at receiving docks, including IoT (Internet of Things) based RFID tracking, AOI (Automated Optical Inspection) systems and machine learning predictive quality algorithms for dynamic incoming lot sampling.
- Supplier Collaboration Platforms: Enhancing electronic systems, such as cloud-based Electronic Data Interchange (EDI), for automated Advance Shipping Notices (ASNs) and closed-loop, shared root-cause corrective action workflows with suppliers.

ACKNOWLEDGMENT

I would like to thank the Management, Operations and Quality Inspection staffs of Belrise Industries Ltd. Bhamboli, Chakan for the valuable support, guidance and resource sharing given during this project. Heartfelt thanks are due my academic mentors and colleagues for their insightful feedback and encouragement that aided in the successful completion of this study.

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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 12, UCBO - 2026

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