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## INVENTORY MANAGEMENT STRATEGIES FOR SUSTAINABLE FOOTWEAR MANUFACTURING- A STUDY OF AGRA'S FOOTWEAR INDUSTRY

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### ABSTRACT

Agra's footwear manufacturing cluster, which establishes the major part of the country's footwear economy, is struggling with long-established operational inefficiencies, degraded by growing environmental pressures. This paper explores the possibility of addressing these twin challenges through strategic inventory management in circular economy. Taking a mixed-methods approach, the study shows that inventory mismanagement leads to excessive stock, stockouts, and waste stockpile—disrupts cost-effective and environmentally sound operations. Facts from the real world reveal that basic methods such as ABC analysis, EOQ model calculations, and green procurement can quite intensely affect holding costs, minimize waste. The research also provides a spotlight on systemic issues such as policy driven inventory shortages, low levels of digital uptakes and poor supply chain infrastructure. It presents a comprehensive plan for developing a circular economy hub in Agra and suggests a phased plan for MSMEs to switch from manual to smart inventory systems. The footwear industry can become more resilient, profitable, and environmentally sustainable by rethinking waste as a resource and inventory as a strategic asset.

**KEYWORDS:** Inventory Management, Footwear Industry, Circular Economy, Waste Valorisation, Sustainable Production, Circular Economy Practices, Environmental Impact Reduction, Smart Supply Chain Solutions

### INTRODUCTION

Inventory management is a significant consideration in the footwear industry, which caters to a basic human requirement and exists on a global basis. Effectively managing inventory is critical to have the correct materials ready and available when required, limiting waste, and lowering costs in the supply chain, which all relate closely to profits and competitiveness. This function is particularly important in manufacturing industries, with planning and controlling inventories being a key activity in being able to manage operations effectively. However, in the context of India, these gaps are compounded

by the fact that many small- and medium-sized enterprise (SME) owners do not have a full understanding of what the real costs of holding inventory are although professionals and academics are trying to better understand these gaps.

footwear industry presents an interesting real-world test of how the fundamental issues of stock management; cost savings and environmentally friendly behavior are interconnected. As a key part of India's footwear economy, shoe making here promises fresh jobs, rising exports and broader economic lift-off for the region. Local firms blend old skills with new production equipment, a blend that also creates persistent inventory headaches. Managers must juggle shifting seasons, a patchwork of specialty leathers and the pressing need to weave green habits into every step of the supply chain. In such an environment, smart stock practice stops being just a way to trim bills, it becomes a device for using resources wisely and cutting waste. Worldwide shoe demand is climbing fast, driven by population growth, changing tastes and openings in new markets. That trend calls for fresh thinking on how to steer inventory so every pair leaves the workshop quickly, costs little to move and treads lightly on the planet. Brands that sit at the front of the footwear trend now see sustainability as something they must do, not a nice extra. To stay sharp and bounce back when challenges hit, they lean on strong inventory habits that keep operations running smoothly.

The complexity of inventory management in Agra's shoe manufacturing facilities is examined in this study, along with existing procedures and areas for development. To support the industry's long-term growth and worldwide competitiveness, the objective is to identify opportunities to apply inventory management to increase cost effectiveness and promote sustainable manufacturing practices.

### **Key Inventory Challenges in Agra's Footwear Industry**

Challenge	Impact
Overstocking	Increased storage costs, deadstock
Stockouts	Production delays, customer dissatisfaction
Manual Inventory Handling	Human errors, loss of tracking accuracy
Lack of ERP Integration	Inconsistent data, delayed decisions
Seasonal Demand Fluctuation	Difficult to forecast, causes mismanagement

### **LITERATURE REVIEW**

Inventory management sits at the heart of supply chain network; it covers every move a product makes, from the moment it is bought until it lands in a customer's hands. That task grows even more vital in the factory world, where squeezing costs and boosting profits remain on keeping shelves stocked just right. When the control slips, the bills add up-holding fees rise, goods sit too long, or orders run dry;

yet, good oversight lines up just enough of the right parts exactly when shoppers expect them, keeping expenses in check. In short, the aim is simple: buy materials in the amount and quality needed, at the hour they are needed; while keeping storage costs as low as possible so the business can gain every benefit of an orderly storeroom. (Obadire et al., 2022; Sharma & Arya, 2016). Agra's existing supply chain procedure, throws up serious hurdles for rolling out cutting-edge methods such as a Just-in-Time (JIT) model. JIT works only when a web of dependable, quick-to-respond suppliers sits close enough to deliver top-grade parts on a moment's notice, and right now that network is anything but steady. (Kootanaee et al., 2013). Managing inventory plays a key role in handling the supply chain. It covers the methods and plans used to supervise the movement of goods and materials from purchase to delivery. This matters a lot for factories that want to cut costs and boost profits. When you don't manage your inventory well, you can lose a lot of money. You might end up with high storage costs outdated stock, or run out of items. But when you do it right, you make sure your business has just enough stock on hand at the right time to meet what customers want, without spending too much. The main aim of keeping track of inventory is to get the right amount and quality of materials when you need them, while keeping storage costs low to get the most out of your inventory system. (Conceição et al., 2021; Sharma & Arya, 2016).

Agra's supply chain, as it stands, makes it tough for businesses to roll out modern stock-control methods such as Just-in-Time (JIT). JIT works only if suppliers are dependable, quick to respond, and usually close by so they can send quality materials at a moment's notice. Because Agra's local suppliers are still scattered and sometimes poorly organized, adopting that approach becomes tricky—a point many researchers echo when they call for better integration to sharpen forecasts, smooth production, and trim raw-material stock. (AlArjani et al., 2021).

Agra's footwear industry faces economic struggles and environmental issues. To thrive, manufacturers need strategies that minimize risks and create new opportunities to grow and innovate. They should focus on using green procurement methods to bring sustainability into their supply chain. This involves getting materials and services from suppliers who follow strict environmental and ethical practices. Doing this helps reduce waste, avoid depending too much on certain suppliers, and lowers the risk of supply shortages. These steps not improve a company's eco-friendly profile but also save money over time and strengthen its brand reputation. (Choudhary et al., 2024, Lestari, 2022).

Managing inventory well means focusing on demand forecasting, lead times, and safety stock. This helps prevent running out of stock or ending up with too much. Businesses often use methods like Economic Order Quantity or ABC analysis to handle inventory. These approaches provide a clear structure to manage both ordering and storage costs. They also help rank inventory by importance and value, so businesses don't have to rely just on instincts. (Reyes et al., 2015).

## METHODOLOGY

### Research Design

This study follows a mixed-method research approach. It combines both qualitative and quantitative methods to provide a broad perspective on how inventory management works in Agra's footwear manufacturing industry and how it affects cost control and sustainability. The research takes an exploratory and descriptive path to identify patterns, issues, and effective practices in this field.

### Data Collection Methods

Secondary data was collected from a wide range of sources, included reports from government agencies such as the Ministry of Micro, Small & Medium Enterprises (MSME), the Council for Leather Exports (CLE), The Agra Footwear Manufactures and Exporters Chambers (AFMEC) and documents pertaining to the Uttar Pradesh Leather Industry Policy. Academic sources, including journals, case studies, e-books, sourced from databases like, Google Scholar, ResearchGate, and Various related website.

### Data Analysis Tools

The collected data were analysed using a combination of quantitative and qualitative tools. Quantitative data were analysed using Microsoft Excel and Python to compute descriptive statistics including the Economic Order Quantity (EOQ), Safety Stock, and Reorder Point. A comparative analysis was also conducted to evaluate the cost efficiency of units before and after the adoption of improved inventory practices.

### Findings & Discussion

Systematic inventory management could generate substantial cost savings and efficiencies, it is inhibited by internal and external habits of operation as well as regulation, with a considerable time lag in technology adoption. This part separates these results analysis, linking them with the general economic and environmental conditions concerning the sector.

The quantitative analysis conducted for this study underscores the substantial, measurable benefits that structured inventory management can bring to Agra's footwear manufacturers. The data presented in **Table 1** demonstrates the potential for significant annual cost reductions through the implementation of various inventory strategies. **Numerical examples** show substantial cost reduction in different inventory strategies such as ABC Analysis and Just-in-Time (JIT) illustration the highest potential savings, estimated at ₹1,20,000 and ₹1,10,000 per annum, respectively. This suggests that even basic, systematic approaches can yield considerable financial returns.

## ABC Analysis

### Concept

Categorize inventory into A, B, and C based on value. Focus control on high-value 'A' items.



### Formula

Savings = (Value of A items × Cost Reduction %) + B/C Control Savings

### Given:

- Total inventory holding cost = ₹6,00,000/year
- A items = 70% of value → ₹4,20,000
- Reduction in holding cost = 25%
- Additional savings on B/C items = ₹15,000

### Calculation:

Savings = ₹4,20,000 × 0,25 + ₹15,000  
= ₹1,20,000

## Just-In-Time (JIT) Method

### Concept

Reduce inventory levels by synchronizing orders with production.



### Formula

Savings = Old Holding Cost – New Holding Cost + Waste Reduction + Rush Order Savings

### Given:

- Previous inventory = ₹4,00,000
- Holding cost = 20% = ₹80,000/year
- New inventory: ₹1,00,000 → Holding cost = ₹20,000
- Waste reduction = ₹25,000
- Rush order savings = ₹25,000

### Calculation:

Savings = ₹80,000 – ₹20,000 + ₹25,000 + ₹25,000  
= ₹1,10,000

## Green Procurement

### Concept

Use sustainable raw materials and processes to reduce waste.



### Formula:

Savings = (Old Waste – New Waste) + Other Savings

### Given:

- Annual purchase = ₹10,00,000
- Old waste = 8% → ₹80,000, New waste = 1% → ₹10,000
- Other savings = ₹15,000

### Calculation:

Savings = ₹80,000 – ₹10,000 + ₹15,000  
= ₹85,000

## Economic Order Quantity (EOQ)

### Concept:

Find the optimal order quantity to minimize total ordering and holding costs.

$$= \sqrt{\frac{2DS}{H}}$$

### Formula:

EOQ =  $\sqrt{2DS/H}$

### Given:

- D = 24,000 units/year
- S = ₹400/order
- H = ₹50/unit/year

### Calculation:

- Reduced spoilage = 30,000
- Bulk discount = 25,000
- Overstock handling = 36,400

**Total Savings = ₹95,000**

### Cost Comparison:

Old order size = 1000 units  
→ Ordering cost = ₹9,600  
Holding cost = ₹25,000  
New EOQ = 620 units  
→ Ordering cost = ₹15,480  
Holding cost = ₹15,500  
Total = ₹30,980

### Other Savings:

- Reduced spoilage = 30,000  
Bulk discount = 25,000  
- Overstock handling = 36,400

**Total Savings = ₹95,000**

### Buffer Stock Strategy

**Concept**  
 Maintain safety stock to prevent stockouts.



**Formula:**  
 Net Savings = (Old Stockout Loss - New Stockout Loss) - Extra Holding Cost

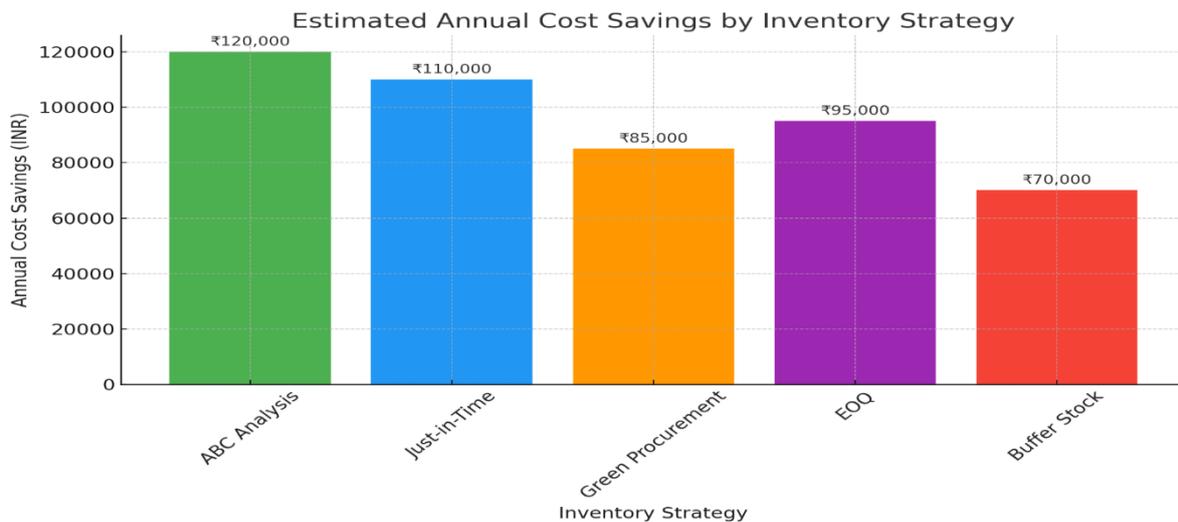
**Given:**

- Stockout cost = ₹10,000/event
- Before: 10 events/year = ₹1,00,000
- After: 2 events/year = ₹20,000
- Extra holding cost = ₹10,000

**Calculation:**  
 Net Savings = ₹1,00,000 - ₹20,000 - ₹10,000 = ₹70,000

### Estimated Cost Savings by Inventory Strategies

Inventory Strategy	Annual Cost Savings (INR)
ABC Analysis	₹ 1,20,000
Just-in-Time	₹ 1,10,000
Green Procurement	₹ 85,000
EOQ	₹ 95,000
Buffer Stock	₹ 70,000



**Managing the Regulatory and Economic Obstacles: The Combined Stressors on MSMEs:**

The internal challenges and problems in the functioning of footwear MSMEs in Agra are further intensified by the external disturbances created by national economic and regulatory factors. In particular, two policies have really changed the dynamics in which we manage inventory and costs: the Goods and Services Tax (GST), and the Bureau of Indian Standards (BIS) certification requirement.

Many small, informal businesses are ill-equipped to meet the certification process, which is time-

consuming, complicated, and divides footwear into over 20 categories. As a result, many customers have cancelled their orders because they won't accept non-certified products. With an estimated 350,000 pairs of unsold shoes piled up in factories and warehouses, the direct result has been a disastrous inventory crisis that has frozen about 2.5 billion rupees in capital.

**Waste Generation and Management: Statistics, Costs, and Circular Solutions:**

Beyond economic and regulatory pressures, Agra's footwear industry grappling with a significant environmental challenge rooted in its production and inventory practices. The cluster generates an estimated 45 tonnes of waste daily, creating a substantial environmental liability. This waste is composed of approximately 40% leather and 36% synthetic polymers like PVC and EVA, many of which are carcinogenic, making disposal particularly hazardous. The waste generation is split between the formal sector, which produces over 31 tonnes per day, and the informal, home-based sector, which generates more than 13 tonnes daily.

Currently, Agra lacks a formal system for processing this industrial waste. While formal units often have arrangements with waste dealers, the informal sector's waste management is hazardous. The Agra Municipal Corporation (AMC) collects about 57% of the waste from these home-based units, but the remaining 43%—nearly 6 tonnes per day—is improperly discarded in drains, open spaces, or burned, polluting the Yamuna River and releasing toxic gases. This mismanagement carries a high cost globally, fashion waste costs the economy over \$400 billion annually, and the environmental damage from mismanaged waste can range from \$3,300 to \$33,000 per ton per year.



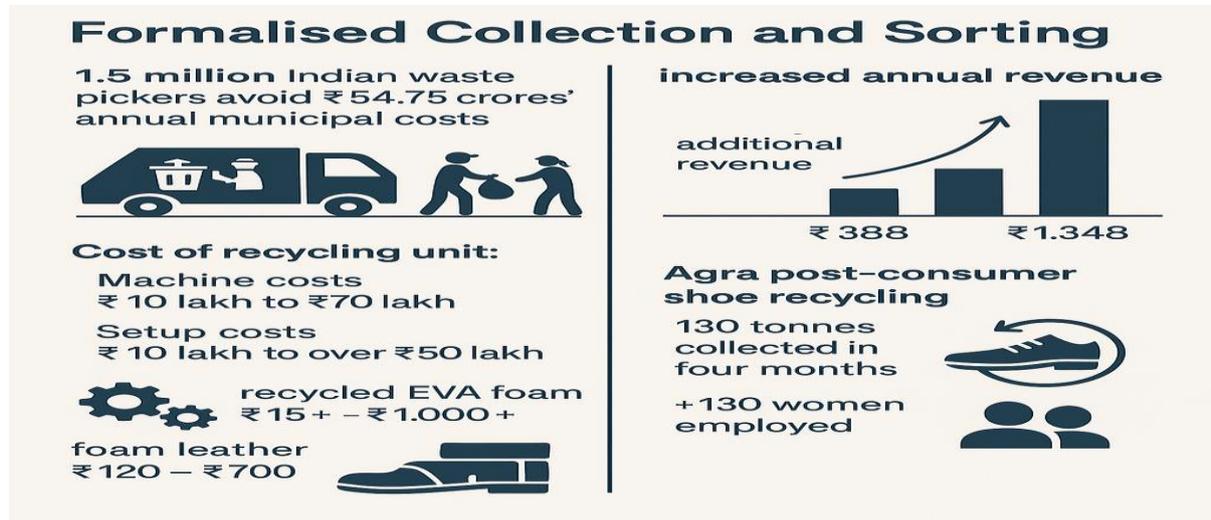
Source-(Choudhary et al., 2024).

However, this environmental expense could be transformed to an economic asset through waste valorization and circular economy principles. Wastes could be potentially considered not wastes but

valuable resources. There exist multiple management strategies that open up an opportunity to convert this cost to a revenue stream.

- **Recycling and Upcycling:** Recycling is one of the easiest waste valorization processes. Shoe leather skim and offcuts may be made to produce small products like keychains, doormats, or even handbags, creating new revenues from waste. In the commercial sector, scrap EVA may be used in place of lightweight aggregates in mortar, to be utilized in building construction, which is one example of versatility.
- **Waste-to-Energy (WtE):** With such high calorific value, this polymer and leather waste could be an acceptable fuel. With comparable calorific values to coal, leather waste could be suitable in brick kilns, reducing costs and fossil fuels usage. Agra's vision in using this high-calorific waste in an imagined WtE plant could turn a problem in waste disposal to an opportunity in energy.
- **Formalised Collection and Sorting:** The informal system already provides much, in that 1.5 million Indian waste pickers annually avoid an estimated ₹54.75 crores' annual cost of collection and disposal for municipalities. Formalisation through exclusive collection vehicles and centralised sorting systems would significantly increase waste's recoverable value. An Economic Study on Business Case for Post-Consumer Textile Waste concludes that adopting advanced solutions in sorting will increase revenue 10% and thus annually produce an industry-wide level of additional revenue ranging from ₹388 to ₹1,348 crores.

The economic case for investing in these strategies is compelling. While setting up a small-scale recycling unit is a big outlay in terms of capital—with costs for machines ranging from ₹10 lakh to ₹70 lakh and setup costs ranging from ₹10 lakh to over ₹50 lakh for one such plastic recycles unit (a similar proxy)—the payoff is massive. The marketplace for recycled material is robust; recycled EVA foam products can be sold anywhere from ₹15 to over ₹1,000 depending on shape and quality, while foam leather can be sold anywhere from ₹120 to ₹700 a meter. There is evidence in India, in one successful pilot programme for post-consumer shoe recycling collecting 130 tonnes in four months and creating jobs for in excess of 130 women, to show that large-scale postconsumer shoe recycling works. Through this shift to a circular model, Agra can mitigate environmental degradation, unlock economic value, and foster an enhanced industry sector.



Source- (Faheem & Ahmad, 2021)

### The Digital Divide: High Potential vs. Low Adoption of Technology

There's an enormous difference between transformative potential of existing technological innovations in inventory management and reality among Agra's SMEs. High-end digital solutions offer direct solutions to inefficiencies identified in this study. For instance, AI-powered systems for predicting demands can analyse historical data, trend data, and even sentiment in social media to reduce 50% error in forecasting, and correspondingly, risk mitigation in over- or under-stocking. Integrated Enterprise Resource Planning systems enable consolidation of all the processes in a supply chain, ranging from procurements to sales, in one comprehensive view. Even beginner level technology, in this instance, automation through barcode or QR codes, can practically eradicate components and even completed-goods' costly misplacement, common in manual systems. Savings are unmistakable enhanced accuracy, clear-time clarity in real-time, cost avoidance, and overall improved efficiency. Despite such potential, adoption among Agra cluster companies is alarmingly low, Research after research reveals one typical series of primary adoption barriers among Indian SMEs. These are:

- **Financial Constraints:** Software and hardware costs, in addition to implementation costs, represent an extremely large initial expenditure, one big turnoff to cash-strapped businesses.
- **Deficits in Digital Literacy:** There is a large gap in terms of skills among both the owners and employees in SMEs, in addition to overall ignorance regarding the possible positive impact created by digital tools.
- **Inadequate Infrastructure:** In certain areas, unreliable Internet access and an unsound IT infrastructure make it challenging to deploy cloud systems.
- **Organizational Resistance:** There is always an intrinsic resistance to change and fear of impairing

long-established, albeit inefficient, manual processes.

- **Perceived Non-Relevance:** The owner-operators of small-scale businesses believe that advanced technologies like AI lack relevance to them because they run small-scale businesses.

This digital divide, while not exclusively an expense or training issue, is symptomatic of the deeper socio-economic insecurity that is the working life for so many MSMEs in Agra. The decision not to invest in technology is, in so many instances, an intelligent short-term one made in response to an immediate survival necessity. An SME operator mired in cash-flow difficulties due to the GST regime, facing warehouse-full of dead stock due to the BIS directive, and under intense pressure to cut costs is concerned about making payroll and filling that next order. In this kind of atmosphere, long-term, intangible ROI on an ERP system is overshadowed in comparison to tangible, immediate necessities to remain in business. Technology investment requires large upfront capital, long install period, and worker training—all of which take limited resources of time and money available to immediate survival necessities.

### Recommendations:

#### A Strategic Framework for Eco-Efficient Inventory Management in MSMEs

At the plant level, cumulative and phased activity is desirable in such a way that capacities may be accumulated in stages, not requiring prohibitively large initial expenditure.

- **Basic Control (Phase 1):** Adoption of principal of inventory management fundamentals should be taken up first. This requires use of ABC Analysis to prioritize inventory items in terms of consumption value (not necessarily unit cost). This affords managers a chance to dedicate limited time and resources to exerting control for the "A" items, in general, consisting of the majority of inventory value. In parallel, units should use simple Economic Order Quantity (EOQ) models to calculate optimal order size for principal raw materials, thereby reconciling order costs and inventory carrying costs. This phase requires minimal cash outlay and focuses primarily on process change and fundamental training.

- **Sustainable Sourcing (Phase 2):** With foundational controls in place, it's time to add Green Procurement to sourcing strategies. That includes moving beyond cost as the be-all and end-all basis for selecting suppliers and building an environmental and ethics performance-based scorecard. Buying from suppliers that source sustainably, reduce waste, and work in fair workplaces can reduce the environmental impact of a manufacturer's own facility, mitigate supply chain risks, and meet growing demands from consumers for environmentally responsible products.

- **Waste Valorization (Phase 3):** The final phase will be to be an active participant in the circular economy, where waste from production will be viewed as an avenue for revenue generation. This will involve prudent segregation of waste streams (e.g., cutting rejects in leather, polymer scrap, packaging) at generation. Through connection to a nearby waste-exchange network, materials can be disposed of and sold to up cyclers, to recycling industries, or other industries where such materials

may be utilized as raw materials. In addition to generating other revenue, this reduces disposal costs and leaves the immediate environs cleaner.

### **Policy and Ecosystem Development: Creating an Enabling Environment**

Firm-level programs will be successful only if there is an enabling external environment. There is, therefore, a necessity for government institutions and industry associations to produce specific initiatives.

#### ➤ **For Government (Central & State):**

- **GST Simplification and Support:** To alleviate MSMEs' huge working capital burden, the government could consider simplified GST compliance models specifically for small-scale producers, particularly those who have to wait for extended credit periods. Or, expediting the process of reimbursement of ITC would inject much-needed cash back into MSMEs, consequently enabling them to manage inventory in a better way.
- **Phased and Supportive Rollout of BIS:** The requirement for BIS certification should be re-evaluated and rolled out in phases. This should include an explicit timeline, intensive outreach and training, monetary and technical assistance to MSMEs to bring them up to par, and thus forestall the kind of catastrophic inventory builds and financial shockwaves that recently paralyzed the industry.
- **Circular Economy Incentives:** The government can play an important part in promoting the circular economy in the form of tax incentives, grants, or subsidies to businesses that can consistently demonstrate their activities in waste valorization, recycling, and upcycling.

#### ➤ **For Industry Associations (e.g., CLE, ASMA):**

- **Develop a Waste Management Cooperative:** Industry organizations have a perfect niche to be advocates for development of a cooperative to manage collection, separation, consolidation, and sales of shoe waste from member MSMEs. It will create an "industrial symbiosis" platform that is not in existence, and will be a concerted approach to solving the fragmented waste issue.
- **Develop an Agra Localized Sustainable Supplier Guidebook:** In line with national programs such as the SU.RE directory, local groups should create and revise an inventory guidebook of certified sustainably sourced raw materials specifically for Agra's manufacturers to facilitate easier green procurement.
- **Focused Capacity Development and Training:** Periodic, hands-on, and affordable workshops on basics inventory management techniques (ABC, EOQ) and entry-level digital competencies should be organized by associations to offset the identified major skill gap in this research.

- **Technology adoption** should be viewed as a gradual journey, not an overwhelming, one-time event. A phased roadmap can make the process more manageable and affordable for MSMEs.
- Embracing technology should be approached as a stepwise journey and not a single, shake-the-earth event. It is more cost-effective for MSMEs to manage with incremental steps through a phased roadmap.
  - **Step 1: Verification by Scanning Automation:** Tracking raw materials, work-in-progress items, and finished goods can be done using scanners and software which incorporates barcode or QR code systems. The automation leap forward saves inventory count time tremendously while improving accuracy. Advancing from elementary manual systems through scanning is an easy first step.
  - **Step 2: Moving Toward Enhanced ERP Solutions:** Subscription-based (SaaS) models are easily leveraged by MSMEs; however, cloud-based inventory management solutions have real-time monitoring capability too. Basic accounting software agnosticism makes seamless integration easier eliminating high investments on hardware and software license purchases at the onset making them perfect for startups.
  - **Step 3: Integrated Enterprise Resource Planning (ERP):** Growing businesses that need sophisticated decision making can evolve from simpler SaaS providers and switch to cloud based ERPs offering advanced modules priced competitively enabling comprehensive holistic cross-functional business oversight integrating sales, procurement, production planning, finance alongside look-ahead forecasting.
  - **Step 4: Leveraging Advanced Analytics:** For mature SMEs, the final step is to explore the integration of **AI-driven demand forecasting tools**. These advanced systems can connect to the ERP database and analyse vast amounts of data—including historical sales, market trends, seasonality, and even external factors to generate highly accurate demand forecasts, which are the cornerstone of proactive and efficient inventory management.

#### **Development a Collaborative Circular Economy Hub in Agra:**

To truly transform the industry, a formal ecosystem for circularity must be proactively built. This recommendation moves beyond individual firm actions to propose a city-wide strategic initiative. This initiative would directly address the logistical and collaborative gap identified in the discussion, creating a self-sustaining ecosystem that turns waste into wealth and establishes Agra as a leader in sustainable manufacturing.



## CONCLUSION

The impact of inventory management on improving sustainability and cost effectiveness in the footwear manufacturing industry in Agra has been critically examined in this study. According to the results, structured inventory techniques like ABC analysis, EOQ, and green procurement not only result in quantifiable cost savings but also make a substantial contribution to operational resilience and waste reduction. Systemic issues like the burden of regulatory compliance, underutilization of technology, and infrastructure constraints, however, limit these advantages. According to the analysis, inventory management must be in line with the principles of the circular economy through a phased, integrated approach. It also emphasizes how urgently institutional support is needed, especially through capacity building, policy reform, and the creation of cooperative platforms like local supplier directories and waste management cooperatives. If technology adoption is done gradually, it can close current gaps and encourage the ability to make decisions in real time. Repositioning sustainable inventory management as a strategic imperative that supports the competitiveness, environmental responsibility, and long-term viability of Agra's MSMEs is ultimately necessary, rather than as a separate operational function. Future studies should examine policy changes and scalable digital solutions that help similar industrial clusters make the shift to circular production models.

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