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**A STUDY ON DRIVERS OF ORGANIZATIONAL PERFORMANCE IN THE COPPER RECYCLING INDUSTRY OF PALGHAR DISTRICT.****<sup>1</sup>Prof. Dilip Jain and <sup>2</sup>Dr. Samadhan Khamkar**<sup>1</sup>Research Scholar, VIVA Institute of Management & Research, Virar<sup>2</sup>Director, Swayam Siddhi Mitra Sangh's College of Management and Research, Bhiwandi**ABSTRACT**

*Copper has been central to industrial development for centuries, and its role in the modern economy shows no sign of diminishing. Its thermal stability, electrical conductivity, and corrosion resistance make it indispensable across sectors from power infrastructure to electronics manufacturing. What sets copper apart from most industrial materials is that it can be recycled indefinitely without any meaningful deterioration in its core properties—yet recycled copper still accounts for only 20–30% of global supply (Glöser et al., 2013), a gap that has real consequences for sustainability and resource security. This study was carried out in the Palghar District of Maharashtra, India—home to some of the country's most active copper recycling clusters, particularly in the Tarapur MIDC and Vasai-Virar industrial belts—and examines what organizational factors actually drive performance in this setting. Data were gathered from 220 male recyclers working across all major industrial clusters of Palghar District and analyzed using Structural Equation Modeling (SEM) alongside Importance-Performance Map Analysis (IPMA) through SMART PLS. The results consistently point to Operational Efficiency, Technological Adoption, and Market Orientation as significant drivers of Organizational Performance, with market orientation showing the strongest effect. The study also discusses the implications of these findings for circular economy integration in India's recycling sector, particularly in the context of Maharashtra's evolving industrial policy landscape.*

**Keywords:** *Organisational Performance, Structural Equation Model, Copper Recycling, Palghar District, Maharashtra, Technological Adoption, Market Orientation, Circular Economy*

**1. INTRODUCTION**

If you trace the supply chain of almost any manufactured product assembled in India's western industrial corridor—whether it is an electrical fitting made in Vasai, a cable harness from Tarapur, or an automotive component from Wada—copper is almost certainly part of the story. The Palghar District of Maharashtra has quietly become one of the more significant hubs for copper processing and recycling activity in the country, sitting as it does at the junction of several old industrial estates that date back to the 1970s and newer ones that have grown with Maharashtra's industrial development programmes. Yet despite its industrial importance, the organizational dynamics of the copper recycling firms operating in this district have received relatively little systematic research attention.

Copper's continued relevance needs little introduction. Its electrical conductivity, thermal stability, and resistance to corrosion make it essentially irreplaceable across a wide range of applications—from wiring in residential construction and high-voltage transmission infrastructure, to the motors and battery systems of electric vehicles (Brininstool & Flanagan, 2015). As electrification deepens and renewable energy infrastructure expands, demand for copper is on an upward trajectory. At the same time, ore grades at primary mining sites globally are declining, extraction is becoming costlier, and geopolitical disruptions are making primary supply less reliable than it once was (Jowitt et al., 2020; Northey et al., 2017). In this context, recycled copper is not simply an environmentally preferable option; it is a supply chain imperative.

Copper scrap enters recycling streams at several points. Home scrap—generated during primary production—is typically the cleanest. New scrap, arising during product fabrication, varies by manufacturing process. Old scrap, collected from end-of-life products, is the most heterogeneous and the most operationally challenging to handle (Graedel et al., 2004; Schlesinger et al., 2011). In Palghar's industrial clusters, all three scrap types are handled, though the mix varies considerably by location.

Tarapur MIDC, for instance, processes significant volumes of industrial and manufacturing scrap given its concentration of large-scale chemical, engineering, and electronics manufacturing units. Vasai-Virar, with its denser SME population, tends to see higher volumes of mixed post-consumer and fabrication scrap. Understanding these regional specificities matters because organizational performance in copper recycling is not purely a function of technology or management philosophy—it is also shaped by scrap availability, scrap quality, and the downstream markets available to each cluster.

### 1.1 The Palghar Context

Palghar District, carved out of the erstwhile Thane District in 2014, spans approximately 5,344 square kilometres along Maharashtra's northern coastal belt. Its industrial profile is shaped by several MIDC estates—Tarapur being the oldest and most established, followed by Vasai-Virar, Manor, Boisar, and smaller estates at Wada, Dahanu, and Palghar town itself. Tarapur MIDC, established in the early 1970s, was historically associated with chemicals and textiles, but over the decades has diversified into engineering, electronics, and metal processing—including a well-established secondary metal recycling corridor. Dahanu, by contrast, retains more of an agro-industrial character but hosts secondary metal processors who draw on scrap from the coastal and agricultural machinery sectors.

The district's proximity to Mumbai—India's largest port city and commodity trading hub—gives Palghar recycling firms meaningful access to imported copper scrap, which accounts for a portion of feed material particularly in the larger Tarapur units. Simultaneously, the westward expansion of Mumbai's urban economy has produced rising volumes of post-consumer e-waste and construction scrap that Vasai-Virar processors are increasingly positioned to capture. Maharashtra's industrial policy has in recent years emphasised green manufacturing and waste utilization, and Palghar's inclusion in special economic development designations has brought some additional infrastructure and incentive support for firms operating in this space. Still, many of the recycling units—particularly in the smaller clusters of Wada, Jawhar, and Makhada—operate with limited technology, informal management structures, and limited market intelligence capability. This heterogeneity makes Palghar District a genuinely interesting research context: it contains the full spectrum from relatively sophisticated industrial recyclers to small informal processors, allowing the study to capture organizational performance variation that would not be visible in a more homogeneous industrial setting.

### 1.2 Why Recycling Efficiency Matters Beyond the Factory Gate

The environmental case for copper recycling is well established. Producing copper from secondary sources consumes roughly 85% less energy than primary smelting and generates substantially lower greenhouse gas emissions (Wang et al., 2021). India, which is both a major copper consumer and a significant importer of primary copper, has a particular national interest in raising recycling rates. The Bureau of Indian Standards and the Ministry of Environment, Forest and Climate Change have both signalled interest in strengthening the formal recycling economy, and copper is frequently cited as a priority material given its strategic role in power infrastructure under programmes like DDUGJY and the PM-KUSUM solar scheme.

Yet improving recycling rates in absolute terms is not sufficient. The firms doing the recycling need to be organizationally capable of doing it efficiently, responsively, and in a way that produces material of consistent quality for downstream buyers. This is where organizational performance—rather than just recycling volume—becomes the meaningful variable. A firm that recycles large volumes of copper but does so with poor yield rates, high energy waste, and no awareness of market price movements is not performing well even if its throughput numbers look adequate. The present study takes the position that organizational performance in copper recycling is a multidimensional construct, shaped by how efficiently operations are run, how actively firms adopt relevant technologies, and how closely they track and respond to market signals.

### 1.3 E-Waste and the Complexity of Modern Scrap Streams

One of the more difficult challenges facing copper recyclers in Palghar—and indeed across India—is the growing proportion of e-waste in the scrap mix.

Waste printed circuit boards (WPCBs) and end-of-life electronic components are simultaneously rich in recoverable copper and problematic in their handling requirements (Jadhao et al., 2020). The hydrometallurgical and pyrometallurgical processes needed to extract copper from e-waste profitably require investment, technical expertise, and environmental compliance capacity that many smaller units in the district currently lack (Deveci, 2016; Özkan, 2018). India's E-Waste Management Rules have created a formal framework for e-waste processing, but compliance and enforcement in informal industrial clusters remain inconsistent. Firms in Tarapur and Vasai-Virar that have invested in certified e-waste processing capabilities represent one end of the capability spectrum; artisanal processors in Jawhar who rely on rudimentary burning and acid leaching represent the other. Bridging this gap is as much an organizational challenge as a technical one.

## 2. REVIEW OF LITERATURE

Li, J., Eheliyagoda, D., et al. (2025) took a genuinely long-run view of the copper recycling problem, modeling supply and demand dynamics across more than 50 countries with projections extending to 2100. Their central finding—that optimizing the recycling process in flexible, context-sensitive ways could substantially reduce macro-level supply gaps—translates well to the Indian context, where regional industrial heterogeneity (much like what is observed in Palghar) means that one-size-fits-all recycling strategies tend to underperform. Their advocacy for circular economy solutions as a means of managing long-term copper sustainability has direct policy relevance for Maharashtra's industrial planning frameworks.

Shahraki, H., Einollahipeer, F., et al. (2024) examined copper supply chain design through the lens of resilience, with a particular focus on how natural disasters—especially earthquakes—can disrupt copper availability given its geographically concentrated production. While Maharashtra is not a high seismic risk zone, the broader lesson about supply chain vulnerability applies: firms in Palghar that rely on single-source scrap procurement or have no backup supplier relationships are exposed to disruptions that more resilient organizations have planned for. Their argument for closed-loop supply chain design as a strategic response, rather than a purely environmental one, resonates with the conditions facing mid-size recyclers in the district.

Li, X., Ma, B., et al. (2024) covered the global scrap copper trade from a materials science and economics perspective, noting both the substantial energy and emission savings from secondary copper and the trade barriers that complicate scrap flows across borders. For Palghar firms that import copper scrap—a common practice among the larger Tarapur units—understanding how global trade restrictions interact with domestic policy is not an academic concern; it is a business continuity issue. Their call for better international standards harmonisation echoes what industry bodies in India have been requesting for domestic processing certification as well.

Chou, F.R., Chauvy, R., et al. (2024) applied material flow analysis to copper use and recovery in Taiwan's PCB manufacturing sector, identifying where material losses occurred and what could be done about them. The methodological approach is instructive for Palghar's industrial planners: without systematic material flow tracking, firms and policymakers cannot identify where the largest inefficiencies lie. Given that Tarapur MIDC has a significant electronics manufacturing presence, the Taiwan PCB experience offers a directly applicable reference for understanding where copper recovery rates in the district's electronics-adjacent scrap streams might be improved.

Wang, T., Berrill, P., et al. (2021) modelled copper scrap flows in the United States economy, estimating that full utilization of probable scrap could reduce energy consumption in copper production by around 15%—with alloy scrap offering the largest single opportunity. Their emphasis on improving yield ratios across scrap categories, rather than simply increasing recycling volumes, speaks directly to the operational efficiency construct central to this study. In the Palghar context, where significant volumes of alloy and composite scrap are generated by the MIDC's engineering sector, the yield improvement opportunity is real and largely unrealized.

Wincewicz-Bosy, M., Dymyt, M., et al. (2021) examined supply chain dynamics in copper mining through the lens of the COVID-19 pandemic, finding that logistics integration and inter-firm coordination were the strongest predictors of supply chain resilience. For Palghar, this finding has particular salience: the district's industrial clusters are geographically dispersed—Tarapur in the south, Dahanu in the north, with Wada and Jawhar in the interior—and coordination between firms within and across clusters is limited. The pandemic exposed similar fragilities in Palghar's industrial supply chains when transporters withdrew and scrap collection networks broke down. Firms that had deeper coordination relationships survived these disruptions better.

Liu, S., Liu, W., et al. (2021) documented the cascading effects of China's 2018 ban on copper scrap imports, which redirected global scrap flows and created both challenges and opportunities for processing industries elsewhere. India, and Maharashtra in particular, benefited to a degree from the resulting availability of scrap that previously went to China—but capturing that opportunity required firms to have the market awareness to spot the shift and the operational capacity to scale up processing quickly. Firms in Palghar with stronger market orientation, by the evidence of this study, were better placed to make that kind of responsive adaptation.

Henckens, M. & Worrel, E. (2020) asked whether copper could remain sustainably available over a millennium-long horizon and concluded that only very high end-of-life recycling rates, sustained over generations, make that scenario plausible. For a country like India—where copper demand is growing rapidly and primary mining capacity is limited—the long-run argument for investing in recycling industry organizational capability is particularly compelling. Building that capability in districts like Palghar, which already have the industrial infrastructure, is precisely the kind of targeted intervention that Henckens and Worrel's analysis implies is necessary.

**3. OBJECTIVES OF THE STUDY**

The study was guided by three specific objectives:

- To examine the influence of Operational Efficiency, Technological Adoption, and Market Orientation on Organizational Performance among copper recycling firms in the industrial clusters of Palghar District, Maharashtra.
- To assess the strategic role of Circular Economy integration as an enabler of sustainability and long-term competitiveness for organizations in the Palghar copper recycling ecosystem.
- To offer grounded, evidence-based recommendations for industry practitioners and policymakers—particularly within Maharashtra's industrial development framework—to strengthen organizational performance through better operational practices and circular economy alignment.

**4. RESEARCH HYPOTHESES**

Based on the reviewed literature and the research framework, three hypotheses were formulated for empirical testing:

- **H1:** Operational Efficiency has a significant positive impact on Organizational Performance.
- **H2:** Technological Adoption has a significant positive impact on Organizational Performance.
- **H3:** Market Orientation has a significant positive impact on Organizational Performance.

**5. RESEARCH METHODOLOGY**

Table No. 1 provides a structured summary of the study's research design.

**Table No. 1: Materials and Methods**

Particulars	Details
Research Method	Structural Equation Modeling (SEM)
Sample Size	220 Male Recyclers from Copper Recycling Industry, Palghar District
Sample Size Justification	A priori analysis using Daniel Soper's calculator recommended a minimum of 160
Effect Size	0.3
Statistical Power Level	0.9

Probability Level ( $\alpha$ )	0.05
Variables	20 Observable Variables and 4 Latent Variables
Sampling Method	Non-random purposive sampling
Study Area	All Industrial Clusters across Palghar District, Maharashtra
Data Sources	Primary and secondary sources
Analytical Tool	SMART PLS (Partial Least Squares for SEM)

The study uses a quantitative research design anchored in Partial Least Squares Structural Equation Modeling (PLS-SEM), implemented through SMART PLS—a method well suited to management research where the objective is explaining variance in a key outcome variable across multiple reflective constructs (Hair et al., 2010). A priori sample size estimation using Daniel Soper's power calculator, with an effect size of 0.3, power level of 0.9, and significance threshold of 0.05, recommended a minimum of 160 respondents. The achieved sample of 220 male recyclers comfortably exceeds this benchmark, providing adequate statistical confidence in the structural model estimates.

Respondents were selected through non-random purposive sampling across all major industrial clusters of Palghar District—Tarapur MIDC/Boisar, Vasai-Virar, Dahanu, Palghar town and Wada, and the interior clusters of Jawhar, Vikramgad, and Mokhada. Only male recyclers were included in the study, reflecting the on-ground reality of the copper recycling trade in Palghar, where the workforce engaged in active recycling operations—scrap collection, sorting, smelting, and processing—is exclusively male. This was confirmed during the pilot survey phase, and the sampling frame was constructed accordingly. Primary data were gathered through structured questionnaires administered to recyclers with direct involvement in operations, scrap procurement, logistics, or plant management. Secondary data were drawn from MIDC industrial directories, Maharashtra Pollution Control Board records, Ministry of Commerce trade data, and peer-reviewed academic literature. The model includes 20 observable indicator variables loading onto 4 latent constructs.

Figure No. 1: A Priori Sample Size Analysis

[Figure 1: A priori power analysis output from Daniel Soper's calculator confirming  $n \geq 160$  for the specified parameters]

**6. DEMOGRAPHIC PROFILE OF RESPONDENTS**

**Table No. 2:** Demographic Profile of Respondents (n = 220, All Male Recyclers)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	220	100%
Age Group (in years)	25–34	53	24%
	35–44	97	44%
	45–54	48	22%
	55 and above	22	10%
Educational Qualification	Diploma / Technical	35	16%
	Bachelor's Degree	114	52%
	Master's Degree & Above	71	32%
Experience in Industry	Less than 5 years	44	20%
	5–10 years	88	40%
	11–15 years	62	28%
	More than 15 years	26	12%
Industrial Cluster (Palghar District)	Tarapur MIDC / Boisar	77	35%
	Vasai-Virar Industrial Belt	66	30%
	Dahanu Industrial Zone	33	15%
	Palghar Town & Wada	26	12%
	Other Clusters (Jawhar, Vikramgad, Mokhada)	18	8%

The demographic profile of the 220 male recyclers surveyed across Palghar District's copper recycling clusters is consistent with well-documented occupational patterns in India's secondary metals sector. Copper recycling in this region—spanning scrap collection, sorting, smelting, wire drawing, and trading—is an exclusively male-dominated trade, rooted in generational practice and the physically demanding nature of the work. All 220

respondents (100%) are male, and this is not a sampling artefact; it reflects the social and occupational structure of the industry as it exists on the ground across Palghar's clusters. The dominant age bracket is 35–44 years (44%, n=97), pointing to a workforce that is largely mid-career with meaningful hands-on experience. The 25–34 cohort (24%, n=53) brings familiarity with digital tools and newer processing methods, while senior recyclers in the 45–54 and 55-and-above brackets (22% and 10% respectively) carry the long institutional memory of how these clusters have evolved through multiple commodity cycles and policy shifts.

Educationally, the sample reflects the mixed profile of Palghar's industrial workforce. Just over half hold a bachelor's degree (52%, n=114), while nearly a third (32%, n=71) have postgraduate qualifications—a notably educated group for what is sometimes characterized as an informal or semi-formal sector. Diploma and technical certificate holders make up 16% (n=35), found largely in plant supervision and processing roles. On experience, the 5–10-year bracket dominates (40%, n=88), with a significant proportion of longer-tenured recyclers (11–15 years: 28%, n=62) who have navigated multiple regulatory and commodity price cycles in the district.

The cluster distribution reflects the relative industrial weight of each area within the district. Tarapur MIDC and Boisar together account for the largest share (35%, n=77), consistent with Tarapur's status as the district's largest and most diversified industrial estate. Vasai-Virar follows with 30% (n=66), reflecting its dense SME population and proximity to Mumbai's urban economy, which generates substantial post-consumer scrap. Dahanu (15%, n=33), Palghar town and Wada (12%, n=26), and the interior clusters of Jawhar, Vikramgad, and Mokhada (8%, n=18) complete the sample—the last group consisting largely of smaller, informally organized recycling units that process agricultural and artisanal scrap streams. The geographic spread was deliberately maintained to capture the full range of organizational capability conditions present across the district's recycling ecosystem.

**7. DATA ANALYSIS AND INTERPRETATION**

**7.1 Reliability and Validity Assessment**

**Table No. 3: Reliability and Validity**

Construct	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Operational Efficiency	0.907	0.904	0.613
Technological Adoption	0.898	0.898	0.638
Market Orientation	0.888	0.885	0.566
Organizational Performance	0.786	0.787	0.555

Establishing the measurement model's reliability and validity is a prerequisite before drawing conclusions from the structural paths. On the reliability front, Cronbach's Alpha values ranged from 0.786 to 0.907 across the four constructs—each comfortably exceeding the 0.70 threshold that Hair et al. (2010) identify as the minimum acceptable standard for organizational research. Composite Reliability, which is generally considered a more appropriate index for PLS-based models, ranged from 0.787 to 0.904, reinforcing the reliability picture. Average Variance Extracted (AVE) values ranged from 0.555 to 0.638, all clearing the 0.50 benchmark that confirms each construct captures more variance from its own indicators than from measurement error. The measurement instruments can therefore be considered reliable and valid for the structural analysis that follows.

**7.2 Discriminant Validity**

**Table No. 4: Discriminant Validity (Fornell-Larcker Criterion)**

Construct	Market Orientation	Operational Efficiency	Organizational Performance	Technological Adoption
Market Orientation	0.753			
Operational Efficiency	0.726	0.783		
Organizational Performance	0.727	0.767	0.745	
Technological Adoption	0.744	0.780	0.696	0.799

Discriminant validity—the empirical distinctiveness of the constructs from one another—was assessed using the Fornell-Larcker criterion, which requires the square root of each construct's AVE to exceed its highest correlation with any other construct. This condition is satisfied across the board: Market Orientation (0.753), Operational Efficiency (0.783), Organizational Performance (0.745), and Technological Adoption (0.799) all returned diagonal AVE square root values larger than their inter-construct correlations. The constructs are empirically distinct, which means the model is not inadvertently conflating related but theoretically separate concepts—a particularly important check in a study covering operationally adjacent constructs like efficiency and technology adoption.

**7.3 Collinearity Statistics**

**Table No. 5:** Collinearity Statistics (VIF)

Items	VIF
MO1	3.002
MO2	2.035
MO3	2.389
MO4	1.952
MO5	2.485
MO6	2.039
OE1	2.037
OE2	2.298
OE3	2.213
OE4	3.017
OE5	2.848
OE6	2.766
OP1	1.908
OP2	1.603
OP3	1.575
TA1	2.343
TA2	2.091
TA3	2.676
TA4	2.413
TA5	2.933

Variance Inflation Factor (VIF) values were examined for all 20 indicator variables as a check on multicollinearity. Values range from 1.575 (OP3) to 3.017 (OE4)—all well short of the 5.0 threshold at which multicollinearity is generally considered to be causing a problem. There is no indication that shared variance among predictor variables is distorting the structural parameter estimates. The model's findings can therefore be interpreted with reasonable confidence that the path coefficients reflect genuine relationships rather than collinearity artefacts.

**7.4 Structural Model and Hypothesis Testing**

Figure No. 2: Structural Equation Model (SEM) Path Diagram

[Figure 2: SEM path diagram generated via SMART PLS showing structural relationships between latent constructs and Organizational Performance across Palghar District copper recycling firms]

**Table No. 6:** Hypothesis Testing Results

Construct	Beta Coefficient	T-Statistics	P-Value
Operational Efficiency → Organizational Performance	0.200	4.172	0.000
Technological Adoption → Organizational Performance	0.282	5.267	0.000
Market Orientation → Organizational Performance	0.366	7.086	0.000

All three hypotheses are supported at the 5% significance level. Market Orientation shows the strongest path to Organizational Performance ( $\beta = 0.366$ ,  $T = 7.086$ ,  $p = 0.000$ ), followed by Technological Adoption ( $\beta = 0.282$ ,  $T = 5.267$ ,  $p = 0.000$ ) and Operational Efficiency ( $\beta = 0.200$ ,  $T = 4.172$ ,  $p = 0.000$ ). Since all p-values fall below 0.05, the null hypotheses are rejected in each case. The finding that market orientation carries more weight than the other two constructs is notable—and perhaps somewhat counterintuitive in an industry that tends to think of

itself in operational and technical terms. It suggests that, among the firms in this sample, those that are better at reading market signals are consistently outperforming those that merely run efficient plants.

**Table No. 7: Hypothesis Summary**

Alternative Hypothesis	Result
H1: Operational Efficiency has a significant positive impact on Organization Performance	Supported
H2: Technological Adoption has a significant positive impact on Organization Performance	Supported
H3: Market Orientation has a significant positive impact on Organization Performance	Supported

**7.5 Importance-Performance Map Analysis (IPMA)**

**Figure No. 3: IPMA Map**

[Figure 3: Importance-Performance Map Analysis (IPMA) generated via SMART PLS—importance (beta weights) on x-axis; performance (LV scores) on y-axis]

**Table No. 8: Latent Variable Performance Scores**

Construct	LV Score
Organizational Performance	55.433
Technological Adoption	54.559
Operational Efficiency	53.843
Market Orientation	52.679

The IPMA results add a useful practical dimension to the structural findings. Organizational Performance itself scored highest at 55.433, suggesting that recyclers, on balance, view their firms as reasonably effective. Technological Adoption (54.559) and Operational Efficiency (53.843) returned comparable performance scores, while Market Orientation had the lowest LV score at 52.679—despite carrying the highest importance weight of the three predictors. This is precisely the kind of finding that IPMA is designed to surface: the construct that matters most for performance improvement is also the one where current performance is relatively weakest. For Palghar District specifically, this points to a gap in market intelligence capability that is likely more pronounced in the district's smaller and more geographically isolated clusters, where formal market monitoring practices are less common.

**Figure No. 4: Performance Analysis Chart**

[Figure 4: Bar chart illustrating LV performance scores across Market Orientation, Operational Efficiency, Technological Adoption, and Organizational Performance for n=220 male recyclers]

**8. DISCUSSION**

Reading the results against the Palghar context produces some interpretations that go beyond what a decontextualized quantitative analysis would yield. Starting with operational efficiency—the weakest of the three predictors, though still significant at  $\beta = 0.200$ —the finding makes sense when you consider that the larger Tarapur MIDC units, which dominate the sample numerically, have had decades to optimize their core smelting and refining processes. The marginal performance gains from further operational refinement are real but diminishing. The smaller Dahanu and interior cluster firms, by contrast, have considerably more operational headroom, but they represent a smaller share of the sample and their challenges are as much about basic infrastructure—reliable power, transport connectivity, water supply for hydrometallurgical processes—as they are about management practice.

Technological adoption's stronger path coefficient ( $\beta = 0.282$ ) reflects a reality that is playing out across Palghar's larger industrial units. Firms in Tarapur and Vasai-Virar that have invested in automated sorting lines, continuous emission monitoring systems, and ERP-integrated production tracking are managing more complex scrap streams more profitably than those relying on manual sorting and batch-based accounting. The growing volume of e-waste entering Maharashtra's scrap ecosystem—driven by the state's rapid urbanisation and electronics consumption growth—is making this technology gap increasingly consequential. Firms without the capability to handle mixed electronic scrap profitably are effectively leaving recoverable copper on the table, or selling it at heavy discounts to processors with better metallurgical capacity (Wang et al., 2021).

The primacy of market orientation ( $\beta = 0.366$ ) deserves the most careful interpretation, because it is the finding most likely to be underappreciated by an industry that tends to define its problems in operational and technical terms. In the Palghar context, market orientation manifests in several specific ways: tracking the LME copper price and adjusting scrap procurement timing accordingly; understanding what quality specifications downstream wire and cable manufacturers in Silvassa and Daman require; monitoring shifts in Maharashtra's regulatory environment—Extended Producer Responsibility notifications, for instance—that determine how e-waste flows into the formal recycling system; and watching what larger integrated copper refiners like Hindalco and Sterlite are doing at the national level that might affect regional scrap supply. Firms that do these things systematically outperform those that treat market intelligence as a peripheral activity. Liu et al.'s (2021) documentation of how China's import ban redistributed scrap flows globally—and how firms with market awareness captured opportunity while others were caught flat-footed—maps almost directly onto the experience of Palghar recyclers during the same period.

There is a circular economy thread running through all three findings that is worth making explicit. Maharashtra's Swachh Maharashtra initiative and the central government's push for a production-linked incentive framework for green manufacturing have created policy signals, even if implementation remains uneven. Firms that are operationally efficient are, in practice, minimizing material losses and energy waste—core circular economy outcomes.

Firms investing in technology are recovering materials that would otherwise be downcycled or landfilled—again, a circular economy result. And firms with strong market orientation are better positioned to find buyers who value certified secondary copper, to participate in take-back schemes, and to engage with regulatory consultations that shape how the recycling economy evolves. The circular economy is not an abstract framework in this district; it is an operational description of what high-performing recycling firms are already doing.

## 9. CONCLUSION

This study set out to understand what drives organizational performance among copper recycling firms in Palghar District, Maharashtra—a question that is both academically interesting and practically consequential for a district whose industrial identity is partly built on secondary metal processing. The findings from 220 male recyclers, spread across the district's five major cluster areas, are reasonably clear: market orientation, technological adoption, and operational efficiency each matter, in that order of magnitude, and the differences between high- and average-performing firms can be mapped onto differences in these three organizational capabilities.

What is perhaps most striking is that market orientation—the capability that is least tangible, least capital-intensive, and most neglected in how recycling firms think about their own development—turns out to be the strongest predictor of performance. This does not mean that operational efficiency and technology investment are unimportant; the data show they are both significant. But it does mean that a firm which has invested heavily in plant and equipment, yet pays little attention to what the market is doing, is likely leaving performance on the table. In Palghar specifically, where many firms grew from family-run scrap trading operations and the recyclers retain an operational rather than commercial orientation passed down through generations, this is an important corrective finding.

India's recycling economy is at an inflection point. Rising copper demand from the energy transition, growing e-waste volumes, tightening environmental regulations, and the government's Atmanirbhar Bharat push toward domestic processing capability all create conditions where well-run recycling firms can play an expanding economic role. Palghar District, with its existing industrial infrastructure, geographic advantages, and diverse cluster ecosystem, is well placed to benefit from these tailwinds—but only if its firms develop the organizational capabilities that the evidence suggests are what actually drive performance.

## 10. SUGGESTIONS AND MANAGERIAL IMPLICATIONS

- Firms across Palghar's clusters—particularly the smaller units in Dahanu, Wada, and the interior areas—should explore lean manufacturing principles as a low-capital route to operational

improvement. Waste reduction, material yield tracking, and process standardization do not require large capital outlays, but they consistently produce measurable efficiency gains in recycling operations.

- Investment in advanced sorting and processing technology is essential for firms that want to handle the growing volumes of complex, mixed-composition scrap—especially from e-waste and electronics manufacturing—that are entering Maharashtra's scrap streams. MIDC's capital subsidy schemes and Maharashtra's green manufacturing incentives provide partial funding pathways that under-utilized firms should actively explore.
- Real-time production monitoring—using IoT-enabled sensors, energy management systems, and basic ERP platforms—gives plant managers the visibility to identify inefficiencies that remain invisible under manual reporting systems. Several technology providers in the Mumbai-Pune corridor offer systems scaled for SME recycling operations at accessible price points.
- Cluster-level market intelligence sharing—perhaps through the existing MIDC industry associations at Tarapur and Vasai-Virar—could substantially improve market orientation across smaller firms that cannot individually afford dedicated commercial intelligence functions. Aggregated LME price tracking, regulatory monitoring, and downstream demand intelligence shared through industry groups would raise the market awareness of the cluster as a whole.
- Partnerships with engineering colleges and technical institutions in the Palghar-Dahanu-Vasai corridor—including Shivaji University's affiliated colleges and institutions in nearby Nashik and Pune—could support workforce development tailored to the district's specific recycling technology needs, reducing the skill gap that currently limits technology adoption among smaller units.
- Diversification into value-added secondary copper products—certified copper rods, grain-refined copper bar, or specification-grade alloy billets—would allow Palghar firms to compete on quality rather than volume in downstream markets, capturing better margins and building longer-term buyer relationships.
- Maharashtra's MPCB and the Maharashtra Energy Development Agency (MEDA) have both signalled interest in supporting formal sustainability reporting among industrial units. Firms that adopt even basic environmental performance tracking stand to benefit from regulatory goodwill, ESG-linked finance options, and the growing preference among large downstream buyers—particularly in the automotive and electrical sectors—for suppliers who can substantiate sustainability claims.
- The Maharashtra Industrial Development Corporation (MIDC) and the District Industries Centre (DIC) at Palghar should consider designing targeted support programmes for the district's copper recycling clusters—including common facility centres for e-waste pre-processing, cluster-level scrap logistics coordination, and streamlined environmental clearance pathways for capacity expansions by compliant recycling units.

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