International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Sustainable Operations and the Value Chain in Indian Retail: Evidence from Fast-Moving Consumer Durables (FMCD)

Koundal Jialal[1], Koundal Sonali[2], Koundal Sapan[3]

[1]PhD, Founder and Chief Architect, Innovision Breakthrough, Gurugram, India
[2]Educator and Master in Humanities and Applied Arts.
[3]PhD Scholar and CPA.

Abstract

Operations management treats sustainability, value-chain design, planning and control as linked, but its models were built on integrated, data-rich chains. This paper examines how those concepts apply across the Indian retail value chain for fast-moving consumer durables (FMCD): room air conditioners, refrigerators, washing machines, televisions, microwave ovens, audio and home electrical products. A conceptual framework is built from Porter's value chain, the triple bottom line, the circular economy and the SCOR (Supply Chain Operations Reference) process model, and tested against FY2024-25 and FY2025-26 disclosures (annual reports, BRSR filings, investor presentations, earnings calls and secondary data) of nine FMCD firms, together with government, industry and academic sources dated 2022 or later. Indian consumer durables is a market of about INR 2 lakh crore (USD 21.2 billion) with household penetration of only 8-10% for room air conditioners and 20-22% for washing machines, against 146, 98, 103 and 108 units per 100 households for air conditioners, washing machines, refrigerators and televisions in China. The evidence shows that regulation has transformed the product (BEE labelling saved 89.84 billion units of electricity in FY2023-24; the inverter share of air conditioners reached 77%) and created a reverse chain (e-waste EPR obligations of 18,000-55,000 tonnes per firm), while the middle of the chain lags: more than 80% of compressors, circuit boards and motors are imported, plants run on 4-19% renewable energy, inventory stands at 61-71 days, one weak summer in 2025 doubled channel stock to 2.5 million air conditioners, and formal physical recovery of consumer e-waste is 10-16% against 70.7% certified processing. After-sales service, at 24-56 lakh requests a year per firm, is the sector's largest customer-facing operation and the least measured. A three-layer framework (structure, flow, loop) and five hypotheses explain the pattern: product-level sustainability runs ahead because it is mandated and sells; chain-level sustainability lags because it is voluntary, costs capital and is invisible at the shelf. The paper closes with action points for firms, the dealer and service network, and policy, and identifies channel inventory norms, service metrics and dealer-based physical take-back as the measures that will decide whether FMCD operations become sustainable in practice.

Keywords: sustainable operations; value chain; consumer durables; Indian retail; energy labelling; extended producer responsibility; after-sales service; BRSR; circular economy

Introduction

India is one of the fastest-growing consumer durables markets in the world and one of the least penetrated. IBEF (2026) puts the market at about INR 2 lakh crore (USD 21.2 billion) in FY2024, up from INR 1.25 lakh crore (USD 13.2 billion) in FY2019, and expects about INR 3.4 lakh crore (USD 36.1 billion) by FY2029, which would make India the fourth-largest consumer durables market by FY2027. A BCG-CII study projects INR 3-3.25 lakh crore (USD 30-35 billion) by 2030 at 8-10% annual growth (NewsBytes, 2025). Yet only 8-10% of Indian households own a room air conditioner (ICRA, 2024), and 20-22% a washing machine, 45-50% a refrigerator and 70-75% a television (Business Today, 2026a). China, by comparison, had passed saturation by the end of 2023: 145.9 air conditioners, 98.2 washing machines, 103.4 refrigerators and 107.8 colour televisions per 100 households (Government of China, 2024; CEIC, 2024). Figure 2 sets the two countries side by side. All money values in this paper are in Indian rupees; dollar figures from sources are converted at INR 95 per USD (Business Recorder, 2026).

This gap between a large, fast-growing market and a thin installed base is the central operations problem of Indian FMCD. Most units sold are first purchases, so demand is highly sensitive to season, price steps and consumer credit, and the chain must be built for sharp peaks: summer for air conditioners, fans and refrigerators, the festive quarter for televisions and washing machines. At the same time, sustainability has moved from the annual report into daily operations through three laws. The Bureau of Energy Efficiency's standards and labelling programme covers 41 appliances and saved 89.84 billion units of electricity and 63.7 million tonnes of CO2 in FY2023-24 (BEE & SEforALL, 2025); its January 2026 revision dropped every air-conditioner rating by one star and made labelling mandatory for televisions (PSU Watch, 2025). The E-Waste (Management) Rules 2022 require producers to recycle 70% of the equivalent quantity in 2025-26 and 80% from 2027-28 (IEA, 2023). SEBI's Business Responsibility and Sustainability Reporting (BRSR) framework makes environmental and operating data auditable for the top 1,000 listed firms (SEBI, 2023).

The operations management literature links sustainability, value-chain design and planning and control, but it does not yet say how its models apply when the product is redesigned by regulation, demand is set by the weather, the reverse chain is a certificate market, and the largest customer-facing operation is barely measured. The research problem is therefore: how can sustainable operations be conceptualised, designed, planned and controlled across the Indian FMCD retail value chain, from supplier to customer and back, and what explains the gap between product-level and chain-level sustainability performance?

The study has four objectives: (1) to conceptualise sustainable operations and the value chain for Indian FMCD as a nine-stage structure from supplier to reverse chain; (2) to describe, with sourced and current data, how Indian FMCD firms design, plan and control operations at each stage; (3) to identify current challenges in manufacturing, retail and the trade network and assess the chain's strengths, weaknesses, opportunities and threats; and (4) to develop an integrated framework and testable hypotheses and derive action points for firms, the dealer and service network, and policy. Three research questions follow. RQ1: how should sustainable operations be conceptualised for a seasonal, import-dependent, service-intensive durables chain? RQ2: how are Indian FMCD firms designing, planning and controlling operations at each stage of the chain? RQ3: what explains the gap between product-level sustainability (energy labels, refrigerants, BLDC motors) and chain-level sustainability (plant energy, inventory, physical e-waste recovery)?

The paper makes three contributions. It applies the operations management canon to the whole Indian FMCD chain from component supplier to end-of-life recovery rather than to one firm or stage. It uses the

mandatory BRSR disclosures of FY2024-25 and FY2025-26 as a comparable firm-level data set; BRSR Core assurance reached the top 500 listed firms only in FY2025-26, so this is the earliest period for which audited environmental and operating data exist across the sector. And it derives a three-layer framework and five hypotheses in a form that can be tested with primary data. The Literature Review builds the framework; the Method section describes the design, sample and analysis; the Results section presents the chain stage by stage, the category evidence, current challenges and the SWOT; the Discussion assesses the hypotheses and answers the research questions; the Conclusion gives action points and limitations.

Literature Review

Porter's value chain remains the standard frame in recent value-chain studies (Di Vita et al., 2023; Kohnova & Salajova, 2023): a chain of primary activities (inbound logistics, operations, outbound logistics, marketing and sales, service) supported by procurement, technology, human resources and infrastructure. In FMCD the chain is an inter-firm chain. It runs from the compressor or panel supplier, often abroad, through the brand's or contract manufacturer's plant, the carrying-and-forwarding depot, the distributor and dealer, to the customer who uses the product for eight to fifteen years and then discards it. Most of the cost and most of the environmental load sit outside the brand's own plant: in components, in energy used by the product over its life, and in what happens at end of life.

The triple bottom line asks that profit, people and planet be managed together, and recent systematic reviews of sustainable supply chain management still frame the field this way (Shekarian et al., 2022; Mohsin et al., 2025; Arabshahi & Garza-Reyes, 2026). Arabshahi and Garza-Reyes (2026), reviewing 133 studies, identify government policy and stakeholder pressure as external drivers and environmental concern and managerial commitment as internal ones; the distinction between compliance-driven and choice-driven sustainability is central to this paper. The circular economy replaces take-make-dispose with loops of reduce, reuse, repair, remanufacture and recycle, with reverse logistics as the operational tool (Mishra et al., 2023). For durables the loop has two doors: repair during use, which extends product life, and recovery after use, which in India is a legal duty under extended producer responsibility (EPR). Indian e-waste studies show that compliance and physical recovery can diverge widely (Jaiswal & Mukti, 2024, 2025; Gaur et al., 2025). The SCOR model (ASCM, 2022) supplies a common process language, Plan, Source, Make, Deliver, Return and Enable, used here to organise the stage analysis. Combining these ideas, this paper defines sustainable FMCD operations as the design, planning and control of the end-to-end chain, from supplier to customer and back, so that it delivers the product at the right place, time, cost and quality while reducing material, energy and emission intensity per unit sold and over the product's life, and improving the livelihoods of the people who make, move, sell, install and service it.

Design decisions fix the structure of an operation for years and set most of its cost and footprint before the first unit is made. Four design areas matter most in FMCD. Product design: around 80% of a product's lifetime environmental impact is decided at the design stage (Tan et al., 2024), and for an appliance that impact is mostly energy in use, so the energy label is the single largest sustainability design choice; design for repair and disassembly decides whether the product can enter a circular loop. Network design: classical models trade facility cost against transport cost and service level (Chopra, 2025; Yuniarti et al., 2025); in India the Goods and Services Tax allowed consolidation into regional hubs, while the production-linked incentive (PLI) scheme has pulled component manufacturing onshore. Capacity design: Indian durables demand is strongly seasonal, and the options of leading, lagging, chasing or levelling demand each carry a sustainability cost, from contract-labour risk to obsolete inventory. Service design: for durables, after-

sales service is part of the product; the density of service centres, technician skills, spare-parts policy and remote diagnosis decide product life and feed failure data back into design, and service quality shapes brand attitude and repurchase (Nasir et al., 2024).

Planning decides what will be made, moved and stocked; control compares what happened with the plan. In a multi-layer chain, small changes in consumer demand are amplified upstream, the bullwhip effect, whose causes Brauch et al. (2024) group into system structure, uncertainty, misaligned incentives and inadequate understanding. Durables distribution, with month-end schemes, pre-season stocking and dealer credit, is a textbook bullwhip setting. Sales and operations planning is the monthly forum where trade-offs between the performance objectives are made visible (Kalla et al., 2025; Nyman et al., 2025), and inventory control sets reorder points and safety stock against a service target (Saldanha et al., 2023; Kirmizi et al., 2024). Lean (Khawka et al., 2024) and total quality management (Ali, 2024) supply the improvement methods, with field-failure data from service calls as the most valuable quality signal in durables. Sustainable operations adds resource productivity, output per unit of material, energy and emissions, as a sixth performance objective beside quality, speed, dependability, flexibility and cost (Slack et al., 2022; Geng et al., 2025).

Three gaps emerge. First, the sustainable supply chain literature models the firm and its first-tier partners and says little about chains where the product is redesigned by regulation and demand is set by the weather. Second, the circular economy literature treats the reverse loop as a design choice, whereas in Indian durables it is a regulatory duty delivered largely through certificate markets, and the role of the service network as the circular economy's front door is under-studied. Third, the planning-and-control literature assumes the planner can see end-consumer demand; in Indian durables that visibility is only now being created through secondary-sales tracking and dealer apps, and no study has yet used BRSR data to compare how far firms have gone. From these gaps five hypotheses are derived; Figure 5 shows the conceptual model, with each hypothesis linking one operating choice to one outcome inside the structure, flow or loop layer, and regulation and market structure as the context beneath all five (Table 3 states each with its result). H1: firms that plan from secondary sales and set channel-inventory norms carry fewer inventory days and less season-end stock than firms that plan from primary sales (Brauch et al., 2024). H2: where sustainability obligations arrive through regulation, performance clusters at the compliance level; where firms set targets ahead of regulation, performance runs ahead of the legal minimum (Arabshahi & Garza-Reyes, 2026). H3: product-level sustainability (energy in use) runs ahead of plant-level sustainability (energy in making) because the former is mandated and sells while the latter is voluntary and costs (Geng et al., 2025). H4: EPR obligations met through certified recyclers do not change product design or material recovery, while obligations met through physical take-back and recycled content do (Mishra et al., 2023; Jaiswal & Mukti, 2024). H5: after-sales service is the largest circular-economy lever in durables but the least measured, and firms that disclose turnaround and first-time-fix are the first to manage product life extension (Nasir et al., 2024).

Method

The study uses a descriptive, multiple-case comparative design based on secondary data (Kass et al., 2024). The unit of analysis is the firm's value chain as disclosed in its own regulatory and investor documents. Nine firms were chosen for theoretical reasons to span the FMCD range: cooling (Voltas, Blue Star), multi-category appliances (LG Electronics India, Samsung India, Whirlpool of India, Godrej Appliances, Havells including Lloyd) and home electricals (Crompton Greaves Consumer, Orient Electric,

Havells). Inclusion criteria were a listed Indian entity or an Indian subsidiary with public disclosures; a BRSR, annual report, investor presentation or earnings call for FY2024-25 or FY2025-26; and a material presence in Indian consumer retail. Table 1 lists the sample with the principal document and the metrics drawn from each.

Three classes of source were used: company documents (BRSR filings with the National Stock Exchange, annual reports, investor presentations, earnings-call transcripts, ESG databooks); government and regulatory documents (DPIIT and PIB on PLI, BEE on labelling, CPCB on e-waste, SEBI on BRSR, MoEFCC rules as summarised by IEA, NITI Aayog-TERI on circularity); and industry and market research (IBEF, KPMG, BCG-CII, CEEW, ICRA, Redseer, McKinsey, Knight Frank), with business-press reports of company statements where a primary document was not available. The reference period is FY2025-26 (April 2025 to March 2026); where a firm's latest document is FY2024-25 this is stated at the point of use. Each page was opened and the figure read from it; search snippets were not used as sources. Where sources disagreed (market size, e-waste recovery) the official or audited figure was preferred and the alternative noted. Every data point and reference is dated 2022 or later.

Analysis proceeded in five steps. (1) Coding to the stage model: every fact was assigned to one of nine value-chain stages (supplier, procurement, manufacturer, product, inventory, distribution, logistics, retail, customer and reverse chain), mapped to the SCOR processes Source, Make, Deliver and Return, and to one of three framework layers (structure, flow, loop). (2) Within-case description: for each firm the facts were assembled into a profile of reach, channel mix, manufacturing footprint, inventory, service operation and sustainability metrics. (3) Cross-case comparison: metrics were compared across firms using ranges and side-by-side tables; where a metric was available for four or more firms it was charted. (4) Thematic synthesis: challenges were grouped under manufacturing, retail and trade network, and the evidence sorted into a SWOT. (5) Hypothesis assessment: because the data are one or two annual observations per firm with differing boundaries, H1 to H5 were assessed on the direction and consistency of the observed pattern rather than by inferential statistics. The decision rule is that a hypothesis is supported when the pattern runs in the hypothesised direction with no contradicting case, partly supported when it runs in that direction but a variable is not disclosed widely enough for a full comparison, and not supported otherwise.

Four safeguards address trustworthiness. Construct validity: each metric was defined before extraction (for example, renewable share as the share of total energy unless the firm reports only electricity) and the firm's own definition recorded when different. Reliability: every figure carries its source, period and section, so another researcher can repeat the extraction. Internal validity: triangulation across source classes, and the direction of bias in a source is stated (EPR tonnages are certified obligations, not physical flows). External validity is bounded: the nine firms are the leading organised players and the findings describe the organised segment, not the long tail of regional assemblers and unregistered importers.

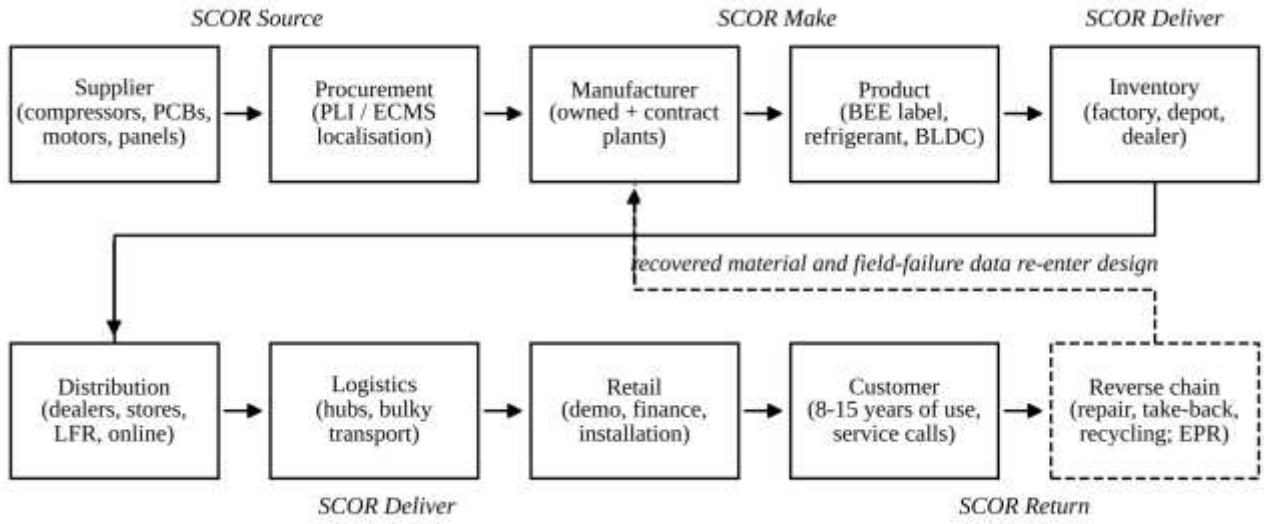


Figure 1. Framework architecture: the FMCD value chain, nine stages mapped to SCOR Source, Make, Deliver and Return (ASCM, 2022), with the reverse loop required by the E-Waste (Management) Rules 2022

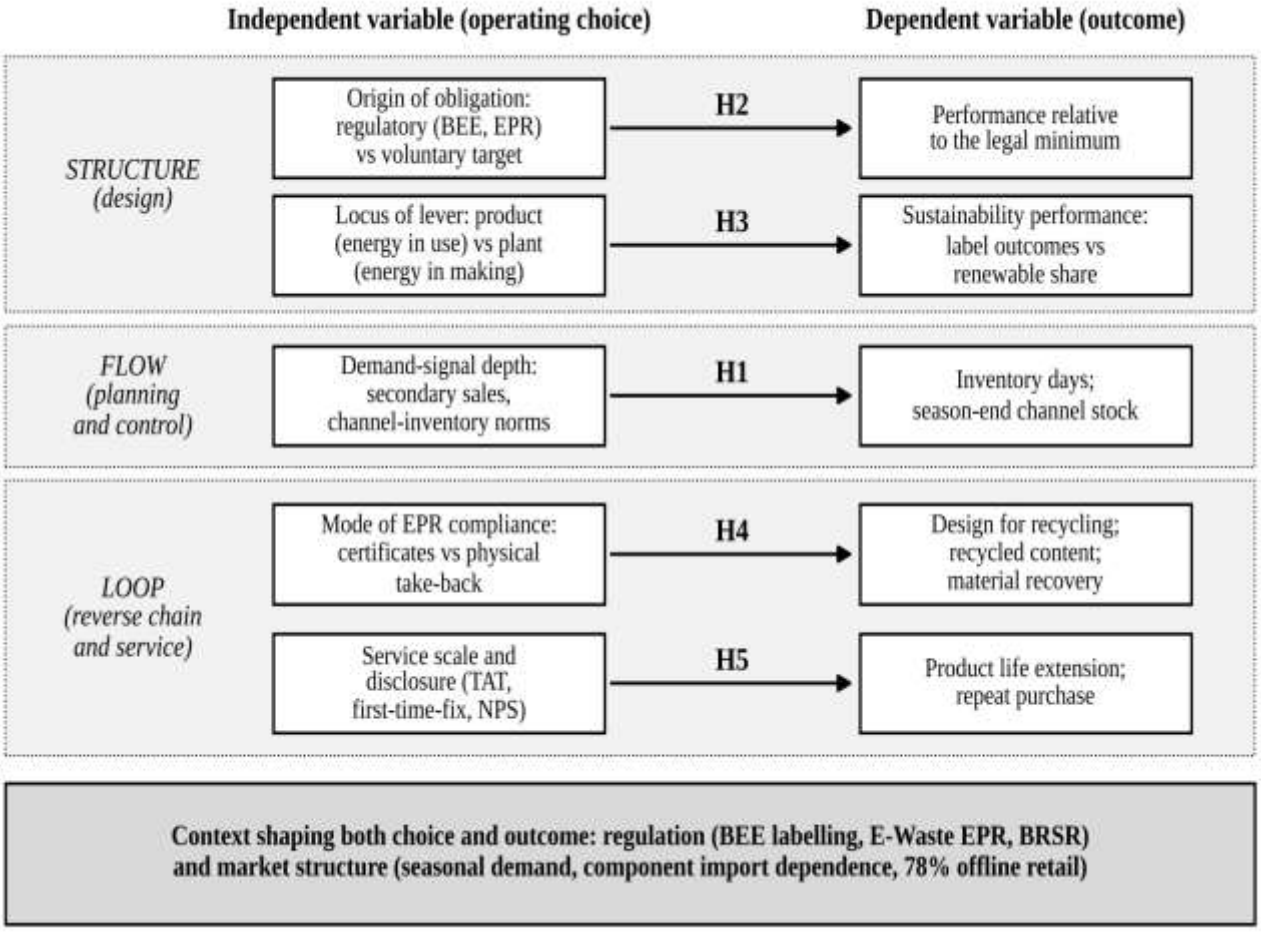


Figure 5. Hypothesis framework: five hypotheses, each linking an operating choice (independent variable) to an outcome (dependent variable) within the structure, flow and loop layers, with regulation and market structure as context

Table 1. Sample of nine FMCD firms, principal documents and metrics drawn

Firm	Main FMCD categories	Principal documents (period)	Key metrics drawn
Voltas	RAC, commercial refrigeration, WM, refrigerators	BRSR FY26; Business Today Jul 2026	Service requests, e-waste EPR, renewables, capacity, MSME sourcing
Blue Star	RAC, commercial refrigeration	BRSR FY26; MD interview Apr 2026	Channel mix, service requests, e-waste EPR, renewables, refrigerants
Havells (incl. Lloyd)	RAC, refrigerators, WM, TV, fans, lighting, water heaters	Corporate presentation Jul 2026; Q4 FY26 update; ESG Databook 2025	Dealers, retailers, inventory days, Lloyd revenue, e-waste EPR, NPS
Whirlpool of India	Refrigerators, WM, MWO, RAC	BRSR FY25	E-waste EPR, renewables
Crompton Greaves Consumer	Fans, lighting, pumps, small appliances	Investor presentation Q2 FY27	Retailers, service centres, BEE compliance
Orient Electric	Fans, lighting, small appliances	BRSR FY26; Q4 FY25 call	Retailers, service requests, e-waste EPR, installation TAT, BLDC share
LG Electronics India	TV, refrigerators, WM, RAC, MWO, audio	IPO note (Religare, 2025)	Touchpoints, service centres, plant output, localisation
Samsung India	TV, refrigerators, WM, RAC, MWO, audio	Press release Dec 2025	Service centres, engineers
Godrej Appliances	Refrigerators, RAC, WM	Industry statements Dec 2025	BEE 2026 price impact

Results

The Indian FMCD chain runs through nine stages with a reverse flow from the customer back to the manufacturer (Figure 1). This section takes each stage in turn. Figures are the latest disclosed, mostly FY2025-26; where a figure is from FY2024-25 or earlier this is stated.

Supplier. The supplier base decides raw-material risk, Scope 3 emissions and the import bill. CEEW (2022) found that more than 85% of air-conditioner compressors, over 80% of printed circuit boards and about 80% of motors were imported, and that domestic value addition in room air conditioners was only 25-50%. BCG-CII puts localisation of the bill of materials at 25-70% across durables categories today, rising to 30-80% by 2030 if component capacity grows (NewsBytes, 2025). Copper, aluminium, steel and the rupee set the cost base; Daikin, Godrej and Voltas all cited commodity costs and currency depreciation alongside the energy-norm change when raising prices in January 2026 (PSU Watch, 2025). Sustainable sourcing is measured at the margin: Voltas buys 28.4% of inputs from MSMEs (Voltas, 2026).

Procurement. Procurement is being reshaped by the PLI scheme for white goods. With an outlay of INR 6,238 crore for FY22 to FY29, the scheme had 85 approved firms after its fourth round in January 2026, with expected investment of INR 11,198 crore (USD 1.27 billion) and expected cumulative production of INR 1,90,050 crore (USD 21.5 billion) over the scheme period (IBEF, 2026); the government expects domestic value addition in air conditioners and LED components to rise from 15-20% to 75-80% (DPIIT, 2025a). The Electronics Components Manufacturing Scheme, raised to INR 40,000 crore in February 2026, had drawn INR 1.15 lakh crore of investment commitments by April 2026 against an initial target of INR 59,350 crore (IBEF, 2026). KPMG (2026) reports air-conditioner domestic production above 90% as of June 2026, up from about 40% in 2018, though assembly onshore still rests on imported compressors.

Manufacturer. The footprint is a mix of owned plants, contract manufacturers and global subsidiaries' Indian plants. Havells runs 17 units with more than 80% of output made in-house and raised Lloyd air-conditioner capacity to 3 million units across two plants; FY26 capex was INR 1,484 crore (Havells, 2026a, 2026b). Voltas raised its Chennai line from 1.0 to 1.5 million units a year on a base built for 2 million but still buys compressors (Business Today, 2026b). LG's Noida and Pune plants produce more than 14.5 million units a year at about 85% utilisation with roughly 54% local sourcing (Religare, 2025). Contract manufacturing is growing from about INR 4 lakh crore in FY25 to a projected INR 14 lakh crore by FY30 (KPMG, 2026), which matters because contract plants carry few of the brand's sustainability commitments. The energy transition inside the factory is early: renewable energy covers about 19% of energy at Whirlpool (FY25), 9% at Blue Star, 7.5% at Havells and 4% at Voltas (Whirlpool, 2025; Blue Star, 2026; Havells, 2025; Voltas, 2026), against 52-100% at the large FMCG firms (Figure 3).

Product. For FMCD the product decision that matters most is energy in use, and regulation has already changed the product. BEE labelling covers 41 appliances (17 mandatory) and saved 89.84 billion units of electricity in FY2023-24 (BEE & SEforALL, 2025). Split-AC efficiency rose 43% at one star and 61% at five stars, and the inverter share of air conditioners rose from 1% in FY16 to 77% in FY23 (Power Line, 2023). The January 2026 revision dropped every air-conditioner rating by one star, made labelling mandatory for televisions and lifted prices 5-10% for air conditioners and 3-5% for refrigerators (PSU Watch, 2025); Voltas reports 12-13% efficiency gains from redesign, Blue Star launched 125 compliant models with an 8% price step, and Crompton moved its fan range to BEE compliance from 1 January 2026 (Voltas, 2026; Business Today, 2026c; Crompton, 2026). Voltas and Blue Star have moved to R32 refrigerant and are trialling R290 (Blue Star, 2026). BLDC motors are 20% of Orient's fan sales (Orient Electric, 2025). In lighting, UJALA distributed 36.87 crore LED bulbs, cut the bulb price from INR 450-500 to about INR 70 and saves 47,883 million units of electricity a year (PIB, 2025). Design for repair and disassembly, by contrast, is not disclosed by any firm in the sample.

Inventory. Inventory is held at the factory, the depot, the distributor and the dealer, and seasonality makes it the chain's largest working-capital and obsolescence risk. Havells held 71 days of inventory in FY26 against 67 the year before (Havells, 2026a). After a weak summer, room-AC channel stock roughly doubled to about 2.5 million units by July 2025, and industry volumes fell in FY26 after a record 12.5-13 million units in FY25 (ICRA, 2025). Havells' Lloyd segment swung from 35% growth in FY25 to a 23% fall in FY26 (Havells, 2026a). Voltas has since targeted channel inventory of 30-45 days (Business Today, 2026b). Each BEE revision adds an obsolescence layer: stock labelled under the old norm must be sold or relabelled before the new year begins, which is why trade partners pulled purchases forward in December 2025 (PSU Watch, 2025).

Distribution. FMCD networks are smaller in outlet count than FMCG but deeper in the influencer layer and the exclusive store. Havells works through about 20,700 direct dealers, 272,000 retailers, 42,000 rural touchpoints and more than 750 exclusive stores; Crompton reaches 275,000 retailers; LG has 35,640 B2C touchpoints; Orient Electric serves 50,000-55,000 retailers directly in a fan market of about 130,000 unique retailers (Havells, 2026b; Crompton, 2026; Religare, 2025; Orient Electric, 2025). Channel mix is shifting: Blue Star sells about 44% through large-format retail and about 10% online; Havells counts 28% of revenue from emerging channels and about 5% online (Business Today, 2026c; Havells, 2025). The electrician, plumber and installer remain the decisive influencers for fans, water heaters and lighting, which is why loyalty programmes and installation promises sit at the centre of distribution design.

Logistics. Logistics cost India 7.97% of GDP, or INR 24.01 lakh crore, in 2023-24 (DPIIT, 2025b). For bulky durables, cube rather than weight sets the cost, and transit damage is the main quality loss. GST started a consolidation into regional hubs that is still running: warehousing stock across eight cities reached 549 million sq ft in 2025 with Grade A at 45%, and manufacturing took 47% of new demand (Knight Frank, 2025). Appliance exports are rising fast from a small base (year-on-year to May 2026: refrigerators 30%, washing machines 27%, air conditioners 20%), though India's share of global consumer-durables exports is still under 1% (KPMG, 2026; NewsBytes, 2025). Emissions per unit shipped are not disclosed by any firm in the sample.

Retail. The durables market is still about 78% offline (Religare, 2025), but e-commerce grew 25% in the first quarter of calendar 2026 (KPMG, 2026). Smart-TV shipments were flat in 2025, with a weak first half and a 10% year-on-year rise in the fourth quarter on festive offers, financing and the GST cut on sets of 32 inches and above; 43-inch sets led volume, 55-inch and larger drove growth, and QLED shipments nearly doubled (Counterpoint Research, 2026). Two policy moves changed the shelf in a single year: the September 2025 GST revision cut the rate on air conditioners and large televisions from 28% to 18%, a price cut that the January 2026 BEE revision then largely absorbed (PSU Watch, 2025). BEE's 2025 labelling regulations also require retailers to display labels, now with a QR code for traceability, in stores and on products (Business Standard, 2025). The exclusive brand store and the large-format retailer carry demonstration, financing and installation booking, which the marketplace cannot, so retail design in FMCD is a service-design problem as much as a stocking one.

Customer and reverse chain. The customer stage has two halves: service during use and recovery after use. Service is an operation on the scale of distribution. Voltas logged 56.29 lakh service requests in FY26, Blue Star 28.85 lakh and Orient Electric 24.26 lakh; LG runs 1,006 service centres with more than 13,000 engineers, Samsung 3,000 centres with 12,000 engineers, Crompton more than 1,300 service centres (Voltas, 2026; Blue Star, 2026; Orient Electric, 2026; Samsung, 2025). Few firms disclose turnaround or first-time-fix rates; Orient's 24-hour installation promise for premium fans and Havells' Net Promoter Score of 70 are the exceptions (Orient Electric, 2025; Havells, 2025). The reverse chain is driven by EPR. FMCD firms report large e-waste tonnages against the 70% target for 2025-26: Whirlpool 54,930 tonnes (FY25), Voltas 38,068, Havells 33,734 (FY25), Orient 26,333 and Blue Star 17,887 (Figure 4). At system level the numbers diverge. CPCB data show e-waste generation nearly doubling from 7.08 lakh tonnes in 2017-18 to 13.98 lakh tonnes in 2024-25, with the share processed through registered recyclers rising from 9.8% to 70.7% (Factly, 2025). Independent estimates put formal physical recovery of consumer e-waste at 10-16%, with the informal sector handling 60-70%, and NITI Aayog-TERI (2026) estimate that only about 18% of an INR 51,000 crore annual material value is recovered (Redseer, 2025). The gap between certified processing and physical recovery is the reverse chain's central measurement problem.

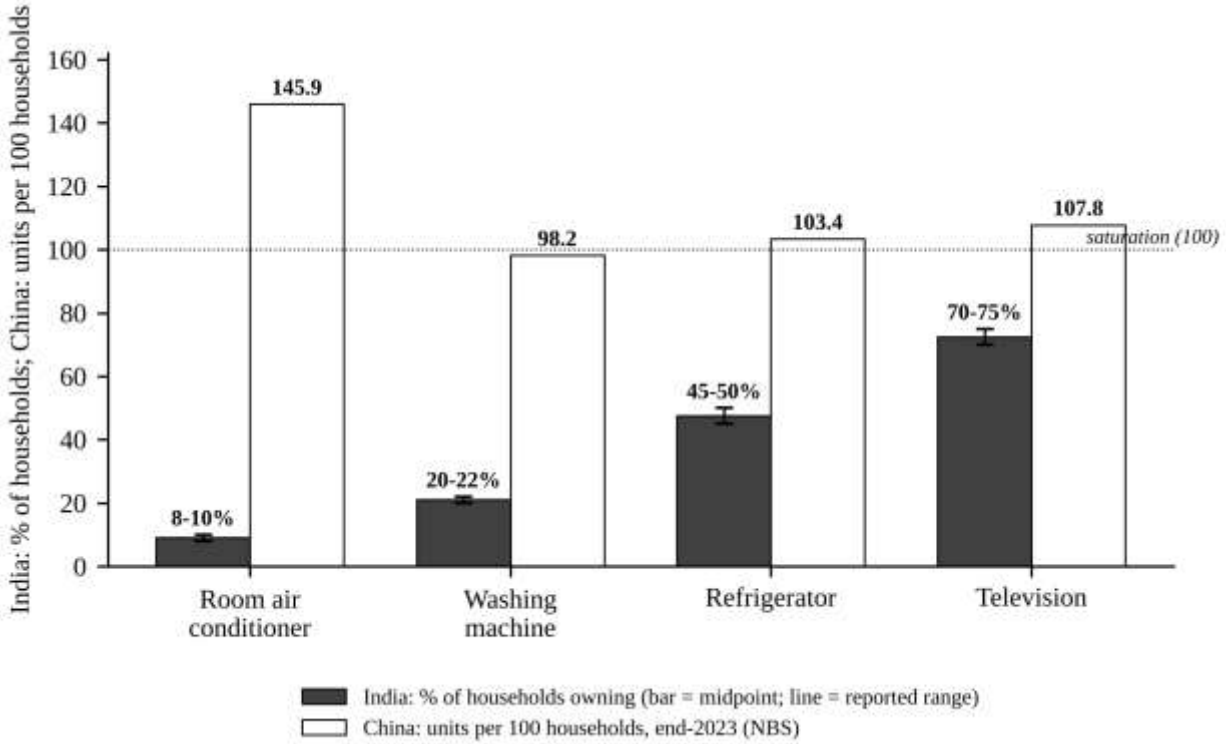


Figure 2. Household penetration by appliance: India, % of households owning (ICRA, 2024; BCG-CII via Business Today, 2026a) against China, units per 100 households at end-2023 (National Bureau of Statistics via Government of China, 2024, and CEIC, 2024)

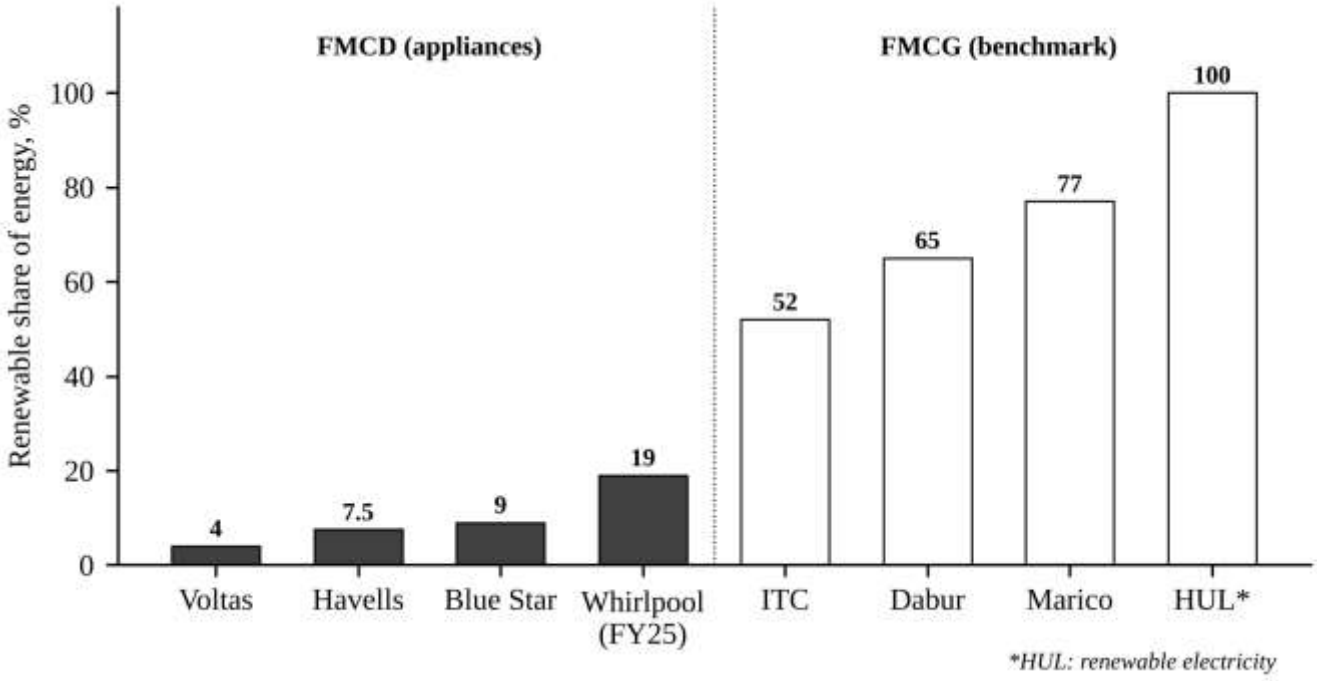


Figure 3. Renewable share of energy at FMCD plants against the FMCG benchmark; BRSR FY26 (Voltas, Blue Star, Dabur, ITC), BRSR FY25 (Whirlpool), ESG Databook 2025 (Havells), company updates (Marico, HUL)

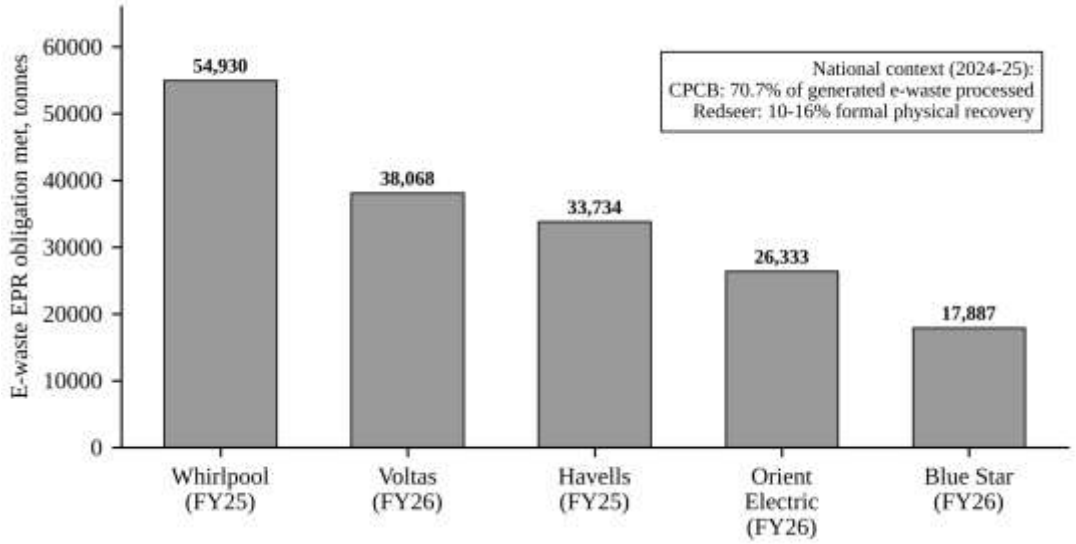


Figure 4. E-waste EPR obligation met by firm, tonnes; BRSR FY26 (Voltas, Orient, Blue Star), BRSR FY25 (Whirlpool), ESG Databook 2025 (Havells); national context from Factly/CPCB (2025) and Redseer (2025)

Table 2. Category profile: market, operations, sustainability lever and main risk (sources: IBEF, 2026; Business Today, 2026a; ICRA, 2025; KPMG, 2026; PSU Watch, 2025; company documents)

Category	Market and penetration	Operations profile	Main sustainability lever	Main operations risk
Room air conditioner	INR 58,400 crore (USD 6.15 bn) FY25; 8-10% of households (China: 145.9 per 100 households); 12.5-13 mn units FY25, fall in FY26	Summer-peaked; compressors 85%+ imported; channel norm 30-45 days	BEE label (ratings cut one star, Jan 2026); R32/R290; inverter share 77%	Weak summer doubling channel stock; redesign cycle; 5-10% price steps
Refrigerator	INR 38,000 crore (USD 4.0 bn) FY25; 45-50% of households (China: 103.4 per 100)	Year-round with summer peak; bulky, cube-driven logistics; 10-15 year life	BEE label (mandatory); refrigerant and insulation; 3-5% price step Jan 2026	Transit damage; end-of-life recovery of refrigerant and foam
Washing machine	INR 18,600 crore (USD 1.96 bn) FY25; 20-22% of households	Festive-peaked; semi-automatic to front-load mix;	BEE label; water per cycle	First-purchase demand sensitive to credit

	(China: 98.2 per 100)	water and energy in use		
Television	70-75% of households (China: 107.8 per 100); 5.9% CAGR FY24-29; smart-TV shipments flat in 2025, Q4 up 10% after the GST cut; 43-inch the largest size, QLED shipments nearly doubled	Festive-peaked; panel 100% imported; 12-18 month model cycles; INR 40,000-50,000 band outperformed	Labelling mandatory from Jan 2026; standby power	Panel price volatility; fast obsolescence feeding e-waste
Microwave oven, audio	Small categories (China MWO: 42.2 per 100 households, 2022); MWO proposed for BEE labelling	Largely imported or contract-made; low service load	Energy label (proposed); packaging	Import dependence; limited repairability
Home electricals (fans, lighting, water heaters)	Fans: ~130,000 unique retailers; UJALA 36.87 crore LED bulbs	Electrician-influenced; high volume, low value; 24-56 lakh service requests a year at leading firms	BEE fan label (Jan 2026); BLDC motors (20% of Orient fans); LED	Counterfeits; installation quality; informal e-waste

The categories share one chain but differ in seasonality, unit value, energy intensity and service load (Table 2). Three cross-category patterns stand out. First, every category is moving the replenishment trigger closer to the consumer: channel-inventory norms for air conditioners, secondary-sales tracking at dealers, marketplace data for televisions. Second, compliance obligations (BEE, EPR, BRSR) have become the main driver of sustainability operations, so performance clusters at the compliance line: labels are met and EPR tonnages certified, but renewable energy in plants, emissions per unit shipped and recycled content are low or not disclosed. Third, the data firms disclose follows the metric regulation asks for, which leaves blind spots exactly where the chain's largest customer-facing operation sits.

Current challenges. In manufacturing, domestic value addition in air conditioners and LED components was 15-20% when the PLI scheme's third round was approved, against a target of 75-80% (DPIIT, 2025a); ICRA (2024) puts room-AC localisation at 30-40% and household penetration at about 8%, and McKinsey (2026) estimates that import dependence in electrical equipment rose from 22% in 2020 to 33% in 2025.

New capacity (Havells 3 million units, Voltas 1.5 million, Haier INR 800 crore for air conditioners and PCBs) is being added on top of a market that fell in FY26, which raises the cost of a second weak season (IBEF, 2026). Each BEE revision improves the product but compresses the design-to-shelf window and strands labelled inventory. In retail, policy moved prices down 10% in September 2025 and back up in January 2026; dealers carried the swing in stock valuation and consumers learned to wait. Channel complexity is rising while the market remains 78% offline, and urban consumer confidence fell for three straight months to 91 in May 2026 (KPMG, 2026). In the trade network, channel-inventory norms of 30-45 days are stated but were far exceeded in 2025; installer programmes reward purchase rather than installation quality; and the network that sells and installs the product is not yet the network that takes it back.

SWOT. The chain's strengths sit at its two ends: an energy-efficient product driven by BEE, and service networks on the scale of distribution. Its weaknesses sit in the middle: components 80%+ imported, 61-71 inventory days, renewable energy at 4-19% of plant energy, service quality and design for repair undisclosed, and EPR met through certificates. The opportunities are penetration headroom (Figure 2; 8-10% for air conditioners against 145.9 units per 100 households in China) with 8-11% market growth to INR 3-3.25 lakh crore by 2030, PLI and ECMS localisation with INR 11,198 crore and INR 1.15 lakh crore committed, exports growing 20-30% a year, and e-waste material worth INR 51,000 crore a year of which only 18% is recovered. The threats are weak summers, BEE revision cycles that strand inventory, copper, panel and currency volatility, a rising electrical import share, an informal e-waste sector handling 60-70% of volume, and softening consumer confidence.

Table 3. Assessment of the hypotheses at the level of the disclosed data

Code	Hypothesis (alternative)	Result	Pattern in the evidence
H1	Planning from secondary sales with channel norms lowers inventory days and season-end stock	Partly supported	Voltas' 30-45 day channel norm followed the 2025 overhang; Havells' inventory rose from 67 to 71 days as Lloyd fell 23%. Only two firms disclose inventory days; none discloses forecast accuracy.
H2	Regulatory obligations produce compliance-level performance; voluntary targets run ahead of the legal minimum	Supported	Every firm meets and discloses the BEE label and e-waste EPR; voluntary measures (renewables, recycled content, design for repair) stand at 4-19% or

			are not disclosed. No contradicting case.
H3	Product-level sustainability runs ahead of plant-level sustainability	Supported	89.84 bn units saved; inverter share 77%; BLDC 20% of Orient fans, against renewable share of 4-19%. The mandated and marketable lever moved first.
H4	Certificate-based EPR does not change design or material recovery; physical take-back does	Supported	No disclosed change in design for recycling or recycled content in the sample; 70.7% certified processing against 10-16% formal physical recovery shows the certificate does not pull material back to the producer.
H5	Service is the largest circular lever but the least measured	Partly supported	24-56 lakh service requests a year per firm, yet only Orient (installation TAT) and Havells (NPS 70) disclose a service-quality metric; whether early disclosers manage product life better cannot yet be tested.

Discussion

The evidence can be drawn into one framework with three layers, each with its own sustainability lever and its own Indian constraint. Structure is the layer of design decisions: where to make, where to store, what the product looks like and how the service network is laid out. In FMCD it is being reset by PLI- and ECMS-led localisation, BEE-led product redesign and the growth of in-house and contract capacity; its lever is product design, because it fixes energy in use for ten years before any unit is sold, and its constraint is that components are still imported and plants still run on grid power. Flow is the layer of planning and control: forecasting, S&OP, inventory, replenishment and scheduling. Its constraint is that demand is set by the weather and the festive calendar and read three layers away from the consumer, so one weak summer doubles channel stock; its lever is inventory and transport intensity, since fewer days of stock

mean less season-end discounting and fewer stranded models at each label change. Loop is the reverse chain: repair during use and collection, recycling and material recovery after use. Its constraint is that it was built by regulation rather than operations, so EPR tonnages are large while physical recovery is small; its lever is to turn the loop from a compliance cost into a material and service source, which the dealer and service network, already touching the customer at installation and repair, is placed to do.

Table 3 assesses the five hypotheses. Three are supported and two (H1, H5) partly supported because firms do not disclose the inventory and service measures needed for a full test. The pattern answers the research questions. RQ1: for a seasonal, import-dependent, service-intensive chain, sustainable operations must be defined over the product's life, not the plant's year, which the working definition in the Literature Review does. RQ2: Indian FMCD firms have redesigned the product, built service networks and begun localising components, but still plan largely from primary sales, run plants on grid power and meet EPR on paper. RQ3: product-level sustainability runs ahead because it is mandated by BEE and sells to the consumer (H2, H3); chain-level sustainability lags because it is voluntary, costs capital and is invisible at the shelf.

The result extends the external-versus-internal driver distinction of Arabshahi and Garza-Reyes (2026) with a specific mechanism: in Indian FMCD the external driver has not only set a floor but has defined which metrics exist at all, because BRSR disclosure follows the regulated metric. It qualifies the circular economy literature (Mishra et al., 2023) by showing that a legally compelled reverse loop delivered through certificates does not feed back into design, consistent with the barriers Jaiswal and Mukti (2024, 2025) and Gaur et al. (2025) identify. And it locates the bullwhip setting of Brauch et al. (2024) in a chain where the amplifier is the weather and the label calendar rather than promotions alone, which is why channel-inventory norms agreed before the season are the first control to install.

Three limits bound the support. Firms disclose what regulation asks for, so inventory days, forecast accuracy, service turnaround and dealer economics are evidenced thinly. Reporting boundaries differ: renewable shares are sometimes energy and sometimes electricity, and Whirlpool and Havells ESG figures are FY2024-25 while most are FY2025-26. EPR tonnages measure certified obligations, not material physically recovered by the brand. Future research could test H1 through dealer-level inventory panels across a full season, H3 and H4 through BRSR panel data as assurance extends to all 1,000 firms by FY2026-27, and H5 through case studies of firms that begin to disclose service metrics, linking them to product life and repurchase.

Concerns

Figure 6 sets the concerns against the suggestions for each part of the chain. In manufacturing, the first concern is component dependence: more than 80% of compressors, circuit boards and motors are imported, room-AC localisation is 30-40% and the electrical import share has risen to 33%, so the rupee and copper set the cost base and Scope 3 sits abroad. The second is the energy transition inside the plant, where renewable energy covers 4-19% of plant energy against published 2030 targets. The third is the regulatory redesign cycle: each BEE revision improves the product but strands labelled stock and forces price steps of 5-10%. The fourth is capacity added into volatility, with Havells, Voltas and Haier expanding after a year in which volumes fell.

In retail, the concern is demand that is first-purchase and credit-led at 8-10% penetration for air conditioners and 20-22% for washing machines, so that any price step moves the buyer. Policy moved prices down 10% in September 2025 and back up in January 2026, and consumers learned to wait. Four

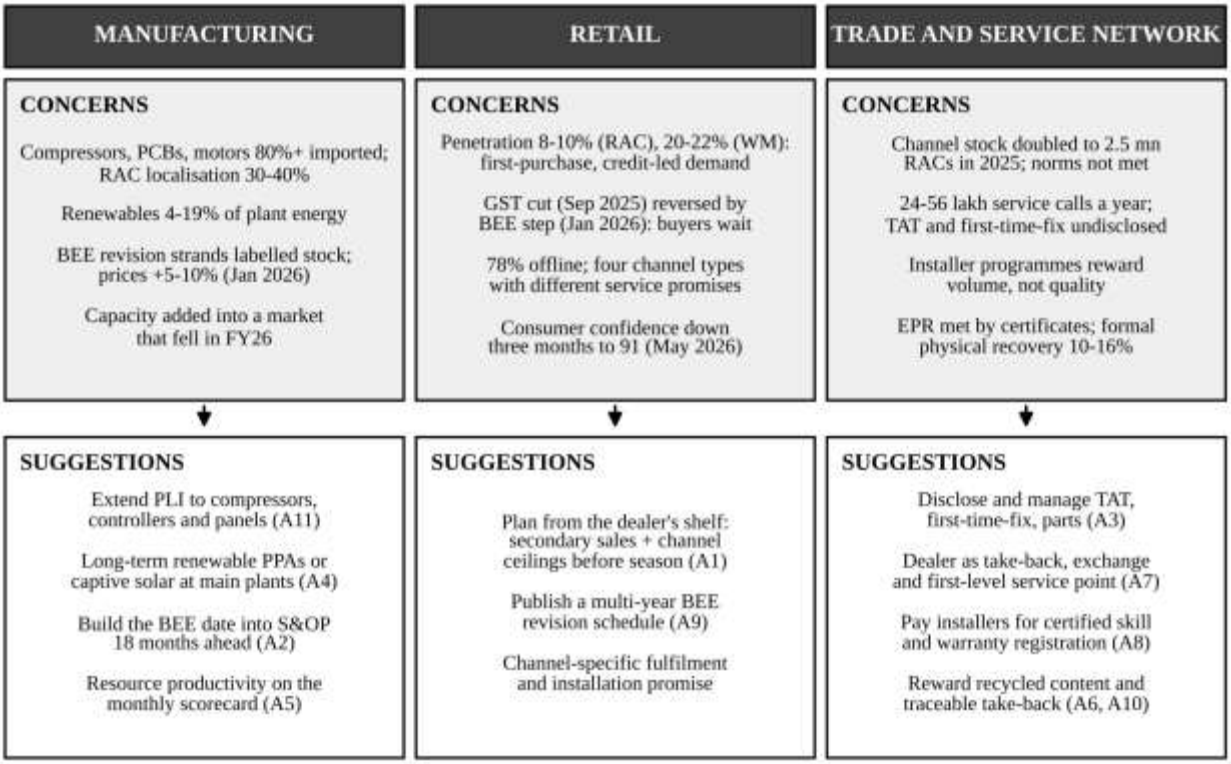
channel types, the exclusive store, large-format retail, the general dealer and the marketplace, now need different packaging, lead times and installation promises while the market stays 78% offline, and urban consumer confidence fell for three straight months to 91 in May 2026.

In the trade and service network, channel stock doubled to about 2.5 million air conditioners in 2025 against norms of 30-45 days that were not met, and the dealer carried the cost. Service handles 24-56 lakh calls a year per leading firm, yet turnaround and first-time-fix are undisclosed, so the sector's largest customer-facing operation runs without public performance measures. Installer programmes reward purchase volume rather than installation quality or warranty registration. And the reverse chain is a certificate market: CPCB counts 70.7% of e-waste as processed while formal physical recovery is 10-16%, so the network that sells and installs the product is not yet the network that takes it back.

Suggestions

The suggestions follow the three layers of the framework and are consolidated as eleven action points in Table 4, each with an owner, a horizon and a measure of success. For operations and commercial leaders: plan from the dealer's shelf by making secondary sales and dealer stock the base of the forecast and agreeing channel ceilings before each season (A1); build the BEE revision date into the S&OP calendar eighteen months ahead with a run-down plan for old-label stock (A2); measure service like distribution by disclosing and managing turnaround, first-time-fix and parts availability (A3); contract renewable power early through long-term agreements or captive solar at the main plants (A4); put energy per unit made, emissions per unit shipped and recycled content on the monthly operations scorecard (A5); and treat the reverse chain as sourcing by contracting recovered copper, aluminium and steel with quality specifications and designing the next range for disassembly (A6).

For the dealer and service network: turn the dealer into a take-back, exchange-at-installation and first-level service point, which adds a revenue line to the dealer and gives the brand a physical reverse chain (A7); pay installers for certified skills, warranty registration and first-time-fix rather than volume alone (A8); and share the secondary-sales signal with the dealer so that dealer credit is not the chain's only buffer against a weak season. For policy: publish a multi-year BEE revision schedule so manufacturers can plan component localisation and capacity around it (A9); reward recycled content and traceable take-back over certified processing and bring the informal sector into the formal loop through registration and aggregation hubs, as NITI Aayog-TERI (2026) and recent academic work recommend (A10); and extend PLI to compressors, controllers and display panels, where the remaining import bill and Scope 3 load sit (A11).



A1-A11 refer to the action points in Table 4

Figure 6. Concerns and suggestions by part of the chain; A1-A11 are the action points in Table 4

Table 4. Action points with owner, horizon, measure of success and basis

No.	Action point	Owner	Horizon	Measure of success	Basis
A1	Make secondary sales and dealer stock the base of the forecast and S&OP; agree channel ceilings before each season	Supply chain and sales heads	0-6 months	Chain inventory days; season-end channel stock; discounting cost	H1
A2	Build the BEE revision date into the S&OP calendar with an old-label run-down plan	COO; product head	6-18 months	Old-label stock at changeover; write-offs per revision	H2, H3
A3	Disclose and manage service	Customer service head	0-12 months	TAT (hours); first-time-fix	H5

	turnaround, first-time-fix and parts availability			(%); repeat-complaint rate	
A4	Sign long-term renewable power agreements or install captive solar at main plants	Plant heads; CFO	12-36 months	Renewable share of energy (%) against the 2030 target	H3
A5	Add energy per unit made, emissions per unit shipped and recycled content to the monthly operations review	COO; sustainability lead	0-3 months	Measures reported monthly, not only in BRSR	H2
A6	Contract recovered metals with quality specifications; design the next range for disassembly	Procurement; R&D	12-24 months	Recycled content (%); share of EPR met by physical recovery	H4
A7	Use dealers as e-waste drop-off, exchange and first-level service points	Channel and service heads	12-24 months	Collection volume through dealers (t); dealer service revenue	H4, H5
A8	Re-base installer programmes on certified skills, warranty registration and first-time-fix	Sales head; service head	6-12 months	Warranty registrations; repeat service calls per 1,000 units	H5

A9	Policy: publish a multi-year BEE revision schedule	BEE; Ministry of Power	6-12 months	Redesign lead time; stranded stock per revision	Concerns: manufacturing
A10	Policy: reward recycled content and traceable take-back over certified processing	MoEFCC; CPCB	12-24 months	Formal physical recovery (%); recycled content in new products	H4
A11	Policy: extend PLI to compressors, controllers and display panels	DPIIT; MeitY	12-36 months	Domestic value addition (%); component import bill	Concerns: manufacturing

Conclusion

Sustainable operations in Indian FMCD is no longer a question of intent but of chain design and control. Regulation has already transformed the product: the energy label has made the Indian air conditioner, refrigerator and fan far more efficient in a decade, and e-waste rules have created a reverse chain where none existed. What regulation has not reached is the middle of the chain, where components are imported, plants run on grid power, inventory swings with the weather and the reverse loop is a certificate rather than a flow of material.

The measures regulation does not yet require, channel inventory days, service turnaround and first-time-fix, renewable share of plant energy and physical e-waste recovery, are the ones that will decide whether FMCD operations become sustainable in practice. The firms that manage them first will be the ones for which sustainability becomes a performance objective rather than a reporting duty.

References:

1. Ali, K. (2024). Total quality management in manufacturing firms: Current and future trends. Foresight, 26(3), 505-530. https://doi.org/10.1108/FS-09-2023-0180
2. Arabshahi, M., & Garza-Reyes, J. A. (2026). Advancing sustainable supply chain management: Emerging trends, challenges and determinants of success. Modern Supply Chain Research and Applications, 8(1), 2-22. https://doi.org/10.1108/MSCRA-04-2025-0026
3. Association for Supply Chain Management (ASCM). (2022). SCOR digital standard. ASCM.
4. Blue Star Limited. (2026). Business responsibility and sustainability report FY2025-26. National Stock Exchange of India. https://nsearchives.nseindia.com/corporate/BLUESTARCO13072026232555SEIntimationBRSRFY26.pdf
5. Brauch, M., Mohaghegh, M., & Grossler, A. (2024). Causes of the bullwhip effect: A systematic review and categorization of its causes. Management Research Review, 47(7), 1127-1149.

https://doi.org/10.1108/MRR-05-2023-0392
6. Bureau of Energy Efficiency (BEE), & Sustainable Energy for All (SEforALL). (2025). Overview of the standards and labelling programme. https://www.seforall.org/system/files/2026-02/Overview%20of%20SL%20Program%20%2007.08.2025Updated%20%281%29.pdf
7. Business Recorder. (2026, October 29). Indian rupee ends flat after hitting two-week low, oil and RBI remain key. https://www.brecorder.com/news/40446500
8. Business Standard. (2025, July 18). Appliance labels in India to carry QR code, star rating and origin under BEE 2025 rules. https://www.business-standard.com/india-news/appliance-labels-india-qr-code-star-rating-origin-bee-2025-rules-125071800380_1.html
9. Business Today. (2026a, September 24). Only 1 in 10 Indian households has an AC: Why India's appliance market has a long runway. https://www.businesstoday.in/india/story/only-1-in-10-indian-households-has-an-ac-why-indias-appliance-market-has-a-long-runway-557625-2026-09-24
10. Business Today. (2026b, July 2). Before stepping down, Noel Tata reveals Voltas' big Make in India plan for ACs. https://www.businesstoday.in/amp/latest/corporate/story/before-stepping-down-noel-tata-reveals-voltas-big-make-in-india-plan-for-acs-540542-2026-07-02
11. Business Today. (2026c, April 8). AC sales to grow 15% in FY27: Blue Star MD. https://www.businesstoday.in/latest/corporate/story/ac-sales-to-grow-15-in-fy27-blue-star-md-524632-2026-04-08
12. CEIC Data. (2024). China durable consumer goods per 100 households [Data series compiled from the National Bureau of Statistics]. https://www.ceicdata.com/en/china/durable-consumer-goods-per-household
13. Chopra, S. (2025). Supply chain management: Strategy, planning, and operation (8th ed.). Pearson.
14. Counterpoint Research. (2026, March 25). India's smart TV shipments flat in 2025, larger screens and QLED gain share [Report summary]. IANS. https://ianslive.in/indias-smart-tv-shipments-flat-in-2025-larger-screens-and-qled-gain-share-report--20260325123630
15. Council on Energy, Environment and Water (CEEW). (2022). Research on technology gaps in India's air-conditioning supply chain. https://www.ceew.in/sites/default/files/ceew-research-on-technology-gaps-in-indias-air-conditioning-supply-chain.pdf
16. Crompton Greaves Consumer Electricals Limited. (2026). Investor presentation Q2 FY27. National Stock Exchange of India. https://nsearchives.nseindia.com/corporate/Crompton12316102026150538InvestorPresentation.pdf
17. Department for Promotion of Industry and Internal Trade (DPIIT). (2025a, January 20). PLI scheme for white goods: Results of the third round [Press release]. https://pliwhitegoods.ifciltd.com/docs/pressReasePLIScheme20January2025.pdf
18. Department for Promotion of Industry and Internal Trade (DPIIT). (2025b, November). Logistics cost in India: Estimate for 2023-24 [Backgrounder]. Press Information Bureau. https://static.pib.gov.in/WriteReadData/specificdocs/documents/2025/nov/doc20251127708301.pdf
19. Di Vita, G., Spina, D., De Cianni, R., Carbone, R., D'Amico, M., & Zanchini, R. (2023). Enhancing the extended value chain of the aromatic plant sector in Italy: A multiple correspondence analysis based on stakeholders' opinions. Agricultural and Food Economics, 11, Article 15. https://doi.org/10.1186/s40100-023-00257-8
20. Factly. (2025). India's e-waste generation doubles in 8 years, but processing remains skewed [CPCB data]. https://factly.in/indias-e-waste-generation-doubles-in-8-years-but-processing-remains-skewed

21. Gaur, T. S., Yadav, V., Mittal, S., Singh, R., & Khan, S. A. (2025). E-waste management challenges in India from the perspective of producer responsibility organizations. IEEE Access, 13, 54462-54473. https://doi.org/10.1109/ACCESS.2025.3553203
22. Geng, D., Sarkis, J., & Zhu, Q. (2025). Corporate sustainable operations management for carbon emissions reduction: An evolutionary perspective. Fundamental Research, 5(4), 1750-1758. https://doi.org/10.1016/j.fmre.2024.07.007
23. Government of China. (2024, October 7). Ownership of major durable consumer goods per 100 households, 1981-2023 [News release citing National Bureau of Statistics data]. english.www.gov.cn. https://english.www.gov.cn/news/202410/07/content_WS67039c8cc6d0868f4e8eb8c3.html
24. Havells India Limited. (2025). ESG databook 2024-25. https://havells.com/media/wysiwyg/PDF/Sustainability/reports/esg-databook/HavellsESGDatabook2025.pdf
25. Havells India Limited. (2026a). Information update Q4 FY2025-26. National Stock Exchange of India. https://nsearchives.nseindia.com/corporate/HAVELLS12204202614533 7InfoUpdate_Q4FY202526.pdf
26. Havells India Limited. (2026b). Corporate presentation, July 2026. https://havells.com/media/wysiwyg/PDF/Presentation/HavellsIndiaLimitedJuly2026.pdf
27. ICRA Limited. (2024, March). Room air conditioners: Research summary. https://www.icra.in/Rating/DownloadResearchSummaryReport?id=5620
28. ICRA Limited. (2025, September). Indian room AC market volumes expected to drop 10-15% in FY26. Indian Retailer. https://www.indianretailer.com/article/retail-business/retail-trends/indian-room-ac-market-volumes-expected-drop-10-15-pc-fy26
29. India Brand Equity Foundation (IBEF). (2026). Consumer durables industry in India [Infographic, May 2026]. https://www.ibef.org/uploads/industry/Infrographics/large/Consumer-Durables-Infographic-May-2026.pdf
30. International Energy Agency (IEA). (2023). India E-Waste (Management) Rules 2022 [Policy database entry]. https://www.iea.org/policies/25027-e-waste-management-rules-2022
31. Jaiswal, S. K., & Mukti, S. K. (2024). E-waste circularity in India: Identifying and overcoming key barriers. Journal of Material Cycles and Waste Management, 26(6). https://doi.org/10.1007/s10163-024-02050-1
32. Jaiswal, S. K., & Mukti, S. K. (2025). Prioritizing factors affecting e-waste recycling in India: A framework for achieving a circular economy. Circular Economy and Sustainability, 5(1), 461-481. https://doi.org/10.1007/s43615-024-00423-0
33. Kalla, C., Scavarda, L. F., & Hellingrath, B. (2025). Integrating supply chain risk management activities into sales and operations planning. Review of Managerial Science, 19(2), 467-497. https://doi.org/10.1007/s11846-024-00756-y
34. Kass, S., Brosig, C., Westner, M., & Strahringer, S. (2024). Short and sweet: Multiple mini case studies as a form of rigorous case study research. Information Systems and e-Business Management, 22(2), 351-384. https://doi.org/10.1007/s10257-024-00674-2
35. Khawka, Z. M. H., Rahman, A. A., Sidek, S. B., Ahmed, S. A. B., Al-Hadeethi, R. H. F., & Al-Dabbagh, T. (2024). Effect of lean supply chain on competitive advantage: A systematic literature review. Cogent Business & Management, 11(1), Article 2370445. https://doi.org/10.1080/23311975.2024.2370445

36. Kirmizi, S. D., Ceylan, Z., & Bulkan, S. (2024). Enhancing inventory management through safety-stock strategies: A case study. Systems, 12(7), Article 260. https://doi.org/10.3390/systems12070260
37. Knight Frank. (2025). India warehousing market report 2025. https://content.knightfrank.com/research/3084/documents/en/india-warehousing-market-report-2025-12733.pdf
38. Kohnova, L., & Salajova, N. (2023). Impact of Industry 4.0 on companies: Value chain model analysis. Administrative Sciences, 13(2), Article 35. https://doi.org/10.3390/admsci13020035
39. KPMG India. (2026, September). The Indian consumer durables sector: Q1 FY27. https://assets.kpmg.com/content/dam/kpmgsites/in/pdf/2026/09/the-indian-consumer-durables-sector-q1fy27.pdf
40. McKinsey & Company. (2026, May). Wired for growth: India's electrical equipment opportunity. https://www.mckinsey.com.br/industries/industrials/our-insights/wired-for-growth-indias-electrical-equipment-opportunity
41. Mishra, A., Dutta, P., Jayasankar, S., Jain, P., & Mathiyazhagan, K. (2023). A review of reverse logistics and closed-loop supply chains in the perspective of circular economy. Benchmarking: An International Journal, 30(3), 975-1020. https://doi.org/10.1108/BIJ-11-2021-0669
42. Mohsin, A. K. M., Schmidt, V., Aschauer, F., Plasch, M., & Gerschberger, M. (2025). Examining the evolution of sustainable supply chain management: A systematic review and bibliometric analysis. Sustainable Development, 33(6), 8213-8238. https://doi.org/10.1002/sd.70093
43. Nasir, N., Rajkumari, Y., & Adil, M. (2024). After-sales service and brand reputation: A case of kitchen appliance industry. International Journal of Quality and Service Sciences, 16(3), 413-431. https://doi.org/10.1108/IJQSS-08-2023-0115
44. NewsBytes. (2025). India's consumer durables market may reach INR 3.25 lakh crore by 2030 [Report on BCG-CII study]. https://www.newsbytesapp.com/news/business/india-s-consumer-durables-market-may-reach-3-25l-crore-by-2030/story
45. NITI Aayog, & The Energy and Resources Institute (TERI). (2026). Advancing circular economy of waste electrical and electronic equipment and lithium-ion batteries in India. https://www.niti.gov.in/sites/default/files/2026-01/Advancing-Circular-Economy-of-Waste-Electronic-and-Electrical-Equipment-Ewaste-and-Lithium-Ion-Batteries-in-India.pdf
46. Nyman, H. J., Tschirch, F., & Hongell, L. (2025). Linking strategy to tactical planning: Using integrated business planning (IBP) as a strategy implementation process. International Journal of Physical Distribution & Logistics Management, 55(11), 213-239. https://doi.org/10.1108/IJPDLM-06-2024-0233
47. Orient Electric Limited. (2025). Q4 FY25 earnings call transcript. National Stock Exchange of India. https://nsearchives.nseindia.com/corporate/ORIENTELEC01052025230439EarningCallTranscriptQ4FY25.pdf
48. Orient Electric Limited. (2026). Business responsibility and sustainability report FY2025-26. National Stock Exchange of India. https://nsearchives.nseindia.com/corporate/OEL29062026204014BRSRIntimation2526.pdf
49. Power Line. (2023, May 11). BEE's star labelling programme results in energy efficiency improvement of ACs. https://powerline.net.in/2023/05/11/bees-star-labelling-programme-results-in-energy-efficiency-improvement-of-acs/

50. Press Information Bureau (PIB). (2025, January 6). UJALA and Street Lighting National Programme: Ten years [Backgrounder]. https://static.pib.gov.in/WriteReadData/specificdocs/documents/2025/jan/doc202516481801.pdf
51. PSU Watch. (2025, December 31). BEE's new star ratings to push AC prices up 10%, refrigerators by 5% from Jan [PTI report]. https://psuwatch.com/amp/story/newsupdates/bees-new-star-ratings-to-push-ac-prices-up-10-refrigerators-by-5-from-jan
52. Redseer Strategy Consultants. (2025). Recycling or ruin: The high-stakes battle for India's e-waste future. https://redseer.com/articles/recycling-or-ruin-the-high-stakes-battle-for-indias-e-waste-future/
53. Religare Broking. (2025). LG Electronics India Limited: IPO note. https://www.religareonline.com/knowledge-centre/ipo/lg-electronics-india-limited-ipo-note/
54. Saldanha, J. P., Price, B. S., & Thomas, D. J. (2023). A nonparametric approach for setting safety stock levels. Production and Operations Management, 32(4), 1150-1168. https://doi.org/10.1111/poms.13918
55. Samsung Electronics. (2025, December). Samsung marks 30 years in India with a new human-centric vision [Press release]. https://news.samsung.com/global/samsung-marks-30-years-in-india-with-a-new-human-centric-vision
56. Securities and Exchange Board of India (SEBI). (2023, July 12). BRSR Core: Framework for assurance and ESG disclosures for value chain [Circular]. https://ca2013.com/wp-content/uploads/2023/07/SEBI-Circular_12.07.2023.pdf
57. Shekarian, E., Ijadi, B., Zare, A., & Majava, J. (2022). Sustainable supply chain management: A comprehensive systematic review of industrial practices. Sustainability, 14(13), Article 7892. https://doi.org/10.3390/su14137892
58. Slack, N., Brandon-Jones, A., & Burgess, N. (2022). Operations management (10th ed.). Pearson.
59. Tan, E. S. H., Lee, A. W. L., Shekar, Y. C., & Tan, Y. S. (2024). Design for circularity: A framework for sustainable product redesign. Procedia CIRP, 122, 479-484. https://doi.org/10.1016/j.procir.2024.01.070
60. Voltas Limited. (2026). Business responsibility and sustainability report FY2025-26. National Stock Exchange of India. https://nsearchives.nseindia.com/corporate/BRSR5005750606202623442 4.pdf
61. Whirlpool of India Limited. (2025). Business responsibility and sustainability report FY2024-25. National Stock Exchange of India. https://nsearchives.nseindia.com/corporate/WHIRLPOOL14082025140049202508 14BRSRsigned.pdf
62. Yuniarti, R., Suparno, & Arvitrida, N. I. (2025). A scoping review and bibliometric analysis of sustainable and resilient supply chain network design. Supply Chain Analytics, 12, Article 100162. https://doi.org/10.1016/j.sca.2025.100162