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Recover, Reuse or Refine?

A battery routing and investment decision for Caplexus Capital

The Margin Masters

Indian Institute of Foreign Trade · IIFT Kakinada

Decision dashboard
Offline dashboard

Excel audit model
Annexures

Model evidence
Python lab

ANK GANIT 2026 • IIM VISAKHAPATNAM × CAPLEXUS CAPITAL

Routing Decision Scorecard

Improve selection first. Extra monthly capacity adds only ₹19.59 lakh over the same 18-month intake.

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Policy or evidence	Capacity t/mo	Warranty risk	Demand cap	Reuse tonnes	Value ₹ cr	Delta ₹ cr	Decision signal
Observed intake (836 lots)	14	Actual	Actual	223.52	8.01	—	Reported cohorts
Optimizer vs 70% replay	14	0.80×	1.25× P75	171.82	8.40	+0.97	Claims stress
Optimizer vs 70% replay	14	1.00×	1.25× P75	171.82	8.27	+1.40	Base decision
Optimizer vs 70% replay	14	1.30×	1.25× P75	171.82	8.08	+2.05	Claims stress
Optimizer vs 70% replay	21	0.80×	1.25× P75	176.16	8.60	+0.83	Claims stress
Optimizer vs 70% replay	21	1.00×	1.25× P75	176.16	8.47	+1.29	Capacity check
Optimizer vs 70% replay	21	1.30×	1.25× P75	176.16	8.27	+1.99	Claims stress
Optimizer vs 70% replay	28	0.80×	1.25× P75	176.16	8.60	+0.83	Claims stress
Optimizer vs 70% replay	28	1.00×	1.25× P75	176.16	8.47	+1.29	Capacity check
Optimizer vs 70% replay	28	1.30×	1.25× P75	176.16	8.27	+1.99	Claims stress
70% legacy replay at 14 t	14	1.00×	1.25× P75	209.73	6.87	—	Policy baseline
Matched 14 28 t uplift	14 28	1.00×	1.25× P75	+4.34	+0.20	+0.20	Defer expansion
Paired 14 28 t stress	14 28	1.00×	1.00× P75	+1.61	+0.04	Annualised	Demand evidence
Paired 14 28 t stress	14 28	1.00×	1.25× P75	+4.34	+0.13	Annualised	Demand evidence
Paired 14 28 t stress	14 28	1.00×	1.75× P75	+7.67	+0.24	Annualised	Demand evidence
Paired 14 28 t stress	14 28	1.00×	2.50× P75	+14.12	+0.44	Annualised	Demand evidence
3W ≥85% SoH cohort	—	3.50%	16 / 457	—	—	—	Grade A pilot
3W 70–<80% SoH cohort	—	26.14%	69 / 264	—	—	—	Hold from fleet
All mature commercial packs	—	9.19%	666 / 7,247	—	—	—	Price claims
Flagged capacity diverts	—	11 ≥85%	55 lots	95.59	—	—	Grade before scale

Capital Allocation & Risk

Compare incremental cash, reserve the ₹15 cr envelope and release a capped pilot against evidence.

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Financial Impact Analysis

Financial metric	A: Refine	B: Expand	C: 3 hubs	Basis	Board gate
Initial capex	15.00	11.00	10.50	₹ crore	Keep on hold
FY28 cash	+0.25	-0.45	-0.72	Ramp 1	Start pilot
FY29 cash	+1.27	-0.33	-0.55	Ramp 2	Review orders
FY30 cash	+2.00	-0.26	-0.43	Ramp 3	Reprice risk
Base NPV	-12.34	-11.85	-11.89	12% rate	All below zero
Downside NPV	-15.44	-12.44	-12.84	Same horizon	Protect cash
Upside NPV	-10.16	-10.88	-10.57	Same horizon	No full release
3-year payback	No	No	No	Cash flow	No terminal
Flat annual hurdle	6.25	4.58	4.37	₹ crore	Test demand
End FY30 cash	-11.48	-12.04	-12.21	Cumulative	Retain option
Recommendation	Toll assay	Pilot only	Test lane	Staged	₹0.50 cr cap

Pilot Budget & Release Conditions

Workstream	Spend gate	Budget L	Owner	Release proof
Grade and routing	Stage 1	10	COO	Matched margin
Fleet / service test	Stage 1	10	Sales	Paid fleet orders
Tolling and QA	Stage 1	5	Finance	Assay and terms
Dealer and grading	Stage 2	15	QA + Sales	Eligible orders
Controlled repeat	Stage 2	10	Board	SLA and claims
Total pilot cap	Two gates	50	CFO	Hold ₹14.50 cr

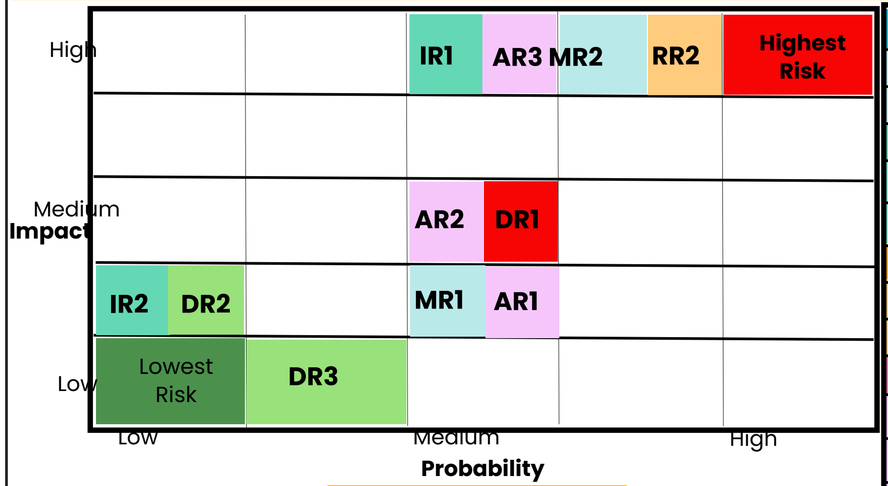
Assumptions

- • ₹ crore cash flows are pre-tax and discounted at 12%; no terminal value or working-capital release.
- • Compare expansion with optimized routing at 14 t, the same demand ceiling and the same warranty case.
- • Refining includes eligible feed, scale-up, realization and fixed charges.
- • Hubs add incremental contribution and verified lane savings after cash costs.

Key Inference

- • All base NPVs are negative. A pays back in ~8.19 years only if FY30 cash continues.
- • The 14 t routing gain is ₹1.405 cr. Additional 28 t capacity yields ₹0.196 cr over 18 months.
- • Reserve ₹14.50 cr and release ₹25 lakh for the first gate.
- • Terminate scale plans if safety, paid demand or downside cash evidence fails.

Risk Analysis



MARKET RISKS
- MR1 – Order shortfall
- MR2 – Price pressure

INDUSTRY RISKS
- IR1 – Safety incident
- IR2 – Toll quality

MACRO RISKS
- RR1 – Refining spread
- RR2 – Freight shock

COMPANY-SPECIFIC RISKS
- AR1 – Poor fitment
- AR2 – Grade leakage
- AR3 – Warranty tail

DATA & SYSTEM RISKS
- DR1 – Missing genealogy
- DR2 – Late build record
- DR3 – Manual override

Mitigation Strategy

- • Audit lot genealogy, reserves and warranty maturity before committing.
- • Require approved fitment and stop on any serious safety event.
- • Tie margin and service to paid orders and assay acceptance.
- • Confirm qualified material and keep EPR evidence separate.

Six-Month Pilot & Release Plan

Test routing at 14 t/month. Release capital against paid demand and mature claims.

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RELEASE PLAN	PHASE 1 (0–2 Months) VALIDATE ROUTING & SIGN PILOT PARTNERS	PHASE 2 (3–4 Months) RUN THE PAID FLEET PILOT & TOLLING TEST	PHASE 3 (5–6 Months) REVIEW THE PILOT & RELEASE CAPITAL
MARKET FOOTPRINT & FLEET FOCUS	• Choose one NCR dealer and compatible 3W fleets with documented vehicle duty. • Use Grade A LFP packs at ≥85% SoH and record actual paid demand. • Obtain comparable fitted new-pack quotes and log expected service costs.	• Begin paid NCR installations only after documented fitment approval. • Track matching duty, grade and use. • Compare six-to-twelve-month offers with funded reserves and swap cost limits.	• Expand through proven dealers only. • Demand must repeatedly fill qualified 14 t slots at positive contribution. • Hold 2W scale until more independent fleet lots reach warranty maturity.
LAUNCH SCOPE & ENABLEMENT	• Freeze the 70% replay to compare both rules on the same intake. • Capture lot genealogy, fitment checks, pack yield, claims and purchase price. • Reconcile outcomes with finance and sign release limits with quality.	• Review warranties by mature cohort and track claims through the service partner. • Run qualified NMC/LCO toll assays and obtain domestic buyer acceptance terms. • Rate actual margins and freight on matched lots, including rejects.	• Stop on serious safety incidents. • Verify accepted assay and floor prices. • Require carrier bids and profitable new tonnes before funding hubs.
ROUTE-TO-USER & ACTIVATION	• Shadow-route each week at 14 t while keeping approved plant decisions. • Track expected contribution net of claims and allocated tonnes by application. • Release up to ₹25 lakh for baseline work, partner onboarding and controlled tests.	• Track paid orders and service costs. • Measure response SLA, warranty accrual and potential fitment exceptions. • Release the second ₹25 lakh only after orders, assays and controls pass.	• Compare A/B/C with verified FY28 costs and paid order volumes. • Track contribution/kg, mature claims, paid conversion, SLA and safety incidents. • Hold ₹14.50 cr until investment tests clear downside and cash hurdles.

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Which evidence would release the next tranche?

Evidence for questions

- Case brief and operating data • Exhibits 1–5, Lots, Second_Life_Packs, Assumptions
- Interactive dashboard • original rule, optimized scenarios, fleet cohorts and investment
- Model evidence and source notes
- Excel audit and Python lab • formulas, cash flows, whole-lot replay and reproducibility

Annexures • sensitivities, operating milestones, risks and data controls →

Annexure A1 • Capital calculation trail

Initial capex plus incremental FY28–FY30 operating cash, discounted at 12%. No terminal value or working-capital release. Measure year-end inventory and receivable exposure before setting cash realization targets or ranking staged capex proposals.

Assumptions and common baseline

Counterfactual	Optimized 14-tonne line and existing collection network remain common to the alternatives. Preserve the current route mix as the reference for reassessing realized claims, and charge no capital uplift for its operations.
Option A scope	Refine NMC and LCO when commercial grade clears the gate. Continue LFP black-mass sales in base. Every additional tonne should have accepted assay, quality, sale terms and contracted processing capacity.
Option B scope	Add line capacity, test automation and one NCR hub. Route uplift is paired optimizer minus optimizer. Per-pack automation savings apply to existing eligible volume; the newly processed lots enter only the capacity cash-flow line.
Option C scope	Use three hubs. Apply savings to existing lanes and positive contribution to genuinely additional tons. Base new volume earns a haircut to qualified recycling margins; contract mix, damage, shrink and service effort before scaling.
Cash treatment	Separate ramp, variable costs, fixed costs and working capital. Exclude financing and tax. Estimate the working balance from cash operating inputs and days tied up. Deduct the change in the balance each year.
Reversal hurdle	At a 12% discount rate, flat annual cash must exceed ₹6.25 cr, ₹4.58 cr and ₹4.37 cr for A, B and C. Release funding only with payback, downside liquidity and counterparties validated.

Qualified refining and hub inputs

H1 FY27 input	Observed volume	Economics
NMC black mass	92.502 t	₹120/kg variable spread
LCO black mass	21.609 t	₹140/kg variable spread
LFP black mass	61.405 t	-₹15/kg variable spread
Delhi NCR catchment	135.292 t	₹9.09/kg freight
Pune catchment	161.813 t	₹9.14/kg freight
Bengaluru catchment	152.960 t	₹17.44/kg freight
All three catchments	450.065 t	₹10.89 per tonne-km

All spreads are Exhibit 2 gross uplifts less ₹70/kg variable cost. Hub freight is weighted by catchment tonnes. Confirm carrier bids, load factor, route classification and handling cost before using stated lane rates as savings.

Base case free cash flow bridge • ₹ crore

Component	A Y1	A Y2	A Y3	B Y1	B Y2	B Y3	C Y1	C Y2	C Y3
Gross benefit	1.17	2.11	2.73	0.16	0.26	0.33	0.19	0.33	0.43
Fixed opex	0.42	0.42	0.42	0.48	0.48	0.48	0.72	0.72	0.72
Maintenance	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.09
Working capital change	0.40	0.32	0.21	0.03	0.02	0.02	0.11	0.08	0.05
Free cash flow	0.25	1.27	2.00	-0.45	-0.33	-0.26	-0.72	-0.55	-0.43
Discounted FCF	0.22	1.01	1.42	-0.40	-0.26	-0.18	-0.64	-0.44	-0.31
Cumulative cash	-14.75	-13.48	-11.48	-11.45	-11.78	-12.04	-11.22	-11.77	-12.21

What gets charged to each option

Refining versus black-mass sale

Credit the salt uplift over a black-mass sale; a second full sale value would overstate cash. Base qualified feed applies H1 annualization, 8% growth, 45/75/90% ramp and 95% commercial realization. Process cost, fixed overhead, maintenance and working capital sit below it. Reconcile buyer deductions, residues, output rejection and assay at settlement.

Expansion versus improved plant

The capacity-only base uplift is ₹0.196 cr across the 18-month matched period. Convert to an annual run rate, apply ramp and delivery realization, then add the separate automation and NCR lane terms. No credit for policy uplift that the current line already earns. Confirm payment terms and the cost of inventory at the expanded line.

New hubs on comparable lanes

Compute route savings on existing qualifying volume. Credit additional feedstock using risk-adjusted marginal contribution. Charge lease, staff, maintenance and working capital. Recheck by chemistry, form and supplier origin as staged procurement bids arrive. Hold procurement quotes to a metered feed introduction and lane-specific budget.

Caplexus case workbook, Exhibits 1–3, cash-flow model and linked assumptions. Figures carry full precision in Excel and Python. Payback interpolates through the first positive cumulative cash year; preserve future-horizon extrapolations as sensitivities.

Annexure A2 • Sensitivity and reversal thresholds

Grade value and operating capacity are distinct. Verify customer demand, price realization and material quality before committing capital.

Demand and the value of added capacity

Product demand / P75	Extra tons	Annual route ₹L	Full B NPV ₹cr
1×	1.61	4.41	-11.98
1.25×	4.34	13.06	-11.85
1.75×	7.67	24.20	-11.68
2.5×	14.12	44.30	-11.37

Where the impact comes from

The capacity pair is optimized at 14 and 28 tonnes with the same risk and product ceilings. A high multiplier is a stress test of demand, not a sales forecast. Doubling capacity adds no value beyond 21 tonnes in the base. Even a 2.5× demand ceiling does not close the full Option B capital gap. Use booked orders and realized throughput rather than registrations or survey willingness as underwriting inputs.

Three reversal tests

A needs contracted feed and salt economics well above the historical yield-adjusted spread. B needs positive measured 14-to-28 incremental margins and recurring eligible order cover that earns the return hurdle. C needs costed lanes plus recurring new qualified supply at positive after-logistics contribution. Pilot policy economics remain distinct from all three. Report net benefit after scrap disposal, yield losses and incremental supervision. Require steady customer demand and audited realized cash in the board investment paper.

Warranty and price sensitivity

Cohort or parameter	Observation / base	Use in the decision
3W ≥85% SoH	16/457 returned	3.50% observed six-month
3W 70–<80%	69/264 returned	26.14% observed six-month
2W Fleet lifetime to date	186/1,199 mature	15.51% observed six-month
12-month illustration	5% conditional tail	8.33% total expected claims
3W expected extra cost	₹2,473 claim + ₹500 service	33% paid volume lift at ₹12k margin
3W comparable new quote	₹63.1k to ₹68.3k	Makes ₹41k a 35–40% discount

Read grade evidence with the denominator

The ≥85% 3W group contains 19 distinct source lots. The lot-cluster bootstrap interval for the 70–<80% band is 20.54–33.17%. High-grade 2W has fewer distinct parent lots than the pack count suggests. Inferences can change with the duty cycle, vehicle, application, channel and correlation between packs from the same feedstock. Collect prospective outcomes for mature lots under the same commercial offer.

Safety and FY27–28 readiness checks

Quarantine safety exceptions, require documented fitment and maintain serial genealogy. Trigger a stop on a serious incident. Verify assets, assays, mass balance, domestic recovery origin and buyer acceptance before treating recycled-content readiness as economic value. Keep the regulatory ledger for certificate issuance separate from the material content claim. A significant deviation from qualifying product scope or performance assumptions reopens the capital review. Price local offtake, transport and rejections into the same trial account.

Sources • Mature cohorts and survey, demand stress grid, cash flow and assumptions • Detailed uncertainty analysis in the dossier

Annexure A3 • A six-month Caplexus engagement

Release up to ₹0.25 crore for baseline work and the first pilot. Earn release of up to another ₹0.25 crore with evidence.

BOARD RELEASE PLAN	MONTHS 1–2	MONTHS 3–4	MONTHS 5–6
	BASELINE & QA	CONTROLLED PILOT	BOARD GATE
DELIVERABLE	Reconcile intake, lot-to-pack linkage and claims. Sign finance definitions for realized contribution and reserves.	Run a paid A-grade 3W LFP fleet trial. Compare equivalent fitment, grade, workload, service and warranty terms.	Review positive contribution versus the matched queue, eligibility rates, lot quality and contracted order coverage.
MEASUREMENT	Shadow-score the existing 14-tonne queue with weekly checks for acceptance rate, care holds and manual overrides. Plant QA signs and owns the lot release ledger.	Record duty, charger, swap actions, actual paid conversion and service costs. Hold longer warranty volumes inside the reserve. Commercial finance reviews invoice, reserve draw and cash before replenishment.	Measure mature return outcomes and commercial conversion. Maintain the service SLA and stop on any safety excursion.
RISK CONTROL	Record serial genealogy, fitment and QA evidence. Obtain quotes from two dealer or financier partners and one qualified refiner.	Run the agreed qualifying assay and tolling trial. Compare net realized spread on matched batches and document domestic origin.	Approve capacity or refining diligence only if downside results clear the decision hurdle. Otherwise retain capex and repeat the asset-light trials.

Five monitoring measures • Risk-adjusted contribution/kg, mature return rate, paid conversion, service SLA compliance, safety incidents.

Annexure A4 • Source-to-number reconciliation

Lot identity, mass, route assignment, warranty maturity and commercial cost assumptions remain traceable.

Control	Input	Treatment	Check	Outcome	Evidence
Lots raw records	866	Drop exact duplicate lot rows	30 removed	836 lots	Lots
Gross weight normalization	12 entries	Convert recorded tonnes to kg	× 1,000	1,190,641 kg	Lots + Exhibit 1
SoH normalization	22 entries	Convert fractions to percentages	× 100	Percentage points	Data Dictionary
Supplier identity	73 aliases	Standardize case supplier labels	Two label families	Comparable source groups	Lots
Pack raw rows	11,603	Exclude PTEST zero-sale records	5 removed	11,598 commercial	Second_Life_Packs
Lot-to-pack join	Lot ID	Many packs can map to one lot	187 / 198 reuse lots	11 late lots unmatched	Both tables
Warranty maturity	31 Mar 2026	Use matured six-month outcome	7,247 mature	666 returns	Warranty status
Right-censored packs	4,351	Retain sales and expected reserve	Separate from mature rate	9.19% mature rate	Build dates
Capacity diversion	55 flags	Use explicit source flag	95.588 t	11 lots ≥85%	Lots notes
Actual reuse and recycle	198 / 638	Maintain observed historical route	223.518 t reused	836 total	Lots
Purchase cost	Gross kg × price	Retain paid feedstock by delivery	Flat across dispositions	Cancels in route delta	Lots
Warranty loss	1.25 × sale	Estimate expected loss by cohort	Six-month term	Product, grade, chemistry	Assumptions
Historic EPR	₹38 / ₹46	Price certified kg by fiscal period	Case ledger	Avoid double count	Assumptions
Routing optimizer	Whole lot	Highest positive value alternative	Monthly demand and kg caps	Exact branch and bound	Python lab
Capex baseline	14 t optimized	Paired 14/28 t difference	Three years	12% discount	Capital audit
Replay limitations	Backtest	Hold new-case claims and demand	Historical fits	Forward pilot validates	Dossier

Audit file • Raw workbook stays untouched. Public evidence uses aggregate counts and scenario summaries. Calculation code can read the original data pack.