



Closing the Asynchronous Delivery Gap: Designing a Multi-Temperature Smart-Locker Service for Perishable Deliveries in High-Density Jakarta

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Abstract. In Jakarta's high-density office towers and apartments, perishable food deliveries are routinely left waiting at lobby desks because the courier arrives while the recipient is unavailable. This paper reports a qualitative, design-led study of this Asynchronous Delivery Gap and asks whether a multi-temperature smart locker, offered as a building-based service, can close it profitably. Design Thinking structured the research process; five theoretical lenses (Theory of Constraints, Decoupling Point Theory, last-yard logistics, Cold Chain Management, and UTAUT) informed the analysis; and the Business Model Canvas synthesised the findings into a business model. Evidence was drawn from eighteen field-observation sessions covering ninety courier handovers, a verified corpus of forty public reviews, eighteen user-testing sessions, and a technical and regulatory review. No handover point offered active heating or cooling, and couriers waited an average of 7 minutes 43 seconds at office towers, long enough for food-surface temperatures to fall by 11–16°C. A tested app-less web prototype removed about ninety per cent of that waiting time, and every participant completed the flow unaided. All twelve recipients accepted a usage fee while all six couriers refused to bear one, fixing where revenue can sit. The study concludes that a Smart-Locker-as-a-Service model, billed to the building or platform rather than the courier, is commercially viable, subject to pilot-stage verification of hot-hold performance.

Keywords: Business Model Canvas; Cold Chain Management; Design Thinking; Last-Mile Logistics; Smart Locker.

1. BACKGROUND

Indonesia's digital economy has expanded rapidly over the past decade, and on-demand food and grocery delivery has moved from an occasional convenience to a daily utility for the urban workforce. The country's digital economy reached a gross merchandise value of about US\$90 billion in 2024, growing thirteen per cent year-on-year, and online food delivery, worth roughly US\$6 billion and the largest such market in Southeast Asia, is one of its fastest-growing segments (Google, Temasek & Bain, 2024).

Despite this growth, the last mile remains the most expensive and complex segment of the delivery chain, often reaching forty per cent of total logistics cost (Mangiaracina et al., 2019), and the friction concentrates not in transit but at the final handover between courier and recipient. When the recipient is unavailable, the parcel waits; for an ordinary parcel this is a minor inconvenience, but for food and beverage it destroys value. Hot meals must stay above roughly 60°C to remain safe and appetising, while chilled items must stay between 0°C and 5°C to slow bacterial growth, and temperature and freshness on arrival are the strongest driver of satisfaction and repeat purchase in Indonesian food delivery (Suhartanto et al., 2019). Iwan et al. (2016) similarly identify the absence of a temperature-controlled reception point as a principal cause of e-grocery failure, so the mismatch between arrival and collection is not merely a scheduling nuisance but a food-safety and quality problem. This friction is sharpest

in Jakarta's high-density office towers and apartments, which combine strict access control, busy lobbies, and concentrated lunch- and dinner-time delivery volumes; the Greater Jakarta office stock totals about 11.3 million square metres, of which roughly 89% is Premium or Grade-A space concentrated in the CBD (Colliers, 2026; Knight Frank Indonesia, 2025). Standard parcel lockers have begun to appear in Indonesian cities, but almost all store items at a single, ambient temperature; benchmarking of PaxelBox and PopBox, together with direct lobby observation, confirms none can hold hot and cold items at once, at their required temperatures, during an unattended wait. This study treats temperature-controlled, multi-compartment smart-locker infrastructure not as a logistics convenience but as a necessary enabler of food safety and customer satisfaction.

This paper names the phenomenon the Asynchronous Delivery Gap: the structural conflict between a courier's need for speed and a recipient's unavailability, during which perishable quality, courier productivity, and customer trust all erode. Food deliveries are frequently left at lobby desks for fifteen to sixty minutes; because temperature and freshness on arrival are the leading drivers of satisfaction, the resulting lukewarm soup or melted dessert produces complaints against the merchant even though the true cause is the reception infrastructure. Customers receive degraded food, couriers lose productive time, and building managers face congested lobbies and parcel liability. The business problem is therefore the absence of an integrated, multi-temperature solution that can preserve product quality during the unattended wait (Iwan et al., 2016). Framed around this gap, the study asked: (RQ1) how do office workers and couriers experience the current handover and what are their unmet needs; (RQ2) what locker features and interface design address these needs, and how does a prototype perform against established usability principles; and (RQ3) how can the validated needs be organised into a feasible Smart-Locker-as-a-Service business model. This paper reports the study's methodology and principal findings and turns them into recommendations for building operators and platforms.

2. THEORETICAL REVIEW

Five complementary lenses frame the analysis. The Theory of Constraints (Goldratt, 1984) points away from transit, where couriers move quickly, toward the last-yard handover inside the building, where the process stalls because the recipient is unavailable, and treats that handover as the binding constraint on the whole delivery system. Decoupling Point Theory (Hoekstra & Romme, 1992) explains why a temporal buffer is needed: because corporate schedules are meeting-bound, a buffer that holds an order between drop-off and later collection

resolves the mismatch, provided it actively preserves temperature rather than merely storing the item. Last-mile logistics (Mangiaracina et al., 2019) locates this friction at the in-building handover, and Cold Chain Management (Suhartanto et al., 2019) supplies the thermal bands the buffer must meet. Finally, the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), building on the Technology Acceptance Model (Davis, 1989), explains adoption through performance expectancy, effort expectancy, social influence, and facilitating conditions; Yuen et al. (2018, 2019) confirm convenience and reliability as the dominant adoption drivers for smart lockers in dense Asian cities.

Three commercial locker solutions were also benchmarked. PaxelBox already offers an app-less web route via QR code and e-wallet payment, confirming the feasibility of an app-less interface, but its static units are ambient-only, with cold-chain capability living in Paxel's delivery fleet rather than the locker itself (Paxel, 2026). GrabFood Locker removes the face-to-face handover but is app-dependent and its enclosed cell is a passive short-hold unit rather than an actively heated or chilled one (Grab, 2024). PopBox confirms market familiarity with unattended lockers but, like other ambient units, offers neither the insulation nor the power to preserve prepared food. None combines active multi-temperature control with an open, platform-agnostic access model; each fails on a different axis, which is the specific gap the solution evaluated here, named Drop, is designed to close (Table 1).

Table 1. Industry benchmark of existing locker solutions

Solution	Access model	Thermal capability	Gap vs. Drop
PaxelBox	App / app-less web; QR + e-wallet; 24/7	Ambient locker; cold chain only in the delivery fleet	No active multi-temperature hold at the static pickup point
GrabFood Locker	App-dependent (Grab app only); QR/PIN	Enclosed ambient short-hold (≈ 4 h); no active hot/cold control	Platform-bound and ambient, not open or multi-temperature
PopBox	Self-service; coded access	Ambient parcel locker only	No insulation or power for perishable food
Drop (proposed)	Open, app-less web; QR + QRIS	Active hot $>60^{\circ}\text{C}$ and cold $<5^{\circ}\text{C}$ simultaneously	Target configuration evaluated in this study

Source: compiled by the author from provider documentation (Paxel, 2026.; Grab, 2024) and field benchmarking.

Together, the five lenses converge on the temporal mismatch between a courier's synchronous arrival and a recipient's asynchronous availability, illustrated in Figure 1, which generates the three research questions evaluated below.

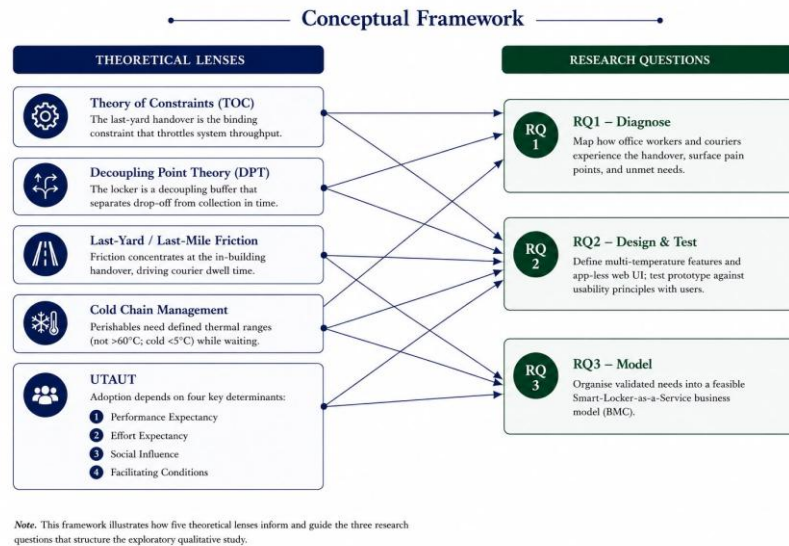


Figure 1. The conceptual framework: five theoretical lenses converge on the Asynchronous Delivery Gap, which generates the three research questions and the proposed solution.

3. RESEARCH METHOD

The study adopts a qualitative, design-led methodology within applied research (Creswell & Poth, 2018), grounded in pragmatism, which emphasises what works to resolve the Asynchronous Delivery Gap rather than testing a universal law. Design Thinking (Empathise, Define, Ideate, Prototype, Test) provides the procedural spine, the five lenses in Section 2 supply the analytical constructs, and the Business Model Canvas (Osterwalder & Pigneur, 2010) provides the final synthesis. The design is iterative: insights from Ideation could send the team back to Empathise, and testing findings could revise the prototype before the business model was finalised.

Evidence comes from two primary and two secondary qualitative streams, designed for triangulation (Table 2). The first primary stream is non-participant field observation: four observers recorded ninety real courier handovers across eighteen sessions at office towers, apartments, and locker sites during peak lunch and dinner windows, noting dwell time, storage conditions, and food temperature. The second is user testing: eighteen participants, twelve office workers and six couriers, each completed a cognitive walkthrough of an app-less web prototype (scan QR, enter PIN, pay via QRIS, collect or deposit) followed by a semi-structured interview. The two secondary streams are digital ethnography of public app-store reviews (Kozinets, 2020), screened by content relevance rather than star rating alone, and a technical and regulatory review of Indonesian food-safety, Halal, and payment-standard documentation, which translates external requirements into the design constraints noted in Section 2.

Table 2. Data collection streams, samples, and research questions served

Stream	Method	Sample	Serves
Primary 1	Non-participant field observation	18 sessions; 90 handovers; 4 observers	RQ1
Primary 2	Cognitive walkthrough + semi-structured interview	18 users (12 office workers, 6 couriers)	RQ2, RQ3
Secondary 1	Digital ethnography (netnography)	40 confirmed reviews of 7,922 screened	RQ1
Secondary 2	Technical & regulatory document review	12 sources across 4 strands	RQ2, RQ3 (design constraints)

Source: compiled by the author.

Analysis proceeds through four strands. Thematic analysis, following Braun and Clarke (2006), codes the field-observation and netnography material into themes that answer RQ1. A comparative gap analysis and process model then position the proposed locker against incumbents and contrast the current (As-Is) courier flow with the proposed (To-Be) flow. A second, deductive thematic analysis, organised around the usability heuristics of Nielsen and Molich (1990) and the four UTAUT constructs, evaluates the user-testing transcripts to answer RQ2. Finally, a Business Model Canvas strategic-fit analysis synthesises the validated themes, positioning gaps, and pricing evidence into a feasible model for RQ3. Rigour rests on the trustworthiness criteria of Lincoln and Guba (1985) — credibility, transferability, dependability, and confirmability — with saturation as the stopping rule, and all procedures followed the ITB MBA programme's research-ethics guidance on consent, anonymisation, and aggregate use of public reviews.

4. RESULTS AND DISCUSSION

The Gap Confirmed: Courier Dwell Time and Thermal Loss

Across the ninety observed handovers, mean courier dwell time was 5 minutes 34 seconds, but it varied sharply by site type (Table 3). Office towers were worst, because turnstiles and meeting-bound recipients collide with a waiting courier, reaching a mean of 7 minutes 43 seconds and a maximum of 13 minutes 10 seconds; locker sites were fastest at 2 minutes 41 seconds, but that saving disappeared whenever a unit was full or declined an item. No site offered active heating or cooling: sixty-five of ninety handovers had no climate control at all, and even locker sites offered an ambient-only compartment for only about sixty per cent of drops. Infrared readings at six sessions showed hot-food surfaces falling 11–16°C during a single wait, for example from 49°C to 33°C in ten minutes, with every starting temperature already below the 60°C hot-hold floor; a cold drink left in an ambient locker slot for 80 seconds

warmed from 9°C to 18°C — the degradation Cold Chain Management predicts for any handover point without active thermal control.

Table 3. Courier dwell time by site type (n = 90 handovers, 18 sessions)

Site type	Sessions	Mean dwell	Max dwell
Class-A office tower	7	7:43	13:10
CBD apartment	6	5:27	8:50
Existing locker site	5	2:41	6:15
All sites	18	5:34	13:10

Source: author's analysis of field-observation records.

Six Themes from Field Observation and Public Reviews

A verified netnography corpus of forty reviews, drawn from 7,922 screened across four delivery apps, corroborated the field evidence and surfaced a Trust-and-Hygiene concern the field work alone could not capture; a first pass using only one- and two-star reviews returned no relevant cases, so a content-relevance screen was used instead. Thematic analysis of both streams produced six themes (Table 4). Quality Degradation appeared in every field session, the strongest evidence that the gap is universal, while Trust and Hygiene, driven by damaged or falsely marked deliveries, was the largest online theme, and Willingness-to-Pay, corroborated more fully in testing below, completes the set. Two personas synthesise these themes: Putri, a time-restricted office worker whose friction is inefficiency and quality degradation, and Budi, a rush-hour courier whose cost is the 7:43 mean wait at office towers. Their needs are opposite in kind, preserving quality for Putri, removing waiting and any attached fee for Budi, a tension the business model below must resolve.

Table 4. Thematic analysis: five field/review themes and their design implications

Theme	Prevalence	Design implication
Quality Degradation	100% of field sessions; 30% of reviews	Active multi-temperature compartments, not passive storage
Trust and Hygiene	55% of reviews; 72% of sessions	Locked, single-recipient access; verified proof-of-drop
Operational Inefficiency	89% of sessions; 10% of reviews	Drop-and-go QR/QRIS deposit; no courier wait
Convenience and Control	67% of sessions; 3% of reviews	Asynchronous pickup with notifications and clear signage
Incumbent / Access Limits	5 of 5 locker sessions	App-less web interface; modular multi-temperature lockers

Source: author's thematic analysis of field-observation and netnography data.

Positioning Against Incumbents: As-Is versus To-Be

Section 2 benchmarked PaxelBox, GrabFood Locker, and PopBox from provider documentation (Table 1); field observation and the netnography competitor file now add independent evidence that all three fail the thermal half of the job in practice — condensation

inside an ambient PaxelBox slot, PopBox’s own reviewers warning against perishables, and a GrabFood Locker cell-assignment failure that reverted a courier to a manual wait (Table 5). The operational payoff of closing this gap is the time a locker removes from the courier’s day: in the As-Is flow the courier waits (mean 7:43 at office towers) or abandons the order unsigned; in the To-Be flow the courier scans a QR code, deposits into an assigned compartment, and leaves (Figure 2). Four couriers independently estimated savings clustering around ‘eight to fifteen minutes down to under a minute’, triangulating field measurement, self-report, and the tested walkthrough timing reported below.

Table 5. Comparative gap analysis: Drop against direct and indirect incumbents

Solution	Access model	Thermal capability	Evidence of the gap
PaxelBox	App QR / OTP, 24/7	Ambient only; condensation observed	IR-confirmed warming/cooling in slot
PopBox	PIN via SMS/e-mail, 3-day hold	Ambient only	Own reviewers warn against perishables
GrabFood Locker	Grab app only, $\approx$ 4h passive cell	Passive ‘warm’ cell, not controlled	Cell-assignment failure reverted to manual wait
Manual reception desk	None (open handover)	None	65 of 90 handovers had zero climate control
Drop (proposed)	Open, app-less web; QR + QRIS	Active hot $>60^{\circ}\text{C}$ / cold $<5^{\circ}\text{C}$	Target configuration evaluated in this study

Source: author, triangulating field observation with the netnography competitor file.

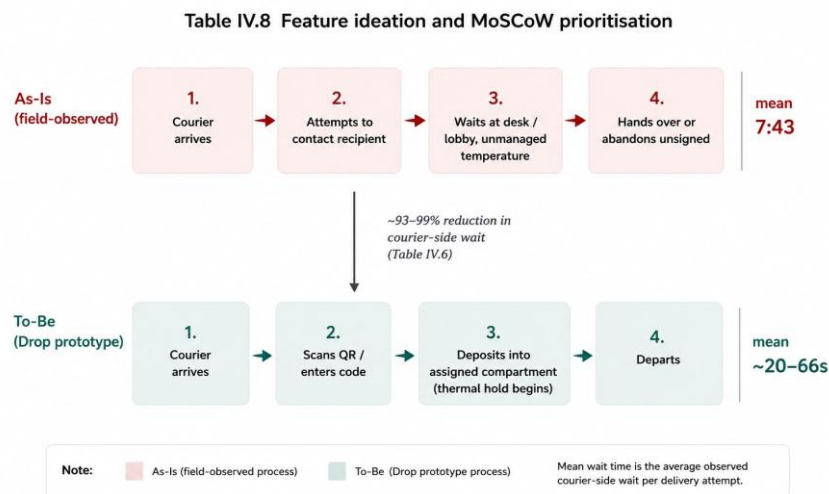


Figure 2. As-Is versus To-Be courier process. The As-Is flow is field-observed (Table 3); the To-Be flow is the tested Drop prototype.

Source: author

From Themes to Features: Prioritisation and Design Constraints

Ideation translated the six themes and a technical/regulatory review into a feature set using MoSCoW prioritisation, weighting each feature by whether it addresses a confirmed theme, whether a regulation requires it, and whether it is testable in a low-fidelity sprint (Table 6). Two features entered on evidentiary grounds rather than preference: verified proof-of-drop answers the disputed-delivery finding in Table 5, and logged compartment temperature answers the monitoring rule derived from Indonesian food-safety and Halal regulation and QRIS payment standards (Table 7).

Table 6. Feature ideation and MoSCoW prioritisation

Feature	Theme / constraint addressed	Priority
Multi-temperature compartments	Quality Degradation; hot/cold thermal targets	Must
Contactless QR / QRIS deposit and pickup	Operational Inefficiency	Must
Secure lock, single-recipient one-time code	Trust and Hygiene	Must
Verified proof-of-drop (photo + confirmation)	Trust and Hygiene; disputed-delivery finding	Must
Logged compartment temperature per transaction	Regulatory monitoring rule (Table 7)	Must
Dual interface: web kiosk and app-less mobile link	Operational Inefficiency; Access Limits	Should
Loyalty or subscription pricing option	Willingness-to-Pay	Could

Source: author, extending the Table 4 themes.

Table 7. Design constraints derived from technical and regulatory review

Constraint	Basis	Design implication
Hot-hold >60°C, sustained	Indonesian food-hygiene regulation on holding time/temperature	Active heated compartment required
Cold-hold <5°C	Food-hygiene regulation and cold-chain practice	Active chilled compartment
Logged, continuous temperature monitoring	Risk-based regulatory oversight	Per-compartment sensor logging, not a static set-point
Halal segregation	Halal-logistics regulation	Separate compartments or documented handling procedure
QRIS compliance; asynchronous confirmation	National QR payment standard	Compartment release gated on settlement webhook
Door-open / thermal interlock	Manufacturer good-practice design	Interlock prevents cold-chain or hot-hold interruption

Source: author, condensed from the technical and regulatory review (Instrument D).

Prototype, Usability, and Willingness to Pay

The validated needs and technical/regulatory constraints (hot-hold above 60°C, cold-hold below 5°C, logged monitoring, Halal segregation, QRIS-compliant payment) were translated, via MoSCoW prioritisation, into a Must-have set: multi-temperature compartments, contactless QR/QRIS deposit and pickup, secure single-recipient access, verified proof-of-drop, notifications, and logged temperature. These were embodied in an app-less web prototype tested with eighteen users through a cognitive walkthrough paired with an interview. Every participant completed every applicable task, at a mean of about 105 seconds for the office-worker sequence and 66 seconds for the courier deposit, both far below the Table 3 baseline. Usability is good but not deployment-ready (Table 8): the top open item is a slot-size confirmation warning the tested flow lacks, alongside fixes to payment-status visibility, button-colour consistency, and a manual code-entry fallback. A doubt raised independently by three of twelve office workers, whether prolonged hot-holding genuinely beats room-temperature-then-reheating, is left as an open product-scope question rather than resolved by assumption. On pricing, all twelve office workers accepted a small usage fee in principle, several preferring it folded into a building service charge, while all six couriers refused to bear any cost themselves — a structural constraint on where revenue can sit, not a result to average out.

Table 8. Usability findings: confirmed features and prioritised revisions

Status	Finding	Basis / recurrence
Confirmed	Overall scan → PIN → pay → collect sequence: logic and speed	Uniform across 18 sessions
Confirmed	App-less, no-install web link	Volunteered as a positive in both segments
Revise: high	Slot-size confirmation/warning before the door opens	New finding; moderate severity
Revise: high	Visible loading state after payment	Contributed to a payment restart
Revise: medium	Manual code-entry fallback beside QR scan	Raised across two segments
Open question	Maximum duration for active hot-holding vs. reheat	3 of 12 office workers, independently

Source: author, consolidated from the user-testing records.

Synthesis: A Smart-Locker-as-a-Service Business Model

The validated themes, positioning gaps, and pricing evidence converge, via the Business Model Canvas, on a Smart-Locker-as-a-Service (B2B2C) model, populated block by block in Table 9 from the evidence gathered above. Revenue is billed to the building service charge or a platform partner, never the courier, and the cost structure is phased: ambient and chilled compartments launch first, addressing Quality Degradation, the most common complaint, while heated compartments await a supplier confirmed to sustain 60°C at the compartment

door, since the one benchmarked heating unit reached only 55°C. Every block traces to a specific piece of evidence rather than founder assumption. For the recipient, the solution converts an uncontrolled wait into a temperature-held compartment protecting the attribute that most determines satisfaction; for the courier, it removes on the order of ninety per cent of dwell time at the highest-cost site type; and for the building, it replaces a congested lobby with an orderly, revenue-sharing service.

Table 9. Business Model Canvas for the Drop multi-temperature smart-locker service

Block	Content (evidence-led)	Evidence source
Customer Segments	Office workers/residents in Grade-A towers; couriers and platforms; building management (B2B2C)	Table 4
Value Propositions	Thermal integrity; secure single-recipient handover with proof-of-drop; near-zero dwell time	Tables 3–4
Channels	App-less web kiosk and QR/QRIS; delivery-platform notifications; building partnerships	Table 8
Customer Relationships	Automated self-service pickup; reliability guarantee; on-site onboarding signage	Table 8
Revenue Streams	Usage fee on the building/platform side, never the courier; subscription fee	Willingness-to-pay finding
Key Resources	Multi-temperature locker hardware; IoT/software platform; lobby footprint; usage data	Table 7
Key Activities	Deployment and maintenance; thermal/compliance monitoring; partnership management	Tables 6–7
Key Partnerships	Building management; F&B/super-app platforms; compliant hardware maker; QRIS gateway	Table 7
Cost Structure	Hardware CAPEX phased by compartment type; energy; maintenance; platform costs	Table 7

Source: author, synthesised from the thematic, comparative, and testing evidence above.

5. CONCLUSION AND RECOMMENDATION

This study set out to establish whether a multi-temperature smart locker can profitably close the Asynchronous Delivery Gap in Jakarta's high-density buildings. On RQ1, the current handover is thermally unmanaged and operationally unpredictable: no site offered active heating or cooling, and courier dwell time reached 7 minutes 43 seconds at office towers, long enough for measurable, sometimes severe, temperature loss. On RQ2, the Must-have features were embodied in an app-less web prototype that every one of eighteen users completed unaided, well below the observed baseline, though a small set of consistency, visibility, and error-prevention issues should be resolved before piloting. On RQ3, a Smart-Locker-as-a-Service model, with revenue billed to the building or platform side rather than the courier, is the most feasible structure, phased to launch first with ambient and chilled compartments while a compliant heated-compartment supplier is qualified.

For managers, five actions follow directly from the evidence: resolve the prioritised usability findings (Table 8), above all the slot-size confirmation warning; launch a controlled pilot in one or two Grade-A office towers, the segment with the longest observed dwell time; structure pricing so the usage fee is billed to the building or platform side and never to the courier; phase hardware deployment, beginning with ambient and chilled compartments already validated off-the-shelf; and commission a short, targeted test of maximum hot-hold duration before finalising any thermal marketing claim. For researchers, priorities include a larger quantitative adoption study, formal net-present-value and payback modelling using pilot-stage cost and revenue data, and empirical verification of door-open thermal-recovery time against the dwell-time distribution in Table 3. Because the study is qualitative and purposive, transferability beyond the Jakarta CBD context studied here should be confirmed before generalising to residential or mall settings.

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