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Cloud-Based Inventory Control Improves Order Fulfillment Accuracy For University Micro-Entrepreneurs

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Abstract

Purpose: This study addresses inventory mismanagement among Shopee student-preneurs, specifically tackling dead-stock accumulation, stockouts, and limited storage that trigger order cancellations and penalize store performance.

Method: A six-month intervention engaged twenty fashion student-preneurs at ITB Asia Malang through structured phases. The program implemented a cloud-based Google Sheets system with Reorder Point formulas, utilizing pre/mid/post-tests and operational tracking.

Practical Applications: The digital tool enables real-time stock monitoring, automated alerts, and data-driven procurement. This cost-effective model helps e-commerce micro-entrepreneurs optimize limited storage, prevent capital lock-up, and streamline fulfillment workflows.

Conclusion: Cognitive mastery improved significantly from 40 to 85. The system substantially reduced stockouts and dead stock, enhancing operational efficiency. Despite external supplier variables, cloud-based inventory control successfully improves order fulfillment accuracy and business sustainability.

Introduction

The rapid proliferation of digital marketplace ecosystems has fundamentally transformed entrepreneurial opportunities for university students, catalyzing the emergence of a distinct demographic known as student-preneurs. In Indonesia, platforms such as Shopee have substantially lowered entry barriers, enabling undergraduates to establish independent micro-enterprises with minimal initial capital. At Institut Teknologi dan Bisnis (ITB) Asia Malang, this phenomenon has gained considerable traction, particularly within the fashion retail sector, which aligns closely with youth consumption patterns and dynamic trend cycles. Consequently, e-commerce participation has transitioned from a supplementary income stream to a primary pedagogical laboratory for experiential business learning and financial independence.

Despite this promising landscape, student-entrepreneurs frequently encounter severe operational bottlenecks that stem from the intersection of rigorous academic demands and informal business structures. Unlike established micro, small, and medium enterprises, student-run ventures typically operate without formal managerial training, dedicated logistical infrastructure, or standardized operating procedures. Preliminary diagnostic assessments conducted among fashion-focused student-preneurs at ITB Asia Malang reveal that inventory governance remains predominantly reliant on unstructured manual documentation and visual estimation. This ad hoc approach is further constrained by the physical limitation of utilizing dormitory rooms as makeshift storage facilities, creating an environment prone to spatial inefficiency and data fragmentation.

Figure 1. Workshop at Institut Teknologi dan Bisnis Asia Malang

Source: Private Documentation, 2025.

The absence of systematic inventory control precipitates two critical vulnerabilities: the accumulation of non-performing merchandise (Leow & Keni, 2025) and recurrent stockout incidents during peak demand periods (Rosales et al., 2018). Dead stock not only congests limited living spaces but also immobilizes working capital, thereby restricting portfolio diversification and price competitiveness within highly saturated digital markets (Atamaya, 2025; Orobia et al., 2013; Sugiono & Alimbudiono, 2020). Conversely, undetected stockouts trigger automatic order cancellations on e-commerce platforms, resulting in algorithmic penalties, diminished store visibility, and reputational degradation. These compounding inefficiencies underscore a critical gap between digital marketplace accessibility and foundational operational competency among academic entrepreneurs.

Contemporary operations management literature extensively documents the strategic necessity of inventory optimization systems for small enterprise sustainability, emphasizing automated tracking, data-driven procurement, and safety stock calibration (Alahyane, 2024; Hassan et al., 2025; Rusli et al., 2024; Sheludko, 2023; Vadi et al., 2021). However, existing frameworks predominantly target established firms with dedicated IT infrastructure and financial capacity for enterprise resource planning software. Scholarly discourse remains notably sparse regarding low-cost (Vadi et al., 2021), cloud-native inventory solutions tailored to resource-constrained academic entrepreneurs (Rusli et al., 2024), thereby highlighting a contextual gap that warrants targeted community engagement and applied research intervention.

This engagement specifically targets the student-preneur cohort at ITB Asia Malang due to its representative intersection of high digital marketplace participation, acute spatial constraints, and limited access to formal supply chain training. The selection of this

demographic is justified by the urgent need to prevent early-stage business attrition caused by operational mismanagement rather than market failure. By embedding inventory literacy within an accessible digital framework, the initiative seeks to transform informal dormitory-based operations into structured, data-informed micro-enterprises capable of sustaining long-term viability alongside academic commitments.

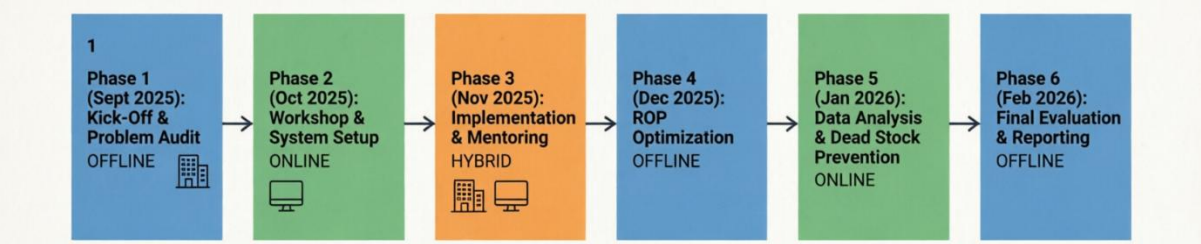
To address these systemic inefficiencies, the program implements a phased capacity-building intervention centered on a cloud-based inventory control architecture utilizing Google Sheets integrated with automated Reorder Point formulas. This methodology replaces fragmented manual tracking with a centralized, real-time monitoring system accessible via standard mobile devices. Through structured workshops, hybrid mentoring, and iterative data validation, participants are guided through SKU standardization, historical sales analysis, and dynamic threshold calibration, thereby cultivating both technical proficiency and strategic decision-making competencies.

The anticipated societal transformation extends beyond individual business optimization to encompass broader entrepreneurial resilience and digital inclusion within higher education ecosystems. By democratizing access to inventory analytics, the intervention aims to reduce transactional friction, minimize capital stagnation, and enhance order fulfillment accuracy across the student-preneur community. Furthermore, the project contributes to pedagogical discourse on experiential learning by demonstrating how lightweight digital tools can bridge theoretical business education and practical operational execution in resource-limited academic settings.

Method

This community engagement initiative employs a participatory action research design integrated with a longitudinal pre-test/post-test quasi-experimental framework to evaluate the efficacy of cloud-based inventory control among digital micro-entrepreneurs. The target population comprises active undergraduate students at Institut Teknologi dan Bisnis (ITB) Asia Malang who independently operate fashion retail ventures on the Shopee platform. A purposive sampling technique was applied to select twenty student-preneurs exhibiting documented inventory mismanagement indicators, including reliance on manual tracking, spatial constraints in dormitory storage, and recurrent stockout incidents. This deliberate participant selection ensures direct alignment with the project's objective of addressing operational bottlenecks in resource-constrained academic enterprises while maintaining contextual relevance for scalable intervention.

Figure 2. Six-Phase Intervention Program Flowchart Showing Delivery Methods and Timeline



Source: Author's Work, 2025.

The intervention was systematically executed over a six-month period from September 2025 to February 2026, structured into six sequential phases to ensure gradual competency development and sustained technology adoption. Phase I commenced with an on-campus diagnostic audit to map business profiles, catalog product variants, and assess physical storage conditions. Phase II transitioned to virtual workshops introducing digital inventory architecture and guiding participants in configuring Google Sheets databases. Phase III facilitated hybrid mentoring for historical data migration, standardized SKU assignment, and disciplined transaction logging. Phase IV focused on offline calibration of Reorder Point (ROP)

formulas tailored to individual sales velocity and supplier lead times. Phase V utilized online analytics sessions to classify fast-moving versus slow-moving inventory and devise liquidation strategies. Phase VI concluded with on-site evaluation, cognitive assessment, and sustainability planning for independent system utilization.

Data collection employed a mixed-methods approach combining quantitative cognitive assessments and qualitative operational tracking. Primary instruments included standardized knowledge tests administered at baseline (pre-test), midpoint (mid-test), and program termination (post-test) to measure comprehension of inventory principles. Secondary instruments comprised structured observational checklists, system usage logs, and operational performance trackers recording stockout frequency, dead stock accumulation, space utilization efficiency, and order cancellation rates. All digital inputs were centralized within the cloud-based framework, enabling real-time data extraction and longitudinal monitoring of behavioral shifts in inventory management practices without disrupting participants' academic schedules.

Figure 3. System Architecture System Monitoring Stock and Automated Reorder Point (ROP)

SKU	Nama Barang	Stok Awal	Stok Masuk	Stok Keluar	Stok Akhir	ROP	Status Peringatan	Permintaan Rata-rata/Hari	Lead Time (Hari)	Safety Stock
SKU-001	Gamis	550	120	170	500	505	RESTOCK SEKARANG	50	10	5
SKU-002	Hijab	320	40	190	170	150	MENDEKATI ROP	12	20	10
SKU-003	Baju Panjang	180	0	110	70	90	RESTOCK SEKARANG	13	15	12
SKU-004	Kaos Kaki	900	200	300	800	350	AMAN	10	10	20
SKU-005	Sarung Tangan	140	30	110	60	60	RESTOCK SEKARANG	5	36	5

Source: Author's Work, 2025.

Figure 3 illustrates the operational architecture of the cloud-based inventory monitoring system, specifically detailing the automated Reorder Point (ROP) mechanism designed to support data-driven procurement decisions among student-preneurs. The interface systematically tracks critical inventory variables, including initial stock, inbound and outbound transactions, and real-time current stock levels for each distinct Stock Keeping Unit (SKU). Central to this architecture is the dynamic ROP calculation, which integrates three foundational parameters: average daily demand, supplier lead time (in days), and a predetermined safety stock buffer. By applying the formula ROP = (Average Daily Demand × Lead Time) + Safety Stock, the system establishes a customized threshold for each product variant. When the current stock level approaches or falls below this calculated threshold, an automated conditional formatting rule triggers a localized warning status, categorizing inventory conditions as "AMAN" (secure), "MENDEKATI ROP" (approaching threshold), or "RESTOCK SEKARANG" (immediate replenishment required). This proactive alert mechanism effectively eliminates reliance on intuitive stock estimation, enabling student-entrepreneurs to initiate timely procurement orders, mitigate the risk of stockout-induced platform cancellations, and prevent excessive capital immobilization in non-performing merchandise. Consequently, the dashboard functions as a scalable, low-cost decision-support tool that aligns daily operational workflows with evidence-based inventory management principles within resource-constrained digital marketplace ecosystems.

Quantitative data underwent systematic cleansing to eliminate incomplete entries and standardize metric units prior to statistical processing. Descriptive statistics, specifically mean score calculations and percentage change analysis, were applied to evaluate cognitive progression across the three assessment intervals. Operational indicators were analyzed through comparative trend mapping to quantify reductions in stockout occurrences and dead stock volumes post-intervention. Qualitative observations and system logs were triangulated with test results to interpret adoption fidelity, identify implementation barriers, and contextualize performance fluctuations. This integrated analytical approach ensures robust validation of the intervention's impact on both theoretical mastery and practical operational efficiency.

To guarantee methodological rigor and replicability, the procedural design incorporated continuous feedback loops and adaptive mentoring protocols. Potential risks, including participant attrition, inconsistent data entry, and resistance to digital transition, were mitigated through phased onboarding, peer accountability mechanisms, and simplified interface customization. Data verification was reinforced via cross-referencing self-reported logs with platform transaction histories and periodic physical inventory spot-checks. Every procedural step, from initial diagnostic mapping to final ROP calibration, is explicitly documented to enable replication in analogous academic entrepreneurial ecosystems. This transparent methodological architecture upholds alignment with the project's core objectives while providing a scalable, evidence-based blueprint for future community engagement initiatives.

Result

The six-month community engagement program was systematically implemented at Institut Teknologi dan Bisnis (ITB) Asia Malang, directly targeting twenty active undergraduate student-preneurs operating independent fashion retail ventures on the Shopee platform. The intervention encompassed six structured phases delivered through a hybrid modality of offline campus workshops, virtual mentoring sessions, and continuous digital monitoring. Throughout the program duration, the research team conducted two core capacity-building workshops, delivered over twenty hours of hands-on technical mentoring, and facilitated the complete migration of participants' inventory records from unstructured manual tracking to a centralized cloud-based database. Each participant successfully established a customized Google Sheets inventory dashboard integrated with automated Reorder Point (ROP) formulas and visual warning indicators, ensuring twenty distinct micro-enterprises received sustained operational support and digital onboarding.

Quantitative cognitive assessments administered across the intervention timeline demonstrate a substantial enhancement in participants' theoretical and applied understanding of modern inventory management. Baseline pre-test evaluations revealed an average comprehension score of 40 out of 100, indicating heavy reliance on intuitive decision-making and unstructured visual estimation. Following the foundational digital onboarding and structured mentorship, mid-program assessments recorded a marked improvement to an average score of 75. By the conclusion of the program, post-test results achieved a peak average of 85, confirming successful internalization of inventory control principles, safety stock calculation, and data-driven procurement strategies. This cognitive progression directly translated into sustained behavioral shifts, as participants transitioned from reactive stock monitoring to proactive, schedule-based inventory reconciliation and systematic SKU categorization.

Table 1. Individual Cognitive Assessment Scores of 20 Fashion Student-Preneurs Across Pre-test, Mid-test, and Post-test Interventions

Business	Pre-test Score	Mid-test Score	Post-test Score	Improvement (%)
Seoul Style Studio	38	72	84	+121.1%
Chic & Cozy	42	76	87	+107.1%
Tote & Tales	35	70	82	+134.3%
Hair Candy	45	79	90	+100.0%
Eco Bag Studio	33	68	80	+142.4%
Kaos Kaki Lucu	48	81	92	+91.7%
Thrift *Wanita Pilihan*	36	73	85	+136.1%
Kerudung Segi Empat	41	75	86	+109.8%
Tas Selempang Manis	39	74	83	+112.8%
Atasan Manis	44	78	89	+102.3%

Business	Pre-test Score	Mid-test Score	Post-test Score	Improvement (%)
Kemeja Cantik	37	71	81	+118.9%
Dress *Indah* Boutique	46	80	91	+97.8%
Cardigan Lembut	34	69	79	+132.4%
Blouse Anggun	43	77	88	+104.7%
Overall & Jumpsuit	40	75	85	+112.5%
Legging & Celana Ketat	32	67	78	+143.8%
Crop Top Kekinian	47	82	93	+97.9%
Sweater Hoodie	38	73	84	+121.1%
Rok Plisket	41	76	87	+112.2%
Tank Top & Camisole	39	74	86	+120.5%
Average	40	75	85	116.20%

Source: Author's Work, 2026.

The operational transformation of the targeted micro-enterprises is comprehensively documented through comparative baseline and post-intervention metrics. As delineated in Table 2, the adoption of the cloud-based inventory system fundamentally restructured participants' operational workflows. Real-time stock tracking eliminated recurrent discrepancies between digital marketplace listings and physical availability, while automated color-coded alerts enabled preemptive procurement before critical thresholds were breached. Dormitory storage capacity was optimized through strategic zoning and the deliberate liquidation of slow-moving merchandise, effectively decoupling living spaces from commercial clutter. Financially, participants reported improved working capital liquidity due to reduced capital immobilization in dead stock and a measurable decline in Shopee order cancellations, directly preserving store performance scores and algorithmic visibility.

Table 2. Comparative Analysis of Operational Indicators Before and After Cloud-Based Inventory Control Intervention

Operational Indicator	Pre-Intervention Condition	Post-Intervention Condition
Stock Recording & Monitoring	Unstructured manual tracking; reliant on visual estimation and sporadic physical checks in dormitory storage	Fully migrated to centralized Google Sheets dashboard with real-time mobile access and automated stock deduction
Storage Capacity & Spatial Organization	Dormitory rooms congested with mixed personal and commercial items; dead stock accumulation obstructing living space	Zoned commodity-based storage layout; clear segregation between merchandise and personal living areas
Procurement Decision-Making	Speculative ordering; either overstocking (capital immobilization) or understocking (elevated unit costs)	Data-driven procurement based on historical sales velocity; proportional budget allocation aligned with product turnover rates
Supplier Synchronization & Order Fulfillment	Complete asynchrony; frequent order cancellations due to unverified supplier stock availability	Micro-scale buffer stock implementation based on supplier lead-time analysis; secondary supplier communication protocol established

Operational Indicator	Pre-Intervention Condition	Post-Intervention Condition
Cognitive Mastery of Inventory Principles	Average pre-test score: 40/100; limited understanding of safety stock, ROP, and SKU management	Average post-test score: 85/100; demonstrated competency in ROP calibration, dead stock identification, and data-driven replenishment
Operational Risk Exposure	High frequency of stockout-induced cancellations and Shopee algorithmic penalties	Significant reduction in stockout incidents and order cancellations; improved store performance metrics and visibility

Source: Author's Work, 2025.

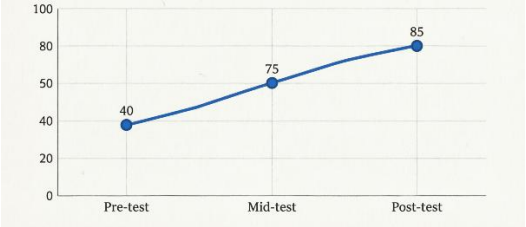
Interpretative analysis of the collected operational data confirms that the cloud-based inventory control intervention successfully mitigated the primary bottlenecks of stockout frequency and dead stock accumulation, aligning precisely with the program's foundational objectives. However, residual stock discrepancies persisted at a minimal level, primarily attributable to external supplier inventory fluctuations that operate outside the participants' direct control. To address this systemic limitation, the program introduced a dual-supplier communication protocol and micro-level buffer stock calibration, which further stabilized order fulfillment rates. Qualitative feedback and post-program testimonials corroborate these findings, with participants highlighting reduced operational anxiety, enhanced time management alongside academic responsibilities, and increased confidence in scaling their digital storefronts. Collectively, these outcomes validate the practical efficacy and replicability of lightweight digital inventory frameworks within resource-constrained academic entrepreneurial ecosystems.

Figure 4. Documentation in Class (Offline)

Source: Private Documentation, 2026.

Discussion

Figure 5. Cognitive Mastery Progression Showing Significant Improvement from Pre-test (40) to Post-test (85) Among Student-Preneurs



Source: Author's Work, 2026.

The implementation of cloud-based inventory control among Shopee-affiliated student-preneurs at ITB Asia Malang has yielded multifaceted outcomes that extend beyond operational metrics to encompass cognitive empowerment, behavioral transformation, and entrepreneurial resilience. The primary objective of mitigating stockout-induced order cancellations and dead-stock accumulation was substantially achieved, as evidenced by the marked improvement in cognitive assessment scores (from 40 to 85) and the documented reduction in inventory-related operational disruptions. These findings align with operations management literature emphasizing the critical role of data-driven inventory systems in enhancing small enterprise agility (Alahyane, 2024; Ayankoya et al., 2025; Thomas & Gabriel, 2024). However, the intervention's success was not merely technical; it catalyzed a paradigm shift among participants from intuition-based decision-making to systematic, evidence-informed procurement strategies, thereby strengthening their capacity to navigate the volatile dynamics of digital fashion retail.

Economically, the program contributed to improved working capital liquidity by reducing capital immobilization in non-performing merchandise and minimizing revenue loss from platform-imposed penalties due to order cancellations. Socially, the intervention fostered a collaborative learning ecosystem wherein participants exchanged best practices through peer mentoring, reinforcing the notion that active community involvement is instrumental to the sustainability of capacity-building initiatives (Hacker et al., 2012; Lennie, 2005; Middlemiss & Parrish, 2010). Environmentally, while not the primary focus, the optimization of dormitory storage spaces indirectly promoted more organized living conditions, reducing clutter-related stress and enhancing students' overall academic-work balance. These multidimensional impacts underscore the program's alignment with broader goals of entrepreneurial education and digital inclusion within resource-constrained university contexts.

Nevertheless, the intervention encountered notable limitations that warrant critical reflection. The persistent, albeit reduced, incidence of stockout events attributable to external supplier inventory fluctuations highlights a systemic boundary of micro-enterprise-level interventions: the inability to control upstream supply chain visibility without integrated API connectivity. This constraint echoes findings from prior studies on small e-commerce ventures, which note that platform-level data asymmetry remains a structural challenge for independent sellers (Sun & Qu, 2025; Towne, 2025). To mitigate this, the program introduced a dual-supplier communication protocol and micro-buffer stock calibration, which partially stabilized fulfillment rates. Future iterations could explore lightweight middleware solutions or consortium-based supplier coordination to enhance real-time stock synchronization without incurring prohibitive software costs.

The durability and replicability of this intervention are reinforced by its reliance on universally accessible, zero-cost digital tools (Google Sheets) and its phased, competency-based implementation design. Unlike enterprise resource planning systems that demand significant financial and technical investment, this model is readily adaptable to analogous student-entrepreneur ecosystems across Indonesian higher education institutions. Key lessons learned include the importance of hybrid mentoring modalities to accommodate academic schedules, the value of visual warning systems to sustain user engagement, and the necessity of embedding sustainability planning from the program's inception. These insights contribute to the growing discourse on scalable, low-tech digital capacity building for academic micro-entrepreneurs.

In contrast to community service initiatives that prioritize short-term output delivery, this program emphasized cognitive mastery and behavioral internalization, thereby enhancing the likelihood of sustained post-intervention adoption. The active participation of student-preneurs in co-designing their inventory dashboards and calibrating ROP thresholds fostered ownership and contextual relevance, a principle corroborated by action research frameworks that position beneficiaries as co-creators rather than passive recipients (Fahadha, 2025; Kohler & Chesbrough, 2019; Lubis et al., 2025). Specific contributions of this engagement include the

development of a replicable six-phase intervention blueprint, the validation of cloud-based spreadsheets as viable inventory tools for resource-limited entrepreneurs, and the empirical documentation of cognitive-operational linkage in digital entrepreneurship training. Collectively, these outcomes establish a reference standard for future community service research seeking to bridge theoretical business education with practical operational execution in emerging digital marketplace ecosystems.

Conclusion

This community engagement initiative successfully addressed critical inventory management challenges faced by Shopee-affiliated student-preneurs at Institut Teknologi dan Bisnis (ITB) Asia Malang, with the primary objective of mitigating operational inefficiencies stemming from dead-stock accumulation, recurrent stockouts, and spatial constraints in dormitory-based micro-enterprises. The principal findings demonstrate that a phased, cloud-based inventory control intervention utilizing Google Sheets integrated with Reorder Point formulas significantly enhanced participants' cognitive mastery of inventory principles, as evidenced by the progression of average assessment scores from 40 (pre-test) to 85 (post-test), while concurrently reducing stockout-induced order cancellations and optimizing limited storage utilization. Practically, these outcomes affirm that lightweight, zero-cost digital tools can effectively bridge the gap between theoretical business education and operational execution for resource-constrained academic entrepreneurs, offering a replicable blueprint for similar university ecosystems across emerging digital marketplace contexts.

The study's unique contribution lies in its empirical validation of the cognitive-operational linkage within student-entrepreneurship training, positioning beneficiaries as active co-designers of their inventory systems rather than passive recipients of technical solutions. Nevertheless, the intervention encountered inherent limitations, notably the inability to fully synchronize real-time stock data with external suppliers lacking API integration, which resulted in residual, albeit minimized, fulfillment discrepancies. Methodologically, the reliance on self-reported operational logs, while mitigated through triangulation with platform transaction histories and physical spot-checks, suggests opportunities for future research to incorporate automated data capture mechanisms. Accordingly, subsequent initiatives should explore consortium-based supplier coordination protocols or lightweight middleware solutions to enhance upstream supply chain visibility, while also investigating the longitudinal sustainability of behavioral changes post-intervention. Ultimately, this research underscores the transformative potential of accessible digital capacity-building in fostering entrepreneurial resilience, contributing valuable insights to the broader discourse on experiential learning, technology-enabled micro-enterprise development, and inclusive digital economy participation within higher education settings.

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