

## Methodology for assessing the accuracy of inventory results

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### Abstract

This article highlights the need to develop an objective methodology for evaluating the accuracy of inventory results, given the crucial roles that reliable data play in financial reporting and inventory management. The relevance of this research is also motivated by the persistent low levels of accuracy, which have led to significant financial losses and wasted energy. This work will develop a statistically based, technology-supported approach to inventory accuracy assessment that can pinpoint all types of errors quantitative, qualitative, and document-related in real-time. The novelty of the proposed methodology lies in the combination of five interrelated stages: formalization of tolerances and sample size calculation using a binomial model, a two-stage physical recount with mandatory recount, calculation of key performance indicators, application of threshold logic for cell blocking in the WMS, and continuous RFID monitoring with visualization on BI dashboards. Such a closed loop of target-measure-verify-classify within the PDCA framework ensures not only objective recording of the current state but also a quantitative link between improvements and economic effect. The main findings of the study demonstrate that integrating WMS blocking logic, continuous RFID identification, and streaming BI analytics can increase inventory accuracy to 97–99% and reduce shrinkage to double-digit percentages without increasing the frequency of full inventories. A pilot implementation in a retail chain showed an increase in accuracy from 72% to 99.4%, a reduction in shrinkage from 17% to 1.7%, and a decrease in audit time from 22 minutes to 38 seconds, accompanied by savings in labor and capital resources. The article will be helpful to inventory accounting and management specialists, logistics and finance managers, as well as WMS and RFID solution developers and integrators.

**Keywords:** Methodology For Assessing Accuracy; Inventory; Binomial Model; Cycle Counting; WMS Blocking; RFID Monitoring; BI Analytics; PDCA

### 1. Introduction

Inventory record accuracy is a fundamental element of the reliability of financial reporting, since it is on these data that the determination of cost of goods sold, subsequent expense recognition, and compliance with the requirement to state inventories at the lower of cost or net realizable value, as established by the International Accounting Standard IAS 2 Inventories, are based. If physical stock does not tally, the firm runs the risk of overstating assets and hence understating write-offs that will be charged in the future. It also leads to a violation of the principle of faithful representation and can, in extreme cases, result in financial statement restatements and a loss of investor confidence [1]. Even with the widespread deployment of WMS capabilities for real-time scanning, an average accuracy level of only 83% was achieved in 2024, according to a study by CAPS Research. In contrast, leading experts consider 95% to be a practical benchmark value. Such a gap implies that almost one in six items in companies' information systems is recorded incorrectly, posing direct threats to procurement planning, customer service, and cost-of-goods-sold calculations [2].

At the macro level, inaccuracies quickly translate into direct losses. Analysts at IHL Group estimated the global cost of inventory distortion the combination of excess and stockouts arising primarily from erroneous records at \$ 1.77 trillion

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for 2023, equivalent to 7.2% of global retail turnover [3]. The magnitude of this figure highlights that every additional tenth of a percent in accuracy yields billions of dollars in savings and frees up working capital.

At the operational process level, the consequences are equally significant. Simulations of five typical warehouses [4] confirmed that deviations in record accuracy directly reduce order picking productivity, increase the proportion of lost sales, and lead to inefficient use of warehouse space; while the introduction of regular cycle counting partially mitigates the damage, it does not eliminate it without comprehensive work on the root causes of errors.

Thus, the accuracy of inventory results ceases to be a narrow technical task of the accounting department and becomes a strategic key performance indicator (KPI) influencing financial reporting, operational efficiency, and company valuation. The development and implementation of an objective, statistically grounded methodology for assessing this accuracy becomes a necessary condition for sustainable inventory management and compliance with international reporting standards.

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## 2. Materials and Methodology

The study of the methodology for assessing the accuracy of inventory results is based on the analysis of 12 key sources encompassing international standards, industry reports, simulations, and empirical cases. The International Accounting Standard (IAS) 2, Inventories, was used as the normative framework for defining the principles of inventory valuation and expense recognition [1]. Data on actual accuracy rates were obtained from reports by CAPS Research, IHL Group, and the AU RFID Lab, which demonstrate current average accuracy values and calculate the economic losses due to inventory errors [2–3, 11]. The methodological foundation was supported by the concepts of the Inventory Accuracy Definition by Vermorel [5] and AQL control by Banton [10], while operational cases by Linuwih and Handayati [6], Susanti and Satriawan [7], and Cykeo [12] illustrate the application of a two-stage recount, RFID control, and WMS blocking logic.

The methodological framework of the study comprises two interrelated blocks: data collection and processing, and the statistical and comparative analysis of these data. A binomial model was applied to prepare the sample. In the first stage, the allowable error (tolerance) and the minimum sample size were determined according to the required test sensitivity [5]. The sample is formed from all ABC classes, allowing for consideration of item characteristics and error granularity [9].

For comparative analysis, the methodology provides for the comparison of the obtained metrics with industry benchmarks from Taglab [9], simulated data of the distribution center by Destro et al. [4], and the results of practical cycle counting implementations in large retail networks. This combination enables not only the objective recording of the current accuracy level but also the establishment of a quantitative link between achieved improvements and economic impact for the subsequent corrective PDCA cycle.

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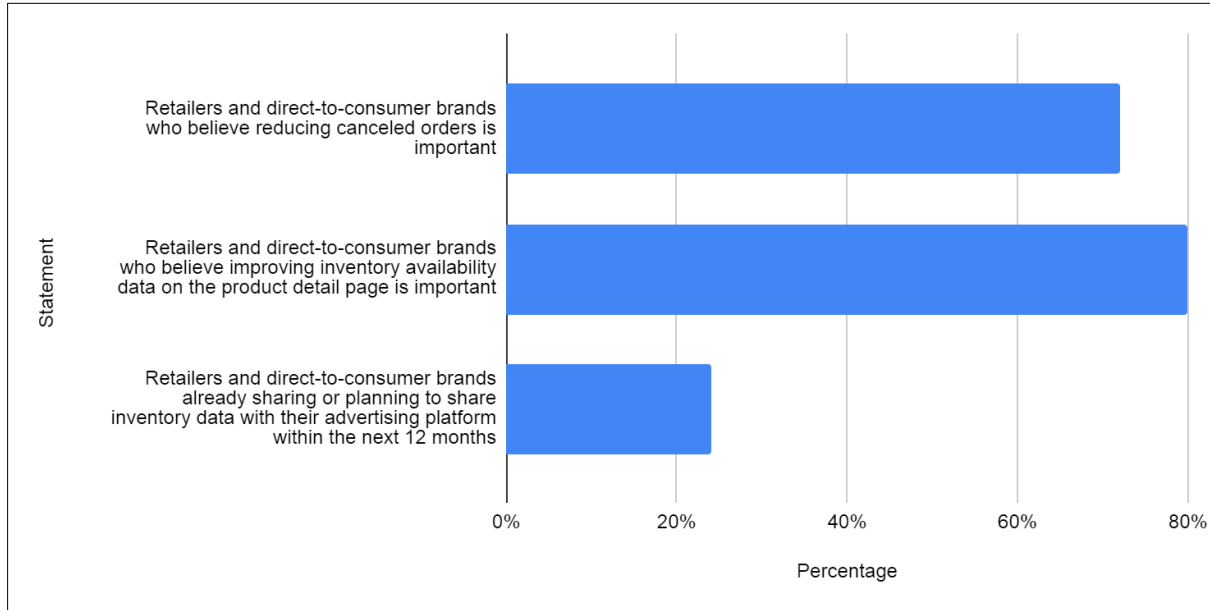
## 3. Results and Discussion

Accuracy of Inventory in the Present Study is understood as the concordance between electronic records of stock balances and the actual physical state of inventory; it encompasses all types of discrepancies from phantom items to incorrect quantities and, as demonstrated by the classic analysis [5], manifests in at least 65% of SKUs in retail chains, meaning that more than every second system value differs from reality. This definition is also enshrined in professional supply-chain literature, where accuracy is most often measured by the magnitude of absolute error and the proportion of correct records.

Quantitative errors occur when the system records a different number of units than are present during the count. In a recent warehouse case, the Gross Variance metric reached 0.53% of all inventory units, while discrepancies affected 52.85% of SKUs, resulting in potential losses equivalent to 154,450,000 IDR. The study emphasizes that even a modest average error percentage may conceal widespread errors and inflict significant financial pain [6].

Qualitative errors occur when the system correctly logs the quantity but fails to reflect changes in a product's consumer properties, such as damage, spoilage, or expiry. An analysis of procedures for returning damaged and expired goods at one enterprise revealed that the absence of regular condition checks results in irrecoverable write-offs that simple accounting adjustments cannot rectify. Even with established regulations, losses persisted because data on product condition was entered into the system too late [7].

Documentary (systemic) errors are not related to the physical goods themselves, but rather to the incorrect recording of movements within the accounting environment, such as duplicate postings, erroneous SKU codes, or inappropriate valuation methods. From a financial perspective, any of these error groups alters the cost of ending inventory, thereby distorting the cost of goods sold, gross margin, and retained earnings. Operationally, errors translate into service failures and lost sales. A survey [8] revealed that 80% of retailers and DTC brands believe improving inventory availability data on the product detail page (PDP) is important, as illustrated in Figure 1.



**Figure 1** Survey-Based Assessment of Inventory Management Priorities and Data-Sharing Intentions among Retailers and Direct-to-Consumer Brands [8]

Thus, inaccuracy extends beyond the warehouse, impacting customer satisfaction, reputation, and working capital. At the warehouse level, it reduces picking productivity and increases storage costs.

The methodology for assessing inventory accuracy is constructed as a linear chain of five interrelated stages, where the outcome of each step serves as the starting point for the next. Such a structure eliminates gaps between strategic objectives and factual analysis: target metrics set at the outset directly determine sample size, recount format, and statistical acceptance criteria, and the final classification of results serves as input data for corrective measures described in subsequent sections.

In the preparatory phase, companies formalize the required level of record reliability by specifying an allowable error value (tolerance) and selecting an inventory selection scheme. Simultaneously, lot selection conditions and the minimum sample size calculated using the binomial model are fixed; this assignment predefines the sensitivity of the subsequent statistical test.

Collection of actual data is implemented through a two-stage count: the primary count (count 1) and a mandatory recount (count 2) for all SKUs with deviations above the established threshold. Recording each operation in the WMS prevents duplicate entries and generates a digital audit trail, which is verified concurrently with the physical count. After reconciliation, four key metrics are calculated: accuracy rate (the ratio of matching entries to total system records), shrinkage, coverage coefficient, and the composite PII index, which aggregates error frequency and amplitude. Industry guidelines regard 97% as the default benchmark: below this threshold, the probability of supply failures grows exponentially, whereas further accuracy improvements yield diminishing economic returns [9], as shown in Table 1.

**Table 1** Categorization of Industry-Specific Inventory Accuracy Rate Benchmarks [9]

Industry	Excellent Accuracy Rate	Good Accuracy Rate	Need Improvement Accuracy Rate
E-commerce and Retail	>98%	95 – 98%	<95%
Manufacturing	>97%	93 – 97%	<93%
Wholesale and Distribution	>99%	97 – 99%	<97%
Healthcare and Pharmaceuticals	>99.5%	98 – 99.5%	<98%
Automotive and Aerospace	>99%	95 – 99%	<95%

Metrics are computed for the entire dataset as well as separately by ABC class, enabling the ranking of deviation causes. Statistical testing is performed at the 95% confidence level [10]. For selective inventories, a two-sided Wilson binomial interval is applied. This mechanism eliminates the risk of a false-negative decision and maintains a balance between labor intensity and accuracy. As an alternative to attribute control, highly automated enterprises employ the normalized deviation of total quantities and the critical z-value; however, in both cases, the concept of AQL remains fundamental. Thus, the proposed scheme ensures a closed loop of target–measure–verify–classify, allowing not only objective capture of the current accuracy level but also establishing a quantitative link between achieved improvements and financial outcomes.

The comparison of recorded and actual data begins with the calculation of relative deviation, where the difference between the recorded and physical quantity is normalized to the recorded value and expressed as a percentage. This metric instantaneously reveals even minor shifts and enables the ranking of anomalies without involving item cost or dimensions. Industry guidelines on operational efficiency establish a threshold beyond which an item moves from the statistical noise zone to a category requiring immediate investigation. The deployment of this trigger in five DCs brought down the volume of adjs by nearly one-third through early catching of systemic failings. Unlike absolute measures, relative dev is unbothered about scale since it applies the same way to a single SKU and a whole category, thus making it the basis for daily check-ins.

Absolute error measures the total volume of discrepancies divided by the recorded volume. It tells how much ‘excess’ or ‘missing’ stock moves between warehouses and the records. This measure lies at the core of the classical Inventory Accuracy coefficient. Field statistics from the Auburn University RFID Lab show that the average accuracy level of commercial warehouses still fluctuates between 65% and 75%, whereas 97% is considered a reliable starting point for most industries; surpassing this barrier demonstrates a sharp reduction in safety-stock costs and order cancellations, while further improvement yields diminishing economic returns [11]. When both error frequency and magnitude must be considered simultaneously, composite indices are used. The most widely used is the Product Inaccuracy Index, which calculates the average absolute error per item and is essentially analogous to Defects Per Million in Six Sigma.

Practice confirms that the best results are achieved by combining all three approaches. Relative deviations function as an operational sensor, absolute error defines strategic targets, and composite indices show how individual defects aggregate into overall financial risk. This combination provides the basis for algorithmic error forecasting and proactive accuracy management, as demonstrated by pilot projects of major 3PL operators, resulting in double-digit shrinkage reductions without increasing the frequency of full inventories.

Digital tools serve as the practical foundation of the methodology described previously: without continuous synchronization of recorded and physical flows, it is impossible to maintain relative deviation within specified tolerances. The key core here is a modern warehouse management system that turns each storage location into an active control element. The WMS algorithm blocks a bin immediately upon detecting a discrepancy above the threshold, prohibiting any process receiving, picking, or moving from using the problematic location until a recount is performed. Such instant isolation interrupts the cascade of errors and allows localization of the root cause before it spreads to adjacent items. In a multi-center project involving a US retail chain, where SAP EWM WMS was operated in conjunction with automatic bin locks, the implementation of the blocking rule reduced shrinkage from 17% to 1.7% and decreased labor effort [12], as shown in Table 2.

**Table 2** Impact of Cykeo Implementation on Key Inventory Management Performance Metrics [12]

Metric	Pre-Cykeo	Post-Cykeo	Improvement
Inventory Accuracy	72%	99.4%	+27.4%
Shrinkage Rate	17%	1.7%	-90%
Audit Time/Pallet	22min	38sec	-97%
Labor Costs	\$583k/yr	\$89k/yr	-85%

A layer of wireless identification is superimposed over the WMS: RFID tags and fixed readers confirm in real time the location of each unit in its planned bin. The system does not rely on operator barcode scanning; instead, the radio channel registers the movement of a batch instantaneously, and the controller compares the event against the record database. If a discrepancy is found, the controller initiates either the same blocking mechanism or an immediate alert.

However, even the most accurate primary record loses value if it remains invisible to the manager. Therefore, the third component of the methodology is BI dashboards with streaming integration of key performance indicators. An interactive dashboard built in Power BI on top of WMS and ERP data refreshes the Accuracy, Shrinkage, and PII metrics every minute, highlights outlier bins with a heat map, and forecasts the probability of stock shortfalls over a one-week horizon using embedded machine learning models.

These three layers the blocking WMS logic, the continuous RFID loop, and the analytical dashboards form a cyclical PDCA loop in which error detection, verification, and correction occur almost synchronously. Under such an architecture, near-perfect accuracy becomes a rare achievement. It becomes a sustained state of the process, supported not by episodic counts but by a real-time data stream.

From this, the following recommendations can be formulated. Cycle counts transform inventory control from a rare stress test into a calm routine. Dispersing the workload across the calendar frees operations from halting shipments and receipts, and staff from having to work overtime shifts. Each small batch of SKUs is verified multiple times throughout the year: statistical power gradually accumulates, and a latent error emerges long before it develops into a significant deviation. The key condition for success is a steady cadence. The inventory team operates according to a clear schedule, applies a double count to identify discrepancies, and logs any adjustments immediately in the WMS. The results of the counts are displayed on the analytical dashboard, where they are compared with historical data, allowing the loss trend to become visible dynamically rather than at the cut-off point of a traditional annual count.

A proper warehouse layout enhances the effectiveness of cycle control without incurring additional labor costs. Value- and velocity-based zoning ensures that high-throughput flows follow the shortest routes and do not intersect with infrequent movements. For operators, this means a repetitive path in which any error immediately stands out. Narrow aisles are designated as one-way, bins are marked with color coding and large identifiers, and addresses are formatted to prevent mechanical confusion of digits. As a result, even a new employee intuitively reads the location of inventory, and the system receives an unambiguous signal as to what is located at each specific point.

Mandatory scanning with every operation turns the physical event into a transaction that can be verified and traced. Regardless of the technology whether it be a barcode, two-dimensional code, or RFID tag the process does not proceed without a positive terminal response. This simple rule blocks the possibility of silent movement and eliminates the main source of documentary errors. Upon scanner signal, the system immediately reconciles the bin's coordinates and status, automatically rejecting any attempt to place an item where an unresolved discrepancy has already been detected. In such an architecture, manual input is minimized and the human factor is controlled through built-in restrictions: a forklift cannot lift a pallet without confirmation, and a conveyor will not start until the box is identified.

Regular write-off audit complements the three preceding elements, turning them into a closed improvement loop. Each adjustment is analyzed for root causes: theft, damage, expiry, or systemic error. Data are classified and visualized on a timeline. If the share of a specific cause increases, a root-cause analysis is triggered using the Five Whys method or an Ishikawa diagram. Remedial measures are taken in a targeted manner, such as changing security patrol routes, strengthening packaging, adjusting temperature controls, or revising operator instructions. Because the audit process is integrated into the information system, the effect of these measures is tracked automatically. Updated accuracy, shrinkage, and picking speed metrics show how much the intervention has reduced the risk of defect recurrence.

The synergy of cycle counts, thoughtful layout, comprehensive scanning, and in-depth write-off analysis creates a self-sustaining loop. Errors are detected at inception, localized before propagation, classified to understand their causes, and remedied with methods proportional to their nature. This approach transforms inventory accuracy from a one-off campaign into a sustained state of process stability, elevating inventory management to the level of predictability required for strategic planning and high customer service standards.

Thus, the proposed methodology for assessing inventory accuracy based on five interrelated stages, from formalizing tolerances and statistical sampling to double counting and integrated verification provides an objective and quantitatively substantiated picture of the actual inventory state. The combination of instant blocking of problematic bins in the WMS, continuous RFID control, and streaming BI analytics within the PDCA cycle enables not only the detection and localization of deviations at their inception but also the rapid implementation of corrective actions. As a result, the methodology transforms inventory accuracy from an episodic audit into a sustained, real-time data-driven process aimed at strategic improvement of financial and operational performance.

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#### 4. Conclusion

The methodology proposed in this article for assessing the accuracy of inventory results constitutes an integrated process that combines statistically grounded sampling and verification techniques with modern digital tools. A clear delineation of stages from the formalization of permissible deviation and calculation of sample size to the two-stage recount and aggregation of key metrics (accuracy rate, shrinkage, coverage coefficient, and the composite PII index)—ensures procedural transparency and repeatability. Such an approach eliminates the gap between strategic inventory management objectives and actual accounting outcomes, transforming accuracy assessment into a reliable decision-making tool.

A key element of the methodology is the application of statistical criteria at a 95% confidence level, using Wilson binomial intervals or z-tests, with AQL consideration, to ensure a balance between the labor intensity of inspections and the reliability of conclusions. Practical cases demonstrate that even with a relatively modest average error rate, the widespread occurrence of errors leads to significant financial losses. In contrast, statistically justified control enables rapid anomaly detection and minimizes correction costs.

The integration of three technological layers instantaneous blocking of problematic bins in the WMS, continuous RFID monitoring, and streaming BI analytics creates a virtuous PDCA loop in which detection, verification, and remediation of deviations occur almost synchronously. The implementation of the instant isolation rule for problematic locations, as demonstrated in a retail chain using SAP EWM, reduced shrinkage from 17% to 1.7% and increased inventory accuracy by more than 27%.

The methodology transforms inventory audits from one-off stress tests into a routine. Cycle counts enable the accumulation of statistical power over a year, while a practical warehouse layout and mandatory scanning at every operation minimize the human factor. Systematic write-off audits ensure the targeted elimination of root causes. As a result, the inventory control process becomes continuous and predictable, directly impacting loss reduction, improving customer service levels, and facilitating the sustainable release of working capital.

Thus, the proposed methodology for assessing inventory accuracy not only provides an objective and quantitatively substantiated picture of stock status but also transforms inventory accuracy into a strategic key performance indicator (KPI). It ensures compliance with international accounting standards, enhances companies' financial and operational efficiency, and creates a platform for sustainable inventory management based on real-time data.

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