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Applying Label Printing and QR Code Scanning to Machinery and Equipment Management in Small and Medium-Sized Garment Enterprises

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ABSTRACT: Small and medium-sized garment enterprises manage large numbers of similar-looking machines that are frequently transferred between sewing lines according to orders, while inventory checks are still largely performed manually. This paper examines the application of a solution combining label design software, a label printer, a QR code scanner, and a spreadsheet to manage machinery and equipment, through the case of a medium-sized make-to-order garment enterprise in Hanoi organized into production teams and sewing lines. The solution comprises QR-coded identification labels printed with a Brother PT-P900W label printer, a spreadsheet-based database, and a scanning procedure with automatic reconciliation using conditional counting functions and conditional formatting, implemented consistently since 2024. A qualitative assessment over the 2024 and 2025 inventory cycles shows that the new process immediately identifies unconfirmed equipment and narrows the scope of re-checking, instead of requiring entire areas to be recounted; organizing data by production team and sewing line also allows machines transferred between orders to be tracked. Reductions in inventory time, manpower, and cost have not yet been measured quantitatively. On this basis, the paper proposes an adoption model for small and medium-sized garment enterprises, comprising two management modes (by fixed area and by sewing line), an allocation of responsibilities, and a proposed extension to code-based receipt and issue of materials and spare parts.

KEYWORDS: QR code scanning, label printer, machinery management, materials management, garment SMEs, inventory, digital transformation.

1. INTRODUCTION

In garment enterprises, machinery and materials are two groups of resources that determine the capacity to fulfil orders. A small or medium-sized garment factory may manage hundreds of sewing machines and special-purpose machines of similar appearance, which are continually transferred between sewing lines according to order schedules, together with many types of materials and spare parts such as needles, bobbin cases, presser feet, belts, and machine oil. When management relies on paper records or disconnected spreadsheets, enterprises find it difficult to determine precisely which machine is on which line and which materials have been issued to which machine, and year-end inventories often require considerable time and manpower.

Asset management has been systematized into an international framework of principles, under which assets should be identified, tracked, and managed throughout their life cycle to optimize the value they deliver to the organization [1]. Automatic identification technologies such as barcodes, QR codes, and radio-frequency identification (RFID) have been shown to improve data-recording accuracy and shorten processing time in warehouse and asset management [2]–[4]. However, small and medium-sized enterprises (SMEs) face barriers related to cost, skills, and technology integration [5], [6]; the textile and garment industry, in particular, is constrained by human resources, investment, and technological compatibility [7]. In Vietnam, about 80% of textile and garment enterprises are SMEs, and their average technology readiness is only 2.59/5 [8]. Solutions suitable for garment SMEs should therefore be low-cost, easy to operate, and closely aligned with the practice of transferring machines according to orders.

This paper examines the application of label printing and QR code scanning to machinery and equipment management, based on the case of a medium-sized make-to-order garment enterprise in Hanoi (hereafter, the case company). The case company organizes production into teams and sewing lines, and its sewing and special-purpose machines are transferred according to order schedules, making it representative of garment SMEs. The study addresses three research questions: (RQ1) What limitations does the manual management process have for frequently transferred machines? (RQ2) How is a low-cost code-scanning solution designed and operated, and what results does it deliver? (RQ3) Through what model can garment SMEs adopt the solution and extend it to materials management?

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2. RESEARCH CONTENT

2.1. Literature review and theoretical background

2.1.1. Machinery and materials management in garment SMEs

In this paper, machinery refers to fixed assets used in production, such as sewing machines, special-purpose machines, cutting machines, and auxiliary equipment; materials refer to replacement spare parts and consumables used to operate and maintain machinery. According to ISO 55000, asset identification data should be established consistently from the moment an asset is put into use in order to support its operation, maintenance, and disposal [1]. In garment enterprises, this requirement is difficult to meet because of three characteristics: large numbers of machines with similar appearance; machines transferred between lines according to orders; and materials and spare parts of many types, with low unit value but high frequency of issue.

In Vietnam, machinery management is also tied to legal requirements for fixed assets. Each fixed asset must have its own file and be classified, numbered, given its own card, and tracked in detail for each fixed-asset recording object [9]; enterprises must take an inventory of assets at the end of each annual accounting period to reconcile them with the accounting records [10], using the fixed-asset card and register forms and the inventory minutes prescribed by the current enterprise accounting regime [11]. Therefore, the identification code on the label and in the database should be consistent with the fixed-asset code and card in the accounting records, so that scanning results can be used directly when preparing inventory minutes.

For SMEs, digital transformation is often hindered by investment costs, lack of skills, and difficulty integrating with existing equipment [5], [6]. In the textile and garment industry, Majumdar et al. [7] identify barriers related to human resources, investment costs, and technological compatibility. A survey of 50 Vietnamese textile, garment, and footwear enterprises found that more than half lacked skilled workers, especially in technical and managerial positions, while training was constrained by time and finance [12]. The Development Strategy for Vietnam's Textile, Garment, Leather and Footwear Industry to 2030 also orients the industry's development towards the Fourth Industrial Revolution [13]; solutions should therefore be commensurate with enterprises' resources and operational characteristics, rather than relying on complex, high-cost systems.

2.1.2. Automatic identification technologies in asset and materials management

Fajar et al. [3] showed that integrating QR codes into inventory management improves data-recording accuracy and shortens search time. Through the implementation of an RFID traceability system in an industrial company, Gomes et al. [2] confirmed the benefits of automatic identification for processing time and data reliability. Gurnita et al. [4] developed an RFID-based decision support system to improve the efficiency of preventive equipment maintenance. Among these technologies, QR codes are the least costly, requiring only printed labels and a scanner or smartphone; a QR code can store more information than a one-dimensional barcode in the same area and has an error-correction mechanism that allows it to be read when the label is dirty or partially damaged [14]. RFID allows bulk reading without line of sight but requires higher costs for tags and reader infrastructure.

2.1.3. Research gap

Existing studies have mainly been conducted in logistics, large industrial enterprises, or public administration agencies; few have examined the order-driven transfer of machines and the management of materials and spare parts in garment SMEs (Table 1).

Table 1. Summary of research streams and gaps

Research stream	Main focus	Limitations relative to the objectives of this paper
Life-cycle asset management	Principles for identifying and tracking assets throughout their life cycle [1]	General framework of principles; not specific to machines transferred according to orders
Automatic identification using QR codes and barcodes	Recording accuracy and search time in inventory management [3]	Warehouse and public-administration contexts; organization by sewing line not considered
Automatic identification using RFID	Equipment traceability and maintenance [2], [4]	High cost and infrastructure requirements relative to SME resources
Digital transformation in SMEs and the textile and garment industry	Barriers related to cost, skills, and integration [6], [7]	Lack of specific, low-cost solutions for machinery and materials management

Source: Compiled by the author.

2.2. Research methodology

The study adopts a case study approach. The case company is a medium-sized make-to-order garment enterprise in Hanoi that organizes production into teams and sewing lines and has a materials warehouse, a cutting room, and a technical–mechanical and electrical department. Machinery and equipment are managed under the fixed-asset regime and include sewing machines, special-purpose machines, cutting machines, and auxiliary equipment such as air conditioners; a data file linked to the label template contains 3,019 records (Figure 2). The study covers both the sewing-line area, where machines are frequently transferred, and areas with fixed equipment, in order to compare two ways of organizing data. The object of the study is machinery and equipment managed as fixed assets; the scope is the management and inventory process implemented consistently from 2024 to August 2026. Results are evaluated over the year-end inventories of 2024 and 2025; the 2026 inventory (scheduled for December 2026) had not yet taken place and is outside the scope of the analysis. The specific methods are as follows:

Survey: The manual inventory process used before 2024 (work sequence, reconciliation method, and handling of discrepancies) was examined as the baseline for comparison with the new process. Because no systematic records of the time and manpower spent on manual inventories were available, the comparison is qualitative.

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Process analysis: The work steps of the previous and proposed processes were mapped to identify points for improvement.

System design: The label template was designed in the label design software supplied with the printer, and a database with standardized fields was built in a spreadsheet.

Pilot implementation: The new process was applied in the areas of the case company, and reconciliation results and emerging issues were recorded over the 2024 and 2025 inventories.

Expert consultation: The person in charge of equipment management, production team leaders, and technical staff were consulted during the development and refinement of the process.

The adoption model for garment SMEs, particularly its extension to materials and spare parts management (Section 2.6), was developed from the case results and the literature review; it is a proposal that has not yet been validated in enterprises. The evaluation of effectiveness in this paper is qualitative.

2.3. Management practices before the improvement

Before 2024, equipment management relied mainly on paper records and disconnected spreadsheet files, and no identification code was attached to individual items. The inventory plan was prepared in November and carried out from December: the person in charge printed the list of equipment from the records, counted manually on site, and then reconciled the count with the master data. When discrepancies were found, the specific items responsible could not be identified, so the inventory team usually had to recount the entire area.

This method has four limitations: (i) repeated manual counting prolongs the process and increases manpower; (ii) accuracy depends on individuals, and items of the same model are easily confused; (iii) there is no visual tool to quickly distinguish items already checked from those missing; and (iv) in the sewing-line area, machines are transferred between teams according to order schedules, so location data in the records quickly become outdated. The fourth limitation is specific to garment enterprises compared with many other industries. Table 2 compares the manual process with the code-scanning process.

Table 2. Comparison of the manual inventory process and the code-scanning process

Criterion	Manual process	Code-scanning process
Equipment identification	Manual counting and visual observation	Scanning the QR code on the label attached to each item
Data reconciliation	Manual reconciliation with records after counting	Automatic reconciliation using conditional formatting
Identification of missing items	Not identifiable individually; the whole area must be re-checked	Displayed visually (colour highlighting) immediately after scanning
Inventory time and manpower	High, owing to repeated counting and reconciliation	Potentially reduced by narrowing the scope of re-checking (not yet measured quantitatively)
Likelihood of restarting the inventory	High when discrepancies are found	Limited; only unconfirmed items are re-checked
Suitability for machines transferred according to orders	Limited; location data quickly become outdated	Flexible when data are organized by team and sewing line

Source: Compiled by the author from the survey at the case company.

2.4. Design and operation of the code-scanning solution

Hardware and software. The solution uses a Brother PT-P900W label printer connected to a computer via USB, which supports automatic cutting after each label; the label design software supplied with the printer (P-touch Editor), which can be linked to a spreadsheet file for batch printing; a handheld scanner that supports QR codes, connects to the computer, and operates in keyboard-emulation mode for on-site scanning; and a common spreadsheet application as the database. A spreadsheet was chosen instead of dedicated asset management software because it is low-cost, flexible, and consistent with employees' existing office-software skills, a common condition in garment SMEs.

Identification labels. Each label measures 50 mm × 24 mm and contains five fields: the name of the managing unit; the asset name; a QR code linked to the asset code; the asset code, structured as “year put into use.sequence number within the year” (e.g., 2024.23); and the year of use. This code structure indicates the time of investment while ensuring that codes are unique and sequential. QR codes were chosen over one-dimensional barcodes because they store the asset code in a small area and remain readable when the label is dusty or partially faded [14], which suits the lint-laden environment of garment workshops (Figure 1). The label shown in Figure 1 belongs to an auxiliary item (an air conditioner) in the company's fixed-asset list; sewing and special-purpose machines use the same template. The template is linked to the data file for batch printing of marked records, which allows labels for new equipment to be printed without affecting records that have already been printed (Figure 2).

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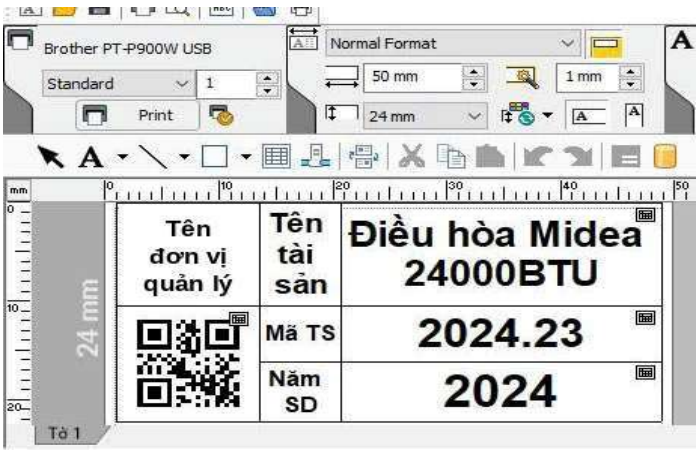

Figure 1. Label design interface showing the information fields and the QR code (field names on the label are in Vietnamese: managing unit, asset name, asset code, and year of use)
Source: Author.

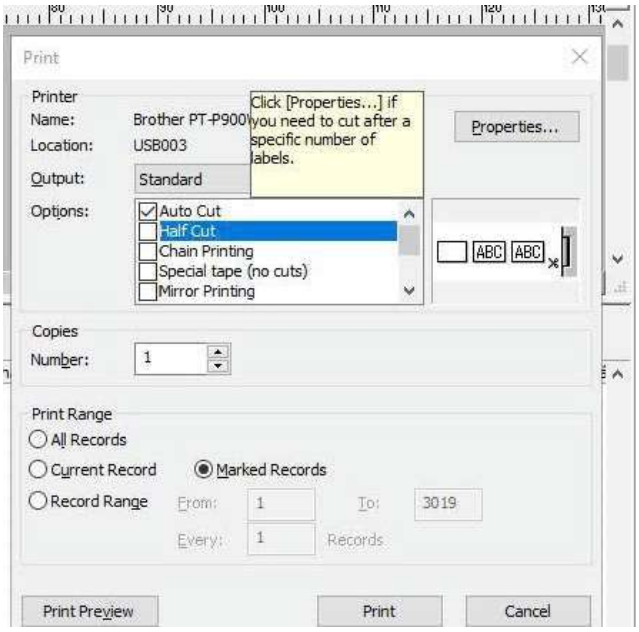

Figure 2. Label print dialog with the Marked Records print-range option; the linked data file has a record range of 1 to 3019
Source: Author.

Database. The database is built consistently in a spreadsheet, with each record corresponding to one asset unit. The data volume at the case company is large: the data file linked to the label template contains 3,019 records, as shown by the record range of 1 to 3019 under Print Range in the print dialog (Figure 2). The structure of the main fields is presented in Table 3. The historical cost field is retained because machinery and equipment are recognized as fixed assets whose historical cost must be tracked on fixed-asset cards and registers [9], [11]; the new asset code on the label is used consistently with the code on the fixed-asset card. For garment enterprises, "current team/line" and "status" fields should be added to support the tracking of transfers and maintenance. Standardizing the data structure and asset codes from the outset is a prerequisite for later expansion and integration with fixed-asset accounting or maintenance management systems, in line with the principles of life-cycle asset management [1].

Table 3. Structure of the main fields in the database

Field	Meaning	Example
Asset name, characteristics, and model	Name and basic technical characteristics	Single-needle electronic sewing machine
Country of manufacture	Origin of the equipment	Japan
Year put into use	Time when use began at the company	2024
Old / new asset code	Code before digitization; unique identifier structured as year.sequence number	2024.23

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Field	Meaning	Example
Quantity, historical cost	Number of asset units in the record; value when put into use	1
Managing/using unit	Fixed area, or team/line currently using the equipment	Sewing line 2
Status (proposed addition)	In use, awaiting repair, awaiting disposal	In use

Source: Author; values in the Example column are illustrative.

Scanning and reconciliation. During an inventory, staff scan the QR code on the label of each item on site. The scanner acts as a keyboard: with each scan, the asset code contained in the QR code is entered into the selected cell followed by the Enter key, and the cursor automatically moves to the next cell. Each data file contains two worksheets: the DanhMuc (master list) sheet, which contains the original list (one asset per row, with the asset code in column D), and the Quet (scan) sheet, where staff place the cursor in column A and scan the items one after another. The asset-code columns in both sheets are formatted as text before data entry, because if they are left as numbers, the spreadsheet automatically converts the code "2024.10" to 2024.1, which duplicates the code of item number 1 of 2024. Scanned data are reconciled with the master list using the COUNTIF function combined with conditional formatting (Table 4): confirmed items keep a white background, while unconfirmed items are highlighted as a warning; duplicate scans and codes not in the master list are highlighted separately in the Quet sheet for handling. A status column allows the list of unconfirmed items to be filtered for re-checking and for preparing the inventory minutes. As a result, staff can immediately identify the group of items requiring re-checking without reviewing the entire list.

Table 4. Rules for reconciling scanned data in the spreadsheet

Purpose	Range	Formula or rule	Display and handling
Flag unconfirmed equipment	DanhMuc sheet, data rows	Conditional formatting rule: =COUNTIF(Quet!$A:$A,$D2)=0	Green fill; scanned items keep a white background
Status for filtering and inventory minutes	DanhMuc sheet, status column	=IF(COUNTIF(Quet!$A:$A,$D2)>0,"Confirmed","Unconfirmed")	Filter by "Unconfirmed" for re-checking
Detect duplicate scans	Quet sheet, column A	Conditional formatting rule: =COUNTIF(A2:$A2,$A2)>1	Yellow fill; delete the repeated scan row
Detect codes not in the master list	Quet sheet, column A	Conditional formatting rule: =COUNTIF(DanhMuc!$D:$D,$A2)=0	Red fill; check equipment transferred in, new equipment not yet updated, or old labels

Source: Author; formulas follow common spreadsheet syntax, assuming the asset code is in column D of the DanhMuc sheet and data start from row 2.

Figure 3 summarizes the process, which comprises a deployment cycle (design, printing, label attachment, data updating, and operation) and a periodic inventory cycle (scanning, reconciliation, status marking, and re-checking and reporting); when a label is found to be missing or damaged, the process returns to the design step and a new label is printed. The process does not completely eliminate the need for manual searches for equipment that is lost, disposed of but not yet updated, or missed during scanning, but it significantly narrows the scope of re-checking.

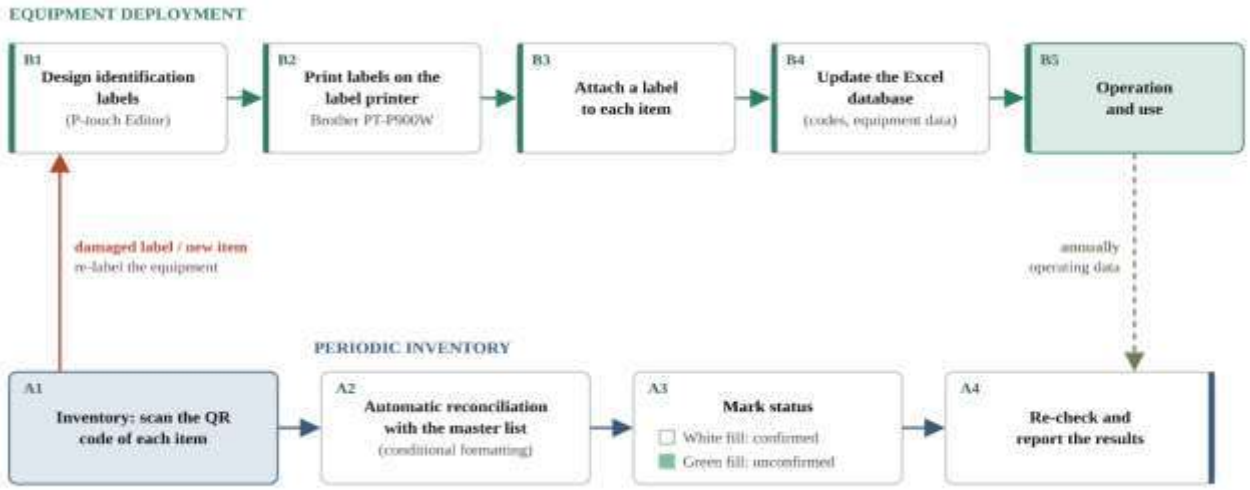

Figure 3. Machinery management process using label printing and code scanning
Source: Author.

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2.5. Deployment organized by area of use

The implementation showed that data should be organized in two ways, corresponding to how stable equipment locations are (Figure 4). In areas where equipment is rarely moved (in garment enterprises, the materials warehouse, cutting room, and technical–mechanical and electrical department), data are managed by area, with a separate file for each, and scanning and reconciliation are performed on site; this clarifies responsibilities, but staff must carry a laptop to synchronize data in each area. In the sewing-line area, sewing and special-purpose machines are transferred between teams according to order schedules, so data are organized and updated by team and line rather than by fixed location, reflecting the actual situation at the time of the inventory. Under this mode, a scanned code that is not on the team's list (the fourth rule in Table 4) usually indicates a machine recently transferred from another team; the team leader confirms it and updates the "current team/line" field in the database. This second mode is the main distinguishing feature of applying code scanning in garment enterprises.



Figure 4. Two modes of data organization according to the area in which machinery is used
Source: Proposed by the author based on the case study.

To ensure consistent operation, responsibilities are assigned to each position. Table 5 presents the proposed allocation for positions common in garment SMEs.

Table 5. Allocation of responsibilities in the code-scanning process

Position	Main responsibilities	Timing
Technical–mechanical and electrical department or fixed-asset accountant	Standardize the label template and data structure; consolidate and reconcile data company-wide; plan and report inventories	When setting up the system; each inventory period
Heads of the warehouse, cutting room, and technical department	Manage the area's data file; coordinate labelling and scanning; confirm the status of equipment	Each inventory period; when new equipment arrives
Sewing team leaders	Update machine transfers by team; coordinate scanning; confirm the machines present in the team	When machines are transferred; each inventory period
Mechanics and warehouse staff	Print and attach labels for new equipment or replace damaged labels; help resolve scanner issues	When equipment is received; when labels are damaged

Source: Proposed by the author based on the case study.

2.6. Extension to materials and spare parts management

At the case company, code scanning has so far been applied only to machinery and equipment. Using the same infrastructure (label printer, scanner, and spreadsheet), the author proposes extending it to materials and spare parts management in garment SMEs (Table 6). Unlike machinery, which is labelled unit by unit, materials have low value and large quantities, so labels are attached to storage locations (shelf bins or boxes) or batches, with each code representing one type of material. When materials are issued for replacement, the mechanic scans the material code and then the machine code, so that each issue is linked to a specific machine; this builds a repair history for analysing frequently failing machines and planning maintenance. Enterprises can use smartphones with a scanning application instead of dedicated scanners to reduce initial costs.

Table 6. Proposed applications of code scanning in materials and spare parts management

Operation	Implementation	Expected benefits
Goods receipt	Scan the storage-location code and the material code, then enter the quantity	Stock updated upon receipt; fewer recording errors
Issue of materials for repair	Scan the material code and the code of the machine being repaired	Materials linked to each machine; repair history established

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Operation	Implementation	Expected benefits
Materials inventory	Scan each location and reconcile actual quantities with the stock recorded in the spreadsheet	Quick identification of locations with discrepancies
Minimum stock alert	Conditional formatting when stock falls below the minimum level	Proactive purchasing of frequently used spare parts
Tracking frequently failing machines	Aggregate the number of material issues by machine code	Support for decisions on repair, replacement, or disposal

Source: Proposed by the author.

2.7. Evaluation of results and applicability

Over the 2024 and 2025 inventories, the code-scanning process allowed the group of unconfirmed equipment to be identified visually and immediately; when discrepancies arose, staff re-checked only this group instead of recounting the entire area as under the previous process. Organizing data by team and line in the sewing-line area ensured that the data reflected machine locations at the time of the inventory, overcoming the fourth limitation of the previous process. These results are consistent with studies on the effectiveness of automatic identification in asset and inventory management [2]–[4]. However, this is a qualitative assessment based on actual implementation; reductions in inventory time and manpower have not been measured quantitatively owing to the lack of systematic baseline data from manual inventories.

The implementation also showed that participants needed time to become familiar with scanning and with handling faded or peeling labels and new equipment not yet labelled; short training sessions, operating instructions for each group, and a clear allocation of responsibilities (Table 5) shortened the adaptation period. Regarding applicability in garment SMEs, the solution does not require complex infrastructure; initial costs consist mainly of a label printer, a scanner or smartphone, and label supplies, which suits SMEs constrained by cost and technological skills [6]. Enterprises should start with one sewing line or one group of machines, standardize asset codes, and then expand to the whole factory and to materials management.

2.8. Limitations and future research

The study has several limitations. First, the spreadsheet-based database operates locally, which poses risks related to backup, synchronization, and version control when several people update it, especially on sewing lines where data change frequently; possible remedies are centralized storage on an online sharing platform or migration to asset management software as scale increases. Second, effectiveness depends on labels being fully attached in the correct positions and on their durability in an environment with lint dust and machine oil. Third, the results were evaluated at a single company, are qualitative, and lack quantitative data on time, manpower, and cost; the materials management component is a proposal that has not been validated in enterprises. Future research should pilot the solution in several garment SMEs, measuring inventory time, discrepancy rates, investment costs, and payback periods before and after adoption; at the case company, recording the number of participants, labour hours, and discrepant items in the 2026 inventory will provide a basis for quantitative evaluation.

3. CONCLUSION AND RECOMMENDATIONS

Regarding RQ1, the manual management process has four main limitations: it is time- and labour-intensive owing to repeated counting; similar items are easily confused; there is no tool for quickly identifying missing items; and location data quickly become outdated for machines transferred according to orders. Regarding RQ2, the solution comprises QR-coded labels printed with a label printer, a spreadsheet database, and a scanning procedure with automatic reconciliation using conditional counting functions and conditional formatting; the qualitative assessment shows that it immediately identifies unconfirmed equipment, narrows the scope of re-checking, and limits repeated inventories, while reductions in time and manpower require quantitative verification. Regarding RQ3, the paper proposes an adoption model for garment SMEs comprising two data organization modes (by fixed area and by sewing line), an allocation of responsibilities by position, and a proposed extension to the receipt and issue of materials and spare parts linked to each machine.

The solution requires low initial investment, is easy to operate, and can be implemented step by step, making it suitable for the resource conditions of garment SMEs. The findings provide a reference for enterprises seeking to standardize machinery and materials management and to build digital transformation roadmaps.

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