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# Material Rejects at the Warehouse–Production Interface: Root Causes and a Proposed Quality Improvement Strategy in a Manufacturing Company

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## ABSTRACT

Material rejects at the interface between the warehouse and the production line raise rework, delay production schedules, and waste materials. This study analyzes the causes of material rejects in PT. ABC, a manufacturing company, and proposes improvement strategies to reduce them. A descriptive qualitative design was applied. Data were collected through direct observation, semi-structured interviews with quality control and production personnel, and a review of inspection records and reject reports during an industrial internship. The causes were classified with a fishbone (Ishikawa) diagram based on the 5M+1E framework (man, method, material, machine, measurement, and environment) and analyzed through data condensation, data display, and conclusion drawing. Two recurring reject cases were examined: defective wire components that escaped incoming inspection and required rework of about 50–100 production units per week, and polycarbonate (Lexan) sheets damaged during storage, about 5–10 sheets per week (20–40 per month). Method and man causes were dominant, namely inconsistent application of the inspection procedure and high workload; unsuitable packaging of fragile materials, poor warehouse organization, the absence of dedicated racks, and the absence of explicit acceptance criteria were contributing causes, and weak communication between quality control and production linked several categories. The proposed strategy combines an inspection-before-release rule with supplier feedback, competency training for quality control personnel, workload balancing during peak periods, standardized protective packaging, 5S workplace organization, and periodic warehouse audits. These strategies have not yet been implemented. The study suggests that reject prevention should begin at material receiving and storage, not at the assembly line.

**Keywords**: 5S methodology; fishbone diagram; quality control; reject material; root cause analysis; warehouse management

## Introduction

Product quality is a central element of competitiveness for manufacturing companies operating in dynamic markets. Products that consistently conform to specifications improve customer satisfaction and, at the same time, support operational efficiency by reducing waste, rework, and avoidable costs. For this reason, operations management treats quality not only as an inspection activity at the end of a process but as a capability that must be designed into every stage of the material flow, from the receipt of purchased materials to the delivery of finished goods [1].

One of the most visible indicators of quality performance is the proportion of rejected items. Reject products are materials, components, or finished goods that do not meet predetermined quality standards and therefore cannot be accepted by the next process or by the customer [2]. High reject rates increase production costs, consume additional labor for rework, delay production schedules, and reduce productivity. Rejects that originate in material flows also disturb inventory availability and increase procurement needs, which places additional pressure on the logistics system that supports

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production [3]. Inventory studies in Indonesian companies have likewise shown that defective deliveries and stock shortages reduce the effectiveness of inventory management [4].

Quality control (QC) at the point of material receipt plays a key role in preventing defective items from entering production. Incoming inspection verifies that purchased materials conform to technical specifications before they are released to production lines, and structured sampling plans such as ANSI/ASQ Z1.4 provide a formal basis for accepting or rejecting incoming lots [5]. Standard operating procedures (SOPs) translate these requirements into consistent routines for inspectors and warehouse personnel, and the effectiveness of SOP implementation has been evaluated as a determinant of consistent work performance [6]. When inspection procedures are applied inconsistently, defective materials can remain undetected until assembly has begun, at which point correction is considerably more expensive. Incoming inspection, however, only screens materials; it does not prevent defects from being produced. Defects in purchased components originate in the supplier's process, so supplier quality management, such as supplier evaluation, corrective action requests, and supplier certification, complements incoming inspection by addressing the source of defects, while acceptance sampling plans define the sample size and acceptance number that make inspection decisions consistent [5], [33].

The warehouse itself is also a source of quality loss. In a warehouse receiving process, a Six Sigma study recorded a defect rate of 10.50% and traced it to material handling, storage practices, and storage condition control [7]. In a plastic manufacturing company, the main causes of defects that occurred during storage included excessive stacking, high warehouse temperature, and poor SOP compliance [8]. Conversely, combining a class-based storage layout with first-in, first-out (FIFO) rules and SOPs reduced the number of damaged and expired products in a retail storage system from 46 to 9 units [9]. These findings show that storage and handling decisions can create or prevent rejects long before materials reach the production line.

PT. ABC faces this problem in its production warehouse. Field observations during an industrial internship identified two recurring reject cases. The first concerned wire and cable components that were released to production without complete QC inspection. Because the defects were detected only during assembly, approximately 50–100 production units had to be reworked within one week, which delayed production schedules and increased labor costs. The second concerned lexan, a polycarbonate sheet material used in production assemblies (Lexan is a trade name of polycarbonate sheets). Approximately 5–10 lexan sheets were damaged each week, or 20–40 sheets per month, mainly because of improper storage positions and inadequate warehouse organization. Polycarbonate sheets are highly impact-resistant, but their surfaces scratch easily, so they require protective film and orderly storage, so their damage is a direct indicator of warehouse management practices.

Root cause analysis is required to move from these symptoms to their underlying causes. The fishbone diagram, also known as the Ishikawa or cause-and-effect diagram, organizes possible causes of a quality problem into categories so that a team can examine them systematically, and it is frequently combined with the 5 Whys technique to reach the deepest cause [10]. In Indonesian industrial practice, the fishbone diagram has been applied together with control charts and failure mode and effects analysis (FMEA) to reduce production defects [12], together with statistical quality control to analyze product defects [13], and on its own to explain goods damage in crossdocking operations, where the proposed improvements reduced the damage rate by 31% [14]. In warehouse settings, the combination of the fishbone diagram and 5 Whys has traced label stock discrepancies to human, method, machine, material, and environment factors [15] and has linked operational inefficiency to weak SOP adherence and an uneven distribution of tasks [16].

The 5S methodology (*seiri*, *seiton*, *seiso*, *seiketsu*, and *shitsuke*: sort, set in order, shine, standardize, and sustain) is a widely used tool for organizing workplaces and supporting quality awareness. Warehouse studies show, however, that 5S is often only partially implemented. In a logistics service warehouse, *seiton* and *seiketsu* were not fully applied [17]; in another warehouse, the arrangement and standardization stages were the weakest [18], while in a central warehouse only the standardize and sustain stages functioned well [19]; and in manufacturing, standardization and discipline were difficult to sustain after initial gains [20]. An action research study of a warehouse that could not stop its operations found that 5S programs can stall at the first three steps when planning, team composition, and management support are not aligned [21], while integrating 5S and FIFO within a DMAIC framework improved space utilization and stock accuracy [22]. In a spare parts warehouse, 5S combined with a new layout cut the average time needed to find parts by more than one third [23]. For fragile materials, the set-in-order step is the most directly relevant to reject prevention, because it assigns dedicated locations and stacking rules that keep heavy items off fragile ones, while the standardize and sustain steps turn these rules into routines.

Previous studies have therefore examined reject reduction through quality control tools, Lean methods, and Six Sigma, but most of them focus either on production processes or on a single warehouse practice. Relatively few studies link root cause analysis of material rejects with the combination of incoming inspection, SOP compliance, workload, packaging, and 5S organization within the production warehouse, which is the first stage of the material flow into production. This gap is relevant for industrial management because weaknesses at this stage can increase defects on the assembly line even when manufacturing processes themselves are well established. From a quality cost perspective, prevention and appraisal at the receiving and storage stages are less expensive than internal failures such as rework on the assembly line [33]. The warehouse also acts as an internal supplier whose output quality determines the performance of its internal customer, the production line. Treating the warehouse–production interface in this way shifts the focus from inspecting assembled products to building quality at the source.

This study addresses this gap by treating the production warehouse as a source of reject materials and by analyzing its causes with a fishbone diagram based on the 5M+1E framework. The objectives of this research are (1) to identify and classify the factors that cause material rejects in the production warehouse of PT. ABC and (2) to formulate practical improvement strategies covering SOP compliance, QC competency, workload allocation, packaging standards, 5S workplace organization, and periodic warehouse audits. The novelty of the study lies in its integration of these elements into one improvement framework that starts from material receiving and storage rather than from the assembly line, and in two propositions derived from the analysis for further testing: that workload weakens compliance with inspection procedures, and that defect escape at incoming inspection, rather than defect occurrence in the warehouse, links warehouse weaknesses to rework on the assembly line.

## Methods

### Research Design and Setting

This study employed a descriptive qualitative design to identify the root causes of material rejects in the production warehouse of PT. ABC and to formulate improvement strategies. A qualitative approach was selected because it allows an in-depth understanding of operational problems, employee practices, warehouse conditions, and quality control activities that cannot be fully explained through quantitative measurement alone [24]. The research was conducted in the production warehouse, focusing on the receiving, inspection, storage, and distribution activities that directly supply

production. The unit of analysis was the reject material, specifically the two cases that most frequently caused rework and production delays: wire components and lexan sheets.

### Data Collection

Primary data were collected through direct observation, semi-structured interviews, and documentation review. Direct observation examined the warehouse layout, material handling procedures, inspection activities, storage practices, and employee work routines. It also focused on conditions related to rejects, including warehouse organization, compliance with SOPs, packaging methods, and inventory handling. Observation provides factual evidence of operational practices under actual working conditions and is therefore widely used in operations and warehouse studies [1].

Semi-structured interviews were conducted with personnel from the QC and production departments to obtain information on inspection procedures, causes of rejects, communication between departments, and daily operational challenges. The interviews also explored how employees perceived SOP implementation, workload distribution, and inspection practices. Documentation review covered inspection records, warehouse documents, reject reports, and production records, which were used to verify the findings obtained from observation and interviews.

### Fishbone Diagram and the 5M+1E Framework

The fishbone diagram places the problem under study at the head of a horizontal spine and arranges its possible causes along diagonal bones, each representing one category of causes. Sub-causes are attached to each bone and can be questioned further, for example with the 5 Whys technique, until a cause is reached that management can act on [10]. Because the diagram makes all categories visible at once, it reduces the risk of focusing only on the most obvious cause, and it provides a structure for discussion with the employees who know the process best [10]. In this study the 5M+1E framework was adapted to the warehouse context, as defined in Table 1.

Table 1. Fishbone categories adapted to the production warehouse context

| Category | Scope of causes examined in the warehouse |
|---|---|
| Man | Competency, workload, concentration, and staffing of QC and warehouse personnel |
| Method | Inspection procedures, SOPs, release rules, and handling and storage routines |
| Material | Characteristics, packaging, and protection of incoming and stored materials |
| Machine | Material handling equipment, racks, and other warehouse equipment |
| Measurement | Inspection instruments, acceptance criteria, and records of inspection results |
| Environment | Housekeeping, layout, space availability, and storage conditions |

(Source: adapted from [10])

### Data Analysis

The main analytical tool was the fishbone diagram based on the 5M+1E framework, which classifies potential causes into six categories: man, method, material, machine, measurement, and environment [10]. The analysis began by defining the problem, namely material rejects in the production warehouse, which forms the head of the diagram. Contributing factors identified in the field were then grouped into the six categories, and each factor was examined to determine its influence on material quality and warehouse performance. A cause was regarded as dominant when it was supported by at least two of the three data sources and was directly linked to one of the two reject cases; causes supported by one data source were regarded as contributing causes. All six categories were examined in the observations and interviews.

The qualitative data were analyzed with the interactive model of Miles, Huberman, and Saldaña, which consists of data condensation, data display, and conclusion drawing and verification [25]. In the condensation stage, observation notes, interview results, and documents were coded according to the fishbone categories. In the display stage, the coded findings were presented as descriptive explanations, summary tables, and the fishbone diagram to show the relationships among contributing factors. In the final stage, dominant causes were identified by triangulating the three data sources, and improvement strategies were formulated with reference to warehouse management principles, quality control practices, SOPs, and the 5S methodology [6], [17], [26].

Overall, the research followed six sequential stages, as shown in Figure 1: problem identification, data collection, root cause analysis with the fishbone diagram, determination of dominant causes, formulation of improvement strategies, and conclusions and recommendations. This sequence links each recommendation directly to a verified cause.

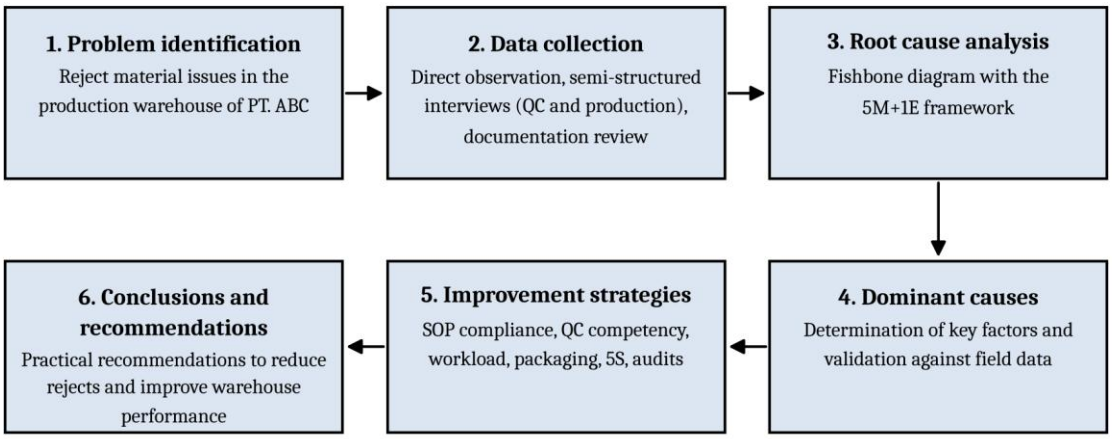



Figure 1. Research framework

## Results and Discussion

### Existing Condition of Material Rejects

Observation in the production warehouse of PT. ABC identified two main reject cases that significantly affected production performance: wire components and lexan sheets. Both materials are essential inputs to production, so defects that occur before assembly directly affect production continuity and efficiency.

Rejected wire components mainly resulted from QC inspections that were not consistently carried out in accordance with the established SOP. As a result, defective components passed the receiving stage and were identified only during assembly. This required rework on approximately 50–100 production units within one week, which lengthened production lead time and increased operational costs. Communication gaps between QC personnel and production supervisors further delayed the identification of defective materials. The defects themselves originated in the purchased components; the warehouse-related cause concerns their escape to assembly rather than their occurrence, which is why the fishbone analysis below focuses on why defective components were not detected before release.

Lexan sheets were the second most frequently rejected material. Lexan is a polycarbonate sheet: it is highly impact-resistant, but its surface scratches easily when sheets rub against one another or are

dragged during handling. The warehouse stored them without adequate protection, so sheets frequently came into contact with one another and with other items during handling and storage. Approximately 5–10 lexan sheets were damaged each week, or 20–40 sheets per month. Damaged sheets could not be used in production, which created unnecessary material waste and reduced production efficiency. Table 2 summarizes the two reject cases and their main operational impacts.

Table 2. Summary of reject materials identified during observation

| Reject material | Estimated volume | Main impact |
|---|---|---|
| Wire component | 50–100 units requiring rework per week | Rework, production delay, additional labor cost |
| Lexan sheet | 5–10 sheets per week (20–40 per month) | Material waste, interruption of production |

(Source: processed field observation data)

These findings indicate that the rejects did not originate in the production process alone. They were closely associated with warehouse management practices, inspection procedures, storage conditions, and communication between operational departments. The result is consistent with studies that trace defects to the receiving and storage stages of the warehouse [7], [8] and with the observation that defective deliveries reduce the effectiveness of inventory management [4].

### Root Cause Analysis Using the Fishbone Diagram

To identify the underlying causes systematically, the contributing factors were mapped onto a fishbone diagram based on the 5M+1E framework. This approach classifies multiple factors into logical categories and directs attention to root causes rather than to visible symptoms [10]. Figure 2 presents the resulting diagram, and Table 3 summarizes the causes, the evidence that supports them, and the reject case each one affects.

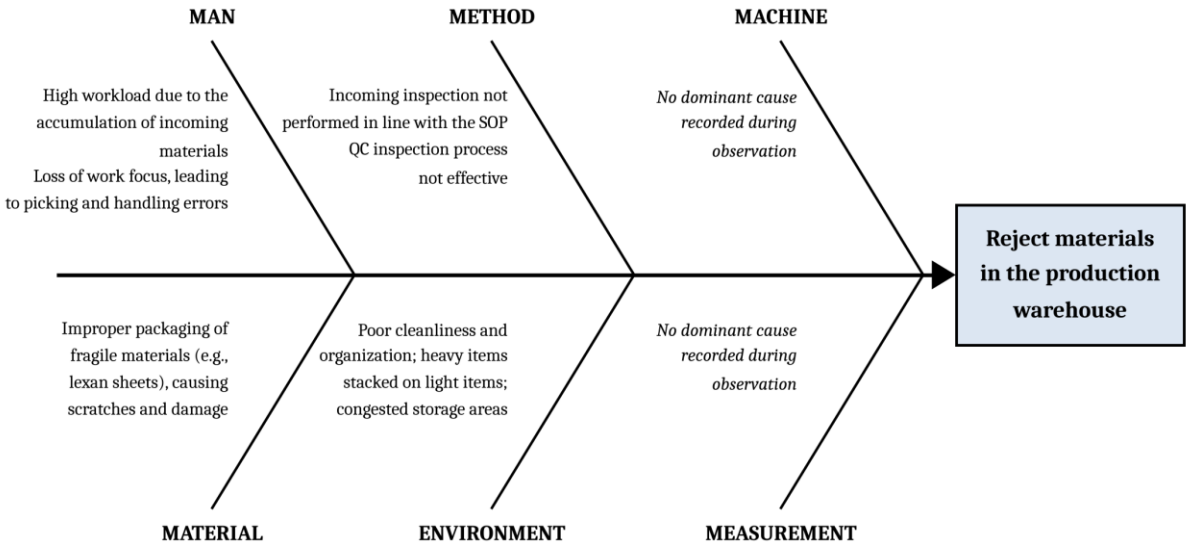



Figure 2. Fishbone diagram of the causes of material rejects in the production warehouse

The analysis found causes in all six categories. Method and man were the dominant categories, because their causes were supported by at least two data sources and were directly linked to the wire component case. Material, environment, machine, and measurement causes were contributing causes supported mainly by observation. Machine and measurement were initially not regarded as sources of rejects, because no equipment failure or faulty measuring instrument was found; however, the absence

of dedicated racks for fragile sheets and the absence of explicit acceptance criteria at incoming inspection fall within these two categories as defined in Table 1.

Table 3. Classification of reject causes by fishbone category

| Category | Identified cause | Evidence | Reject case affected |
|---|---|---|---|
| Method | Incoming inspection not performed in line with the SOP; materials released before inspection was completed; no status identification of uninspected lots and weak QC–production communication | Observation, interviews, inspection records | Wire component |
| Man | High workload from accumulated incoming materials; loss of focus leading to picking and handling errors | Observation, interviews | Wire component, lexan sheet |
| Material | Fragile materials repacked in unsuitable plastic instead of protective wrapping | Observation | Lexan sheet |
| Environment | Poor housekeeping; heavy items stacked on light items; congested storage areas | Observation | Lexan sheet |
| Machine | No dedicated racks or separators for fragile sheet materials | Observation | Lexan sheet |
| Measurement | No explicit acceptance criteria (sample size, acceptance number) applied at incoming inspection | Observation | Wire component |

(Source: processed observation, interview, and documentation data)

### *Method factors*

Under the method category, the incoming inspection procedure was not applied consistently. Inspection by QC personnel was not always completed before materials were released to production lines, so defective wire components could proceed to assembly. This is the direct cause of the rework of 50–100 units per week. The finding agrees with studies that place SOP effectiveness at the center of consistent operational performance [6] and with quality control studies in which SOPs and better raw material handling were recommended after fishbone analysis [12]. It also shows that the existence of a procedure is not sufficient; formal acceptance rules, such as a defined sample size and acceptance number for each incoming lot [5], must be applied before release.

### *Man factors*

Under the man category, high workload and insufficient staffing reduced employee concentration during inspection and material handling. Warehouse personnel often handled several responsibilities at the same time, especially when incoming materials accumulated, which increased the likelihood of inspection errors and incorrect handling. Workload studies offer a useful explanation for this condition. In one warehouse, staff regularly worked overtime beyond the legal limits, and workload analysis showed that additional checkers and forklift operators were required [27]; among warehouse workers in Batam, working hours and workload were significantly correlated with fatigue, which was reported by 72% of the workers studied [28]; and the full time equivalent method has been used to determine whether staffing levels match the actual workload [29]. Research on inspection work points in the same direction: fatigue and declining vigilance during repetitive inspection allowed missing-part defects to pass undetected [30], and mental workload was directly associated with human error among manufacturing employees [31]. At PT. ABC, workload therefore appears to act as an underlying cause that weakens compliance with the inspection method, although no workload data were collected to confirm this relationship.

### *Material factors*

The material factor mainly concerned unsuitable packaging. Fragile materials such as lexan were frequently repacked in ordinary plastic instead of protective wrapping, so scratches and other physical damage occurred during internal transport and storage. A similar pattern was reported in crossdocking operations, where packaging that did not protect goods was one of the dominant causes of damage [14]. Packaging that matches material characteristics is therefore a basic requirement for preserving the quality of fragile materials.

### *Environment factors*

The environment factor also contributed to rejects. Observations revealed poor housekeeping, irregular material placement, and inadequate storage organization. Heavy materials were sometimes stacked on lighter ones, which increased the probability of physical damage, and congested storage areas made retrieval more difficult and increased handling risks. Excessive stacking and weak SOP compliance were likewise identified as causes of storage defects in plastic manufacturing [8], and an orderly storage system has been shown to reduce product damage substantially [9]. Stacking heavy items on light ones also reflects the absence of a stacking rule, so this cause overlaps with the method category. These findings confirm that warehouse organization influences both product quality and operational efficiency.

Taken together, the fishbone analysis shows that the rejects resulted from several interrelated organizational factors rather than from a single operational failure. The method and man factors explain why defective wire components reached assembly, while the material and environment factors explain why lexan sheets were damaged in storage. Corrective actions should therefore address both people and processes rather than rely on isolated technical interventions.

The findings also point to a cross-cutting weakness that is not confined to one category: communication between QC personnel and production supervisors. As described above, communication gaps between the two functions delayed the identification of defective wire components. This weakness links the method and man factors. When an overloaded inspector cannot complete an inspection before materials are requested, the material may be issued without the production side knowing its inspection status, and defects then surface only during assembly. Clear status identification of incoming lots, such as labels or a designated area for uninspected materials, together with routine coordination between the warehouse, QC, and production, would reduce this risk at low cost. Such arrangements are consistent with the role of warehouse audits in detecting procedural weaknesses before they cause losses [26].

## Comparison with Previous Studies

Table 4 compares the present findings with recent studies that applied root cause analysis or 5S in warehouse and quality control settings. Three patterns emerge. First, procedural weaknesses, particularly incomplete SOPs or weak compliance, appear in almost every case, whether in crossdocking [14], storage of plastic products [8], or production quality control [12]. Second, damage to materials during storage is repeatedly associated with packaging and stacking practices, which confirms the material and environment findings at PT. ABC. Third, 5S programs in warehouses are often implemented only partially: set in order and standardize were not fully applied in a logistics service warehouse [17], arrangement and standardization were the weakest stages in another warehouse [18], and in a central warehouse only standardize and sustain functioned well [19]. This suggests that the 5S strategy proposed here should plan every step explicitly rather than assume that early gains will be sustained.

The present study differs from these studies in two respects. It examines rejects that cross the boundary between the warehouse and production, so that a single weakness at incoming inspection becomes visible only as rework on the assembly line. It also connects human factors, specifically workload, with procedural compliance, suggesting that the method failure at PT. ABC may partly be a consequence of staffing pressure rather than of a lack of procedures alone.

Table 4. Comparison with previous studies

| Study | Setting and method | Main causes or findings |
|---|---|---|
| Chair and Aryanto [14] | Crossdocking, auto parts distributor; fishbone | Low worker competence, unsuitable packaging, no standard SOP; damage rate reduced by 31% after improvement |
| Sinaga et al. [8] | Storage in plastic manufacturing; Pareto and root cause analysis | High warehouse temperature, excessive stacking, poor SOP compliance |
| Febriansyah and Siswiyanti [7] | Warehouse receiving; Six Sigma DMAIC | Defect rate of 10.50%; improvements to handling, storage, and storage conditions |
| Kusuma et al. [12] | Sugar factory; control chart, fishbone, FMEA | Process in control; SOPs and better raw material handling recommended |
| Candrianto et al. [17] | Logistics service warehouse; 5S assessment | Set in order and standardize not fully applied |
| Hafiduddin and Rahmawati [19] | Central warehouse; 5S+Safety | Only standardize and sustain functioned well |
| This study | Production warehouse, PT. ABC; fishbone 5M+1E | Inconsistent inspection SOP, high workload, unsuitable packaging, poor organization, no dedicated racks or explicit acceptance criteria |

(Source: compiled from the cited studies and processed research results)

**Improvement Strategies**

Based on the fishbone analysis, six improvement strategies were formulated to reduce material rejects and improve warehouse performance. They emphasize preventive quality management, that is, preventing defects at their source rather than correcting them after they occur. Table 5 links each strategy to the root cause it addresses.

The first strategy is to strengthen compliance with the inspection SOP. Every incoming lot should be inspected and its status recorded before it is released to production, and QC personnel should document inspection results so that defects can be traced to their source. Supervisors should conduct routine checks on SOP compliance across warehouse operations, and the acceptance criteria should be stated explicitly in the procedure [5], [6]. In practice, this rule can be enforced with a quarantine area and status labels for uninspected, accepted, and rejected lots, a block in the inventory system that prevents uninspected materials from being issued, and a written sampling plan for each component type. Because the wire defects originate at the supplier, inspection results should also be fed back to suppliers through corrective action requests and periodic supplier evaluation, so that the source of defects is addressed rather than only their detection.

The second strategy is to improve the competency of QC personnel through periodic technical training on inspection techniques, defect identification, and problem solving. Job training has been analyzed as a means of improving employee performance [32], and in toy manufacturing, operator training combined with workstation and lighting improvements sharply reduced the number of defects that escaped inspection [30]. In the present case, the training should cover defect criteria for wire components, the use of reference samples, and lot rejection procedures, so that inspection results become more consistent and human error is reduced.

The third strategy is to balance workload by assigning sufficient personnel during peak receiving periods. A workload measurement, for example with the full time equivalent method [29], can be used to determine the required number of personnel. Balanced allocation reduces fatigue and improves concentration [28], thereby decreasing the errors in manual inspection and handling that are associated with high mental workload [31].

The fourth strategy is to standardize packaging according to material characteristics. Polycarbonate sheets such as Lexan should keep their protective film until the point of use, be stored vertically in dedicated racks or horizontally on flat pallets with separators, be lifted rather than slid off one another, and never be stacked under heavier items. These rules should be written into the storage procedure and supported by visual labels [8], [14].

The fifth strategy is to implement 5S consistently. Sorting removes unnecessary items, setting in order assigns fixed locations and stacking rules, shining keeps storage areas clean, standardizing turns these practices into written routines, and sustaining builds the discipline to maintain them. Because previous studies show that the set in order, standardize, and sustain steps are the most likely to fail [17]–[20], PT. ABC should plan these steps explicitly, involve warehouse staff in the program, and secure management support [21]. 5S can also be combined with FIFO rules and a DMAIC cycle to measure progress [9], [22].

The sixth strategy is to conduct periodic warehouse audits that evaluate compliance with warehouse procedures, storage standards, and inventory policies. A structured audit instrument such as a warehouse check-up enables early identification of operational weaknesses and supports continuous improvement [26]. Audit results should be shared with both the QC and production departments to close the communication gap identified in this study.

Table 5. Root causes and proposed improvement strategies

| Root cause | Proposed improvement |
|---|---|
| Inspection SOP not consistently applied | Strengthen SOP compliance, record inspection status before release, and supervise routinely |
| Ineffective QC inspection | Provide periodic technical training for QC personnel |
| High employee workload | Measure workload and add personnel during peak receiving periods |
| Improper packaging of fragile materials | Standardize packaging and storage rules according to material characteristics |
| Poor warehouse organization | Implement 5S consistently, supported by FIFO and fixed storage locations |
| Weak operational control and communication | Conduct periodic warehouse audits and share results with QC and production |

(Source: processed research results)

## Proposed Implementation Plan

To make the strategies actionable, Table 6 proposes a priority, a responsible function, and a monitoring indicator for each one. Priority is assigned qualitatively according to the operational impact of the reject case that the underlying cause explains and the effort required; because the two reject volumes are expressed in different units, a cost-based comparison is recommended once reject costs are recorded. Each indicator should first be recorded as a baseline, for example the current 20–40 damaged Lexan sheets per month and 50–100 reworked units per week, before targets are set. Actions that address the inspection-before-release rule and the protection of fragile materials are placed first because they correspond to the two largest reject cases, while 5S and audits are positioned as the

mechanisms that sustain the gains. The plan is a proposal derived from the analysis and has not yet been tested in the company.

Table 6. Proposed implementation plan and monitoring indicators

| Strategy | Priority | Responsible function | Monitoring indicator |
|---|---|---|---|
| Inspection-before-release rule and SOP compliance | 1 | QC, warehouse supervisor | Percentage of incoming lots inspected before release |
| Protective packaging and storage rules for fragile materials | 1 | Warehouse | Number of damaged lexan sheets per month |
| Technical training for QC personnel | 2 | QC, human resources | Rework units caused by undetected defects per week |
| Workload measurement and peak-period staffing | 2 | Warehouse, human resources | Ratio of workload to available working time |
| Consistent 5S implementation | 3 | Warehouse, all personnel | 5S audit score per area |
| Periodic warehouse audits | 3 | Management, QC | Number of audit findings closed on time |

(Source: processed research results)

### Managerial Implications

From an industrial management perspective, the results suggest that reject prevention should begin at the warehouse–production interface. Inspection discipline, staffing, packaging, and storage organization are management decisions rather than purely technical issues, so improvement requires coordinated responsibility between the warehouse, QC, and production functions. The six strategies are mutually reinforcing: training and balanced workload make SOP compliance feasible, while 5S and packaging standards reduce the handling risks that inspection alone cannot remove, and periodic audits sustain all of them over time. For PT. ABC, a reasonable sequence is to restore the inspection-before-release rule and the protective storage of lexan first, because these two actions address the causes of the largest reject volumes, and then to institutionalize 5S and audits. Progress should be monitored with simple indicators such as the weekly number of reworked units, the monthly number of damaged lexan sheets, and the percentage of incoming lots inspected before release. From a quality cost perspective, every defect stopped at receiving avoids the larger internal failure costs of rework and delay on the assembly line [33].

## Conclusion

This study analyzed the causes of material rejects in the production warehouse of PT. ABC using a fishbone diagram based on the 5M+1E framework. Two recurring reject cases were examined: defective wire components that escaped incoming inspection and required rework of approximately 50–100 production units per week, and polycarbonate (Lexan) sheets damaged in storage at approximately 20–40 sheets per month. Method and man causes were dominant, namely inconsistent application of the inspection SOP and high workload. Unsuitable packaging of fragile materials, poor warehouse organization, the absence of dedicated racks, and the absence of explicit acceptance criteria were contributing causes, and weak communication between QC and production linked several categories. These results are consistent with previous studies that link defects to weak quality control, storage practices, and process standardization [2], [8], [12].

The study proposes six integrated improvement strategies: stricter SOP compliance at incoming inspection, competency training for QC personnel, workload balancing during peak periods, standardized protective packaging, consistent 5S implementation, and periodic warehouse audits. Its

contribution lies in proposing an integrated framework of root cause analysis, SOPs, quality control, and 5S for preventing rejects at the warehouse stage, before materials enter the manufacturing line, and in two propositions for further testing: that workload weakens inspection compliance, and that defect escape at incoming inspection links warehouse weaknesses to rework on the assembly line.

This research is limited to a qualitative analysis in a single manufacturing company, conducted by a researcher who was an intern in the company, which may have influenced the observations. The reject volumes are estimates rather than measured rates, the supplier perspective was not covered, and the effect of the proposed strategies was not measured after implementation. Future studies are recommended to implement the strategies and evaluate them quantitatively with indicators such as reject rate, rework volume, inventory accuracy, and production lead time, for example within a DMAIC cycle, to provide stronger evidence of their long-term impact [1], [3]. Future studies could also evaluate the costs and benefits of the strategies, analyze supplier performance, and use quantitative root cause models, such as Bayesian networks learned from historical defect records [11].

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