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Quality Control of Shoe Products Using the New Seven Tools Method and Root Cause Analysis

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Abstract

This study aims to analyze and control product defects in shoes produced by PT XYZ using the New Seven Tools method and Root Cause Analysis (RCA). The research method applied is descriptive with both qualitative and quantitative approaches. Primary data were obtained through observations and interviews, while secondary data consisted of production documents and defect records collected from June 2024 to January 2025. The analysis results show that defect rates exceeded the company's standard threshold (2%), particularly in the sewing and lasting processes. By utilizing tools such as the Affinity Diagram, P-Chart, Tree Diagram, Matrix Diagram, and Process Decision Program Chart (PDPC), the study identified that the main contributing factors to defects stemmed from human, method, machine, material, and environmental aspects. RCA revealed that the root causes included insufficient training, non-compliance with standard operating procedures (SOP), suboptimal equipment, and unergonomic working conditions. The study proposed 33 improvement actions, of which 28 were deemed feasible for implementation. These findings are expected to help reduce the number of defective products and improve overall production quality.

Introduction

Competition in the industrial world is increasing significantly (Caglar et al., 2024; Apriyanti, 2024; Prasanna et al., 2024). Every company is competing to maintain its image in the market. Manufacturing companies need to maintain and increase consumer purchasing power by improving quality, quantity, price, and customer satisfaction. Customer satisfaction is the key to establishing good business relationships, building trust and maintaining loyalty. Product quality determines the success of market competition (Hussain et al., 2025; Hidayat et al., 2024; Skaf et al., 2024).. High-quality products are certainly the first choice for consumers. In addition, in the current era, consumers tend to prioritize good quality rather than choosing products that have high prices but low quality (Sayedi et al, 2023; Setyadi et al., 2024; Widjaja, 2025).

PT XYZ is a company engaged in the manufacturing industry, especially footwear or shoe products. The company was established more than 30 years ago in Surabaya. PT XYZ produces several types of shoes, namely leather shoes, running shoes, walking shoes, kids shoes, and futsal shoes. The shoe products produced by this company are marketed domestically and internationally. In recent years, competition in the shoe industry has intensified (Oliveira et al., 2024; Hsu et al., 2024; Musayeva et al., 2024). This is one of the

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challenges for the company to be able to maintain its existence in the local and international markets. PT XYZ as implemented several quality control methods, but still not maximized.

The company has established 100% quality control on each production line. In making shoes there are 5 (five) production lines which can be seen in Figure 1.

Figure 1. Shoe-making production flow

During the production period of June 2024 - January 2025 there were defects in each production line. The cutting production line has the highest defect rate of 1.3% of the total production of 18268 units. The screen printing production line has the highest defect rate 1.1% of the total production of 6036 units. The sewing production line has the highest 3.1% of the total production of 14318 units. On the lasting production line has the highest defect rate of 7.2% of the total production of 20879 units. The finishing and packing production line has the highest defect rate of 1.4% out of 18216 units. Based on the highest defect data, the company standard is 2%. It is known that the problem of shoe defects that exceed the standard is on the sewing production line and the lasting production line. Sewing production line with defect attributes (unravelled stitching, untidy stitches, and holes) and the lasting production line with defect attributes (wrinkles, imprecision, improper shape).

Quality control is a company's effort to maintain product quality in accordance with predetermined standards (Suwanda, 2024; Ahmed, 2024; Gul et al., 2024). Based on the work culture and problems that occur in the company, the methods to be used are the New Seven Tools and Root Cause Analysis (RCA) methods to identify potential failures and provide suggestions for improvement. Where New Seven Tools are seven tools that define problems with verbal data and collect ideas and formulate plans. The New Seven Tools method is used to control and improve the quality of company products (Aziza & Setiaji, 2020; Widiwati et al., 2025; Wang et al., 2024). New Seven Tools are tools used in qualitative exploration including several stages, namely Affinity Diagram, Interrelationship Diagram, Tree Diagram, Matrix Diagram, Matrix Data Analysis, Activity Network Diagram, and Process Decision Program Chart (PDPC) (Rozi & Nugroho, 2022; Sari et al., 2025; Annandita & Rochmoeljati, 2025). Meanwhile, Root Cause Analysis (RCA) is used to identify, evaluate potential failures and provide suggestions for improvement. In the process of identifying problems, changes can be made by redesigning or creating new processes to prevent errors from recurring (Irwan, 2024; Abbasi et al., 2024; Ugbebor et al., 2024).

Based on the problems that occur at PT XYZ, research is conducted to analyse product defects and improve the quality of shoe products at PT XYZ with the proposed methods of New Seven Tools and Root Cause Analysis (RCA). Therefore, based on the above problems, research was conducted to control the quality of shoe products using the New Seven Tools method and make quality improvement proposals with the Root Cause Analysis (RCA) approach.

Methods

The study uses a descriptive design that incorporates both quantitative and qualitative research methods, thus making it easier to conduct a general analysis of the flaws in footwear items in PT XYZ. The descriptive nature of the inquiry is noteworthy, because it not only describes the quantifiable scale of defects in the form of empirical data, but also explains the background contextual and organizational factors, which underlie them. The combination of quantitative analysis and qualitative understanding will ensure that the evaluation of defects will not be limited to statistical trends but will be able to consider the human, technical, and environmental aspects of the manufacturing process.

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The practical research was done within the footwear manufacturing company, PT XYZ, which has a long history of operation in this industry. The investigation was performed particularly on the sewing and lasting production lines as the initial data showed the defect rates of these processes were continuously above the allowed limit by the company of 2%. By focusing on these two critical processes, the possible production areas that are most vulnerable to quality shortcomings could be explored and specific recommendations could be developed. The review covered a period of eight months, including June 2024 to January 2025, during which information was collected and examined in a systematic manner.

Two data types were used as a basis of this study, namely primary and secondary data. Systematic field observations and semi-structured interviews served as sources of primary data. These observations provided the first-hand evidence of the way the work is performed on the shop floor, conditions operators work under, and the use of the required procedures. Employees, supervisors, production managers, and quality control personnel were also interviewed, thus gaining deeper understanding of their standpoint, challenges, and practices. These qualitative discussions were especially useful in revealing data that would not otherwise have been observed in the numerical records, including the impact of work pressure, operator fatigue and informal workarounds. Secondary data on the contrary were obtained in company archives, such as reports of production, defects records and historical records. These sources allowed the researcher to follow the trajectory of the defects over time and to compare qualitative observations with the actual production results.

The analytical stage used the New Seven Tools, which is a systematic selection of problem-solving tools used to organize and interpret qualitative data. The tools were used in different aspects of analysis. The Affinity Diagram was used to sort out and bundle the numerous amount of issues observed into sensible groups, which are usually categorised as human, machine, method, material and environmental factors. A Causal Relationship Diagram was then used to establish causal relationships between these categories and how some of the issues caused or worsened others. The Tree Diagram further divided large problems into small and solvable parts, thus developing a more detailed map of problem areas. The Matrix Diagram and Matrix Data Analysis were then used to seek relationships between defect causes and improvement proposals as well as balancing the relative importance and feasibility of the different solutions. In order to see how and when the work was done, Activity Network Diagram was created, which noted the possible delays or inefficiencies that might lead to the appearance of defects. Lastly, the Process Decision Program Chart (PDPC) was used to limit the feasibility of the suggested improvement measures and to predict possible challenges in the implementation of the new measures.

Along with the New Seven Tools, the study also involved the use of Root Cause Analysis (RCA) to look deeper into the root cause of the causes of repetitive defects. RCA has been found especially helpful in differentiating between symptoms and actual root causes. To operationalise RCA, the research employed 5W1H model What, Why, Where, When, Who and How to develop corrective actions, which were theoretically correct in addition to being realistic in the operational setting of PT XYZ. This organized system worked to make sure that proposed improvements were well defined, in terms of responsibilities, timing and methodology of implementation.

A balance was established in the study by combining these methodological components to reach breadth and depth. The quantitative element produced a measurable response on the pattern of defects, but the qualitative exploration helped to reveal the systemic and behavioral aspects behind them. This incorporation allowed the findings to go beyond reporting on the levels of defects and offer meaningful, practical suggestions. In the end, the selected methodology will help to ensure that the conclusions drawn in this study are rooted deeply in

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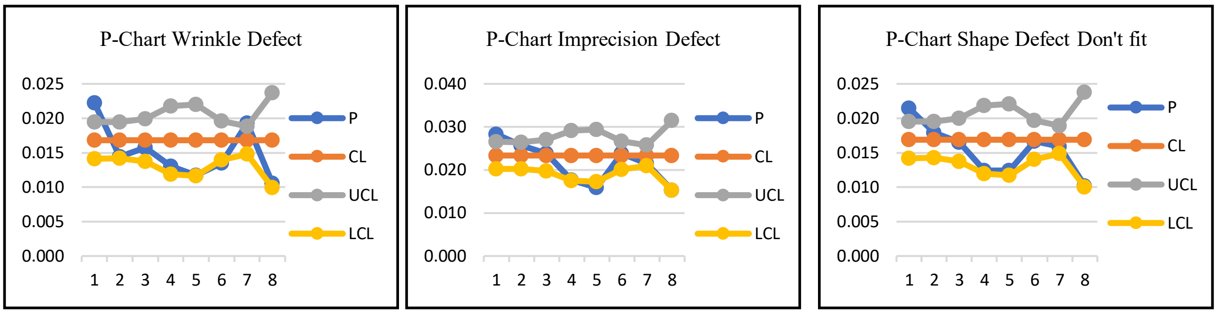
empirical data, and, at the same time, they are fully consistent with the realities of the footwear production setting at PT XYZ.

Results and Discussion

The data on the amount of shoe production in the sewing and lasting process from June 2024 to January 2025 can be seen in table 1. below

Table 1. Production Data And Product Defect Data

month	Total Sewing Production	*Sewing*			Total Lasting Production	*Lasting*		
		Unraveled stitching	untidy stitches	Hole		Wrinkle defect	imprecision	improper shape
June 24	14318	104	198	139	20879	464	591	448
July 24	20372	195	212	204	21259	306	546	381
Agust 24	15378	139	146	161	15339	241	365	253
Sep-24	11671	98	106	100	6125	72	98	94
Okt 24	17543	144	180	167	5546	65	70	87
Nov-24	19012	144	165	261	18816	254	448	314
Des 24	23210	273	188	263	36027	694	775	574
Jan-25	8017	57	62	81	3134	33	37	43
total	**129521**	**1154**	**1257**	**1376**	**127125**	**2129**	**2930**	**2194**

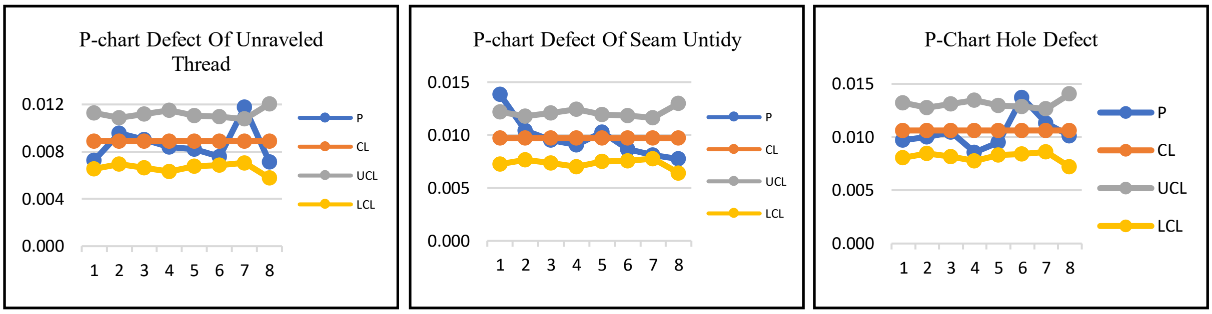


Source: Internal company data, 2024-2025

Control chart is a tool used to monitor and evaluate processes or activities that are in statistical quality control. Control chart has a function as a clue as to whether the number of defects that occur in the product is still within reasonable limits or not. In this study, the control chart uses an attribute control chart, namely P-Chart, which can describe the parts that are rejected because they do not match the desired specifications of the total production.

Figure 2. P-Chart Sewing Production

Based on Figure 2 on the unravelling thread defect, it can be seen that there are out-of-control defects in the 7th period, to be precise in December 2024. On the seam untidiness defect, it can be seen that there are out-of-control defects in the 1st period, to be precise in June 2024.



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And in the hole defect it can be seen that there is an out-of-control defect in the 6th period, November 2024 to be precise.

Figure 3. P-Chart Lasting Production

Based on Figure 3 on wrinkle defects, it can be seen that there are out-of-control defects in the 1st period and 7th period, to be precise in December 2024 and January 2025. on imprecision defects, it can be seen that there are out-of-control defects that exceed the Upper Control Limit (UCL), namely in the 1st period, namely in June 2024. While in the 5th period in October 2024 there is an out-of-control defect exceeding the Lower Control Limit (LCL). And in the defect of non-conforming shape, it can be seen that there is an out-of-control defect in the 1st period, to be precise in June 2024.

New Seven Tools

Affinity Diagram

Man
1. Sewing operators are lacking focus.
2. Work-related fatigue.
3. Operators are undertrained and lack sufficient skills.

Machine
1. Unstable thread tension.
2. Needle is blunt or incompatible with the material type.
3. Sewing machine jammed or malfunctioning due to lack of calibration.
4. Worn-out machine components.
5. Presser foot is too sharp or uneven, causing excessive pressure on the fabric.
6. Presser foot or feed dog is worn out or loose.

Method
1. Improper locking stitch technique.
2. Incorrect thread tension adjustment.
3. Excessive machine speed.
4. No in-process quality checking.
5. Incorrect stitching technique on curved areas.
6. Sewing techniques not in accordance with standard operating procedures (SOP)

Environment
1. Insufficient lighting.
2. Non-ergonomic worktable.
3. Overheated work area / Excessive workplace temperature.

Material
1. The thread is of low quality or does not meet specifications

Figure 4. Affinity Diagram Sewing Production

Based on Figure 4 the classification of types of errors is grouped according to human, machine, method, environment, and material factors. Errors related to human factors include lack of focus during sewing, working in a rushed manner, lack of experience or skill, work fatigue, operator miss-stitching, and failure to lift the presser foot when turning the fabric. Errors related to machine factors include unstable thread tension, a dull needle or one that is not suitable for the material type, worn-out machine components, and sewing machines that jam or malfunction due to lack of calibration. Other machine-related issues include machine speed not matching the type of stitching, overly sharp or uneven presser foot causing excessive pressure on the fabric, and worn or loose presser foot or feed dog. Errors based on method factors include improper backstitch technique, incorrect thread tension adjustment, excessive machine speed, inaccurate stitching technique on curved areas, and the absence of in-process checking. Errors caused by environmental factors include insufficient lighting, non-ergonomic worktables, and excessively hot work areas, which lead to quicker fatigue and reduced focus among workers. Finally, material-related errors involve the use of low-quality

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thread or thread that does not meet specifications, which can result in thread breakage and stitching defects.

Based on Figure 5 the types of errors are classified according to five main factors: human, machine, method, environment, and material. Errors related to human factors include: the operator failing to pull the upper tightly during the lasting process, working in a rushed manner, lack of experience or skill, and not checking the position of the upper before pressing it onto the last. Errors caused by machine factors include: uneven pressure from the lasting machine, suboptimal vacuum suction, inaccurate or loose upper positioning system, unbalanced toe/heel pincer settings, malfunctioning lighting, and improper calibration of the lasting machine. Errors related to method factors involve: incorrect procedures, improper

Method

1. Improper lasting procedure.
2. Incorrect machine settings for temperature, time, and pressure.
3. No heating or softening applied to the upper.
4. No trimming or folding of excess material.
5. No manual correction of upper positioning.
6. *Over lasting*

Machine

1. Uneven pressure on the lasting machine.
2. Lasting machine not properly calibrated.
3. Vacuum suction is not optimal.
4. Upper positioning system is inaccurate or loose.
5. Lighting lamp is not functioning.

Environment

1. Insufficient lighting.
2. Work area is too hot or too cold.

Man

1. Failure to pull the upper tightly during the lasting process.
2. Failure to check the position of the upper before pressing it onto the last.
3. Operator is undertrained and lacks sufficient skills.
4. Working in a rushed manner.

Material

1. Material is not elastic, making it difficult to conform to the shape of the last.
2. Adhesive material is not strong enough.

Figure 5. Affinity Diagram Lasting Production

Interrelationship Diagram

An Interrelationship Diagram is used to analyse cause-and-effect relationships in order to identify the root causes of a problem. This diagram helps determine the correlation between factors that contribute to defects in the silencer product.

Figure 6. Intterelationship Diagram Sewing Production

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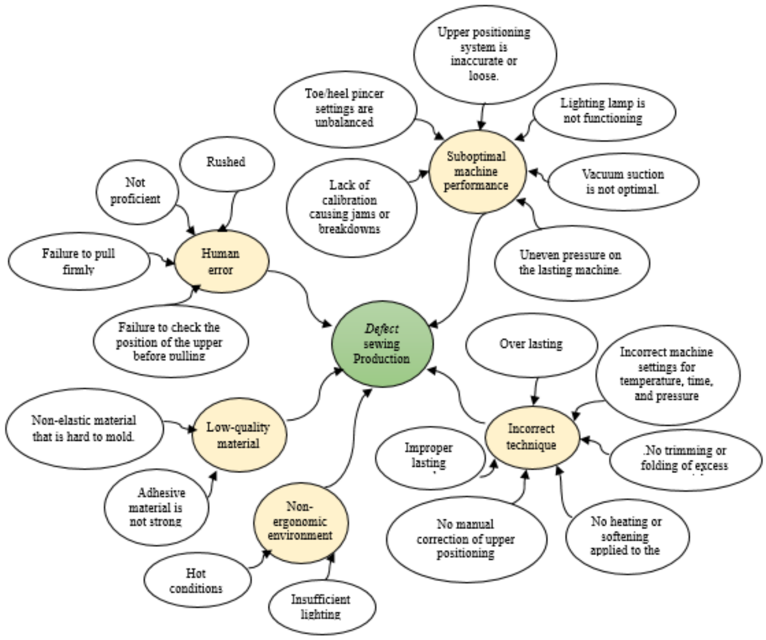
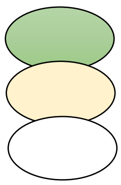


Figure 7. Intterelationship Diagram Lasting Production

Notes:



: Main Problem

: Root Couse

: Error based on the cause

Based on Figure 6 and 7, it can be seen that these interconnected relationships can have an influence on each other. So, this diagram is used to determine the correlation between cause and effect.

Tree Diagram

A Tree Diagram is a technique used to break down a problem into smaller, more detailed sub-components. This diagram clearly illustrates the scope of the problem and helps identify the methods or steps that should be pursued to achieve the desired outcome.

Figures 9 and 10, the Tree Diagrams, are used as an implementation method in this analysis to examine product defects by identifying their root causes and proposing detailed, actionable improvements. This study focuses on production defects in the upper shoe manufacturing process on the sewing line at PT XYZ. The Tree Diagram provides a visual representation of the hierarchical structure of defect causes, which are categorized into several groups: man (human), machine, material, method, and environment.

Through this diagram, complex defect problems can be broken down systematically into smaller, more manageable components, allowing the analysis team to pinpoint the most critical contributing factors. By identifying the relationships between these causes, the company can prioritize improvement efforts, implement corrective actions more effectively, and ultimately enhance product quality and production efficiency.

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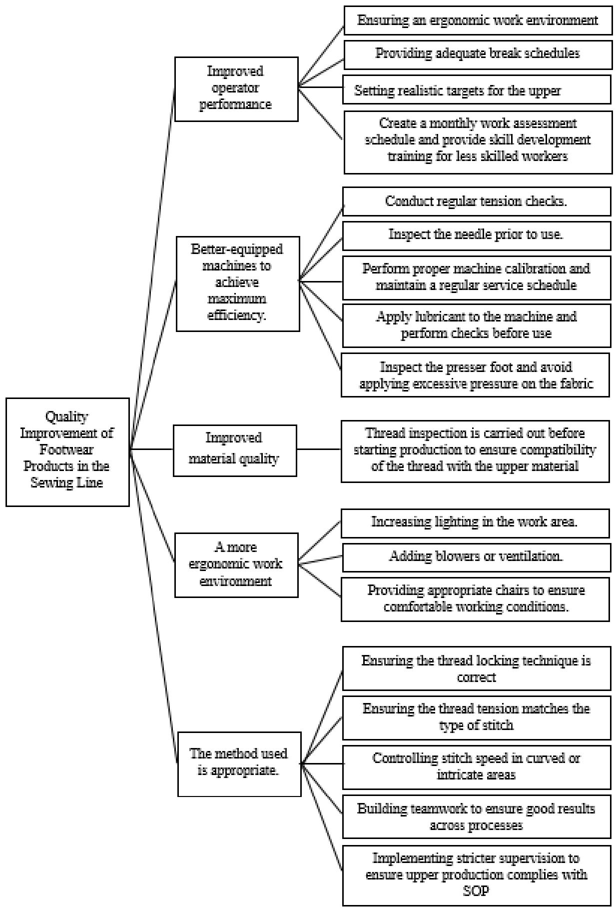

Figure 9. Tree Diagram Sewing Production

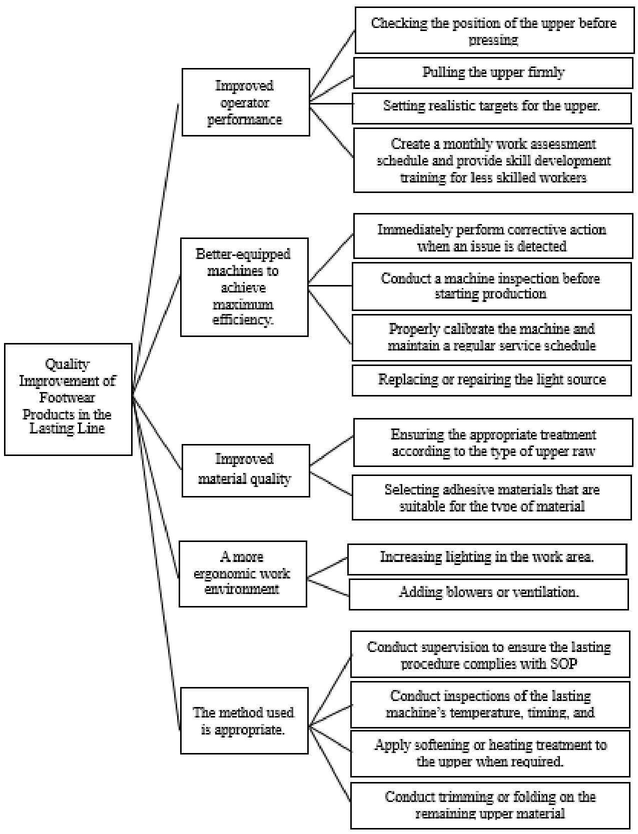

Figure 10. Tree Diagram Lasting Production

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Matrix Diagram

A Matrix Diagram is a tool used to identify relationships between various items across different factors, where the strength of each relationship is represented using specific symbols. A red rectangle indicates a strong relationship, a green triangle represents a moderate relationship, and a yellow circle signifies a weak relationship. The relationships between defect factors, their root causes, and the corresponding proposed improvements are outlined as follows:

Table 2. Matrix Diagram Sewing Production

Factor / Improvement activities / Specific activities	Improved worker performance	High-quality material that meets specifications	Enhanced and optimized machine performance	Proper methods in accordance with SOP	Ergonomic and well-designed work environment
Worker error	■	○	▲	▲	▲
Low-quality material	○	■	○	○	○
Suboptimal machine performance	▲	○	■	▲	○
Improper method	▲	○	▲	■	○
Non-ergonomic work environment	▲	○	○	○	■
Ensure an ergonomic workspace	■	○	○	○	▲
Provide regular rest breaks	■	○	○	▲	○
Set realistic upper production targets	■	○	▲	▲	○
Schedule routine evaluations and train less-skilled workers	■	○	○	▲	○
Check thread compatibility with upper material before production	○	■	○	○	○
Regularly check thread tension to ensure stability	○	○	■	▲	○
Prepare and inspect needles and other tools before starting work	▲	○	■	▲	○
Calibrate machines properly and follow a routine service schedule	▲	○	■	▲	○
Apply lubrication to prevent wear and inspect machines before use	▲	○	■	▲	○
Check the presser foot before use and avoid applying excessive pressure during operation.	▲	○	■	▲	○
Ensure the thread locking technique is correct	▲	○	○	■	○
Ensure thread tension matches the stitch type to prevent breakage or slack	▲	○	○	■	○
Reduce sewing speed in curved or contoured areas	▲	○	○	■	○
Establish teamwork to ensure smooth results across processes	▲	○	○	■	○
Implement stricter supervision to ensure upper construction follows SOP	▲	○	○	■	○
Add lighting and repair damaged or non-functioning lamps	▲	○	○	○	■
Install additional blowers and improve ventilation	▲	○	○	○	■
Provide a comfortable workspace, including proper seating for long-duration tasks	▲	○	○	○	■

Source: Processed Data Results

Based on Table 2, the Matrix Diagram of Sewing Line Defects shows the relationships between variables. There are five factors that contribute to product defects in the sewing line, five main improvement activities, and eighteen specific improvement activities derived from the tree diagram. The matrix illustrates the connections between defect factors and improvement activities, as well as between improvement activities and specific actions. The relationship between factors and improvement activities includes five strong relationships, eight moderate relationships, and twelve weak or unrelated connections. Meanwhile, the

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relationship between improvement activities and specific actions consists of eighteen strong relationships, twenty-two moderate ones, and fifty that are weak or not related.

Table 3. Matrix Diagram Lasting Production

Factor / Improvement activities / Specific activities	Improved worker performance	High-quality material that meets specifications	Enhanced and optimized machine performance	Proper methods in accordance with SOP	Ergonomic and well-designed work environment
Worker error	■	○	△	△	△
Low-quality material	○	■	○	○	○
Suboptimal machine performance	△	○	■	△	○
Improper method	△	○	△	■	○
Non-ergonomic work environment	△	○	○	○	■
Check the upper position before pressing to last	■	○	○	△	○
Pull the upper tightly to fit the last.	■	○	○	△	○
Set realistic upper targets so they can be completed without rushing.	■	○	△	△	○
Set up regular work evaluation schedules and provide training for less skilled workers.	■	○	○	△	○
Ensure proper treatment in the lasting process according to the type of upper raw material.	○	■	○	○	○
Choose an adhesive or glue that is suitable for the type of shoe material so that it can stick firmly.	○	■	○	○	○
Check the machine before use, including temperature, time, pressure, etc.	△	○	■	△	○
Perform proper machine calibration and regular service schedules	△	○	■	△	○
Immediately make repairs when problems are detected	△	○	■	△	○
Repair engine lighting	△	○	■	○	△
Conduct supervision to ensure that lasting procedures are carried out in accordance with SOP	△	○	○	■	○
Check the temperature, time and pressure on the lasting machine	△	○	△	■	○
Warm up or soften the upper if necessary.	△	○	△	■	○
Perform cutting or folding on the remaining upper material	△	○	○	■	○
Adding a blower and improving ventilation	△		○	○	■
Add lighting to the work area	△	○	○	○	■

Source: Processed Data Results

Based on Table 3, the matrix diagram of wrinkling defects in the lasting line illustrates the relationships between variables. There are 5 factors that influence defects in shoe products on the sewing line, 5 corrective actions, and 15 specific corrective activities derived from the tree diagram. The matrix diagram shows the relationships between the factors and corrective actions, as well as between corrective actions and specific activities. The relationships between factors and corrective actions include 5 that are highly related, 8 that are related, and 12 that are unrelated. Meanwhile, the relationships between corrective actions and specific activities include 15 that are highly related, 19 that are related, and 41 that are unrelated.

Matrix Data Analysis

Matrix data analysis is used to analyze the importance value between corrective actions and problems, as well as to analyze whether the corrective actions have been implemented by the company or not.

Table 4. Matrix Data Analysis Sewing Production

Primary	**Secondary**	**Importance (a)**	**PT XYZ (b)**

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Improved worker performance	Ensuring an ergonomic work environment	3	2
	Providing scheduled breaks for workers	3	1
	Setting realistic upper targets that can be achieved without rushing	3	1
	Scheduling regular performance evaluations and providing training for less-skilled workers	3	2
Improved Materials	Inspecting thread before starting production and ensuring compatibility with the upper material	3	2
Enhanced Machine Performance	Regularly checking thread tension to ensure stability	2	2
	Preparing and inspecting needles and other tools before starting work	3	2
	Properly calibrating machines and following a routine maintenance schedule	3	1
	Applying lubricants to prevent machine wear and conducting pre-use inspections	3	2
	Checking the presser foot before use and avoiding excessive pressure during operation	2	2
Proper Methods According to SOP	Implementing stricter supervision to ensure upper production follows SOP	3	2
	Ensuring correct thread locking techniques	2	2
	Adjusting thread tension according to stitch type to prevent breakage or looseness	3	2
	Reducing sewing speed in curved or intricate areas	2	2
	Building teamwork to ensure smooth transitions between production stages	3	2
Ergonomic and Quality Work Environment	Improving lighting by adding lamps and repairing broken or faulty ones	3	2
	Adding blowers and repairing ventilation systems	2	1
	Providing comfortable workspaces, such as ergonomic chairs, for long-duration use	3	1

Source: Interview Results

1 = Fairly important to do　　1 = Not yet implemented

2 = Important to do　　2 = Implemented

3 = Very important to do　　3 = Frequently implemented

Based on Table 4, the matrix data analysis of defects in the sewing line can be used to compare the importance rating and the actual implementation in the company's production process,

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using a rating scale from 1 to 3 as previously explained. The table includes 5 primary and 18 secondary items. In the "importance" column, there are 13 secondary items considered very important and 5 considered important, with a total score of 49. Meanwhile, in the company's production process, 13 secondary items have been implemented and 5 have not, with a total score of 31. The difference between the two scores (a and b) is 18, indicating that improvements are still needed in the company's production process.

Table 5. Matrix Data Analysis Lasting Production

Primary	Secondary	Importance (a)	PT Gradial Perdana Perkasa (b)
Improved worker performance	Checking the position of the upper before pressing it onto the last	3	2
	Pulling the upper tightly to match the shape of the last	3	2
	Setting realistic upper targets that can be achieved without rushing	3	1
	Scheduling regular performance evaluations and providing training for less-skilled workers	3	2
Improved Materials	Ensuring the correct treatment during the lasting process based on the type of upper material	3	2
	Selecting adhesive materials that are compatible with the shoe materials to ensure strong bonding	3	2
Enhanced Machine Performance	Inspecting the machine before use, including temperature, timing, pressure, and other critical settings.	3	1
	Properly calibrating the machine and following a regular maintenance schedule	3	1
	Immediately performing repairs when any issues are detected	3	1
	Repairing or replacing faulty machine lighting	3	1
Proper Methods	Supervising the lasting process to ensure it follows the SOP	2	2

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According to SOP	Checking the temperature, timing, and pressure settings on the lasting machine	3	2
	Applying heat or softening the upper material when necessary	2	2
	Trimming excess upper material after the lasting process	2	2
Lingkungan kerja yang ergonomis	Improving lighting by adding lamps and repairing broken or faulty ones	3	1
	Adding blowers and repairing ventilation systems	3	2

Source: Interview Results

Based on Table 5, the matrix data analysis of defects in the lasting line allows for a comparison between the importance rating and the actual implementation in the company's production process, using a rating scale from 1 to 3 as previously explained. The table includes 5 primary and 16 secondary items. In the "importance" column, 13 secondary items are categorized as very important and 3 as important, with a total score of 45. In the company's production process, 10 secondary items have been implemented and 6 have not, with a total score of 26. The difference in scores between the two comparisons (a and b) is 19, which indicates that improvements are still necessary in the company's production process.

Activity Network Diagram

The Activity Network Diagram is a tool used to create a flowchart that illustrates the sequence of tasks required to complete a project.

Table 6. List of Production Activities in the Sewing Line for Shoe Products

No	Work Process	Code	Start	Duration
1.	Material inspection and marking	A	-	300 second
2.	Pressing heel counter	B	A	15 second
3.	Sewing the vamp (front part of the shoe)	C	B	20 second
4.	Gluing and attaching EVA quarter, EVA back quarter, and EVA back tab	D	C	45 second
5.	Sewing quarter variation	E	D	60 second
6.	Sewing the toe cap	F	E	85 second
7.	Sewing the eyestay for lace-up shoes / sewing the strap for strap-type shoes	G	F	65 second
8.	Sewing zigzag stitch on the back lining	H	G	15 second
9.	Sewing the back tab	I	H	25 second
10.	Sewing the back counter	J	I	50 second
11.	Sewing the loop	K	J	30 second
12.	Sewing the collar lining edge	L	K	20 second
13.	Gluing and attaching the back heel counter	M	L	15 second
14.	Trimming the collar	N	M	55 second
15.	Making the tongue	O	N	75 second
16.	Gluing and turning the collar	P	O	80 second
17.	Punching holes for laces/strap	Q	P	15 second

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18.	Sewing the tongue lock	R	Q	30 second
19.	circular stitching	S	R	55 second
20.	Cleaning up the shoe upper	T	S	15 second
				1070 second

Source: Internal company data

From the table above, it is known that the process diagram for shoe production in the sewing line consists of 20 activities. Based on Table 6, which lists the activities in the upper shoe production process, the sequential activities lead to the following activity network diagram:

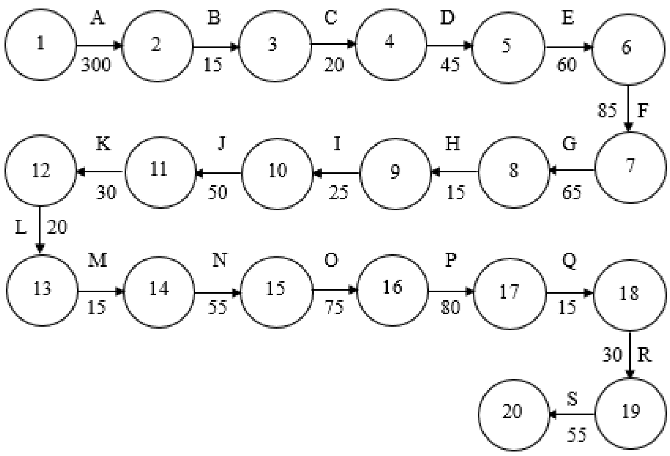

Figure 11. Activity Network Diagram Sewing Production

Based on the activity network diagram of the sewing line shoe product, it is known that there are 20 work activities with a total time of 1,070 seconds or 17.8 minutes per shoe upper.

Table 7. List of Production Activities in the Sewing Line for Shoe Products

No	Work Process	Code	Start	Duration
1.	Strobel upper of the shoe	A	-	1 minute
2.	Inserting the upper into the last	B	A	1 minute
3.	Jempang (pulling/stretching the front part of the shoe)	C	B	0,5 minute
4.	Hoppang (pulling/stretching the back part of the shoe)	D	C	0,5 minute
5.	Marking for outsole attachment	E	D	1 minute
6.	Roughing (thinning the surface of the shoe upper)	F	E	0,5 minute
7.	Opening the shoe to form the shape	G	F	0,5 minute
8.	Priming the outsole and upper, then opening	H	G	1 minute
9.	Applying the first layer of glue on the outsole and upper, then opening	I	H	1 minute
10.	Applying the second layer of glue on the outsole and upper, then opening until half-dry	J	I	1 minute
11.	Attaching the upper and outsole	K	J	0,5 minute
12.	Pressing to ensure perfect adhesion	L	K	0,5 minute
13.	Inspection and injection (if necessary)	M	L	1 minute
14.	Opening to dry the glue	N	M	0,5 minute
15.	Pressing to ensure the shoe maintains its shape	O	N	0,5 minute

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16.	Cooling to stabilize the lasting result	P	O	0,5 minute
17.	Removing the last	Q	P	0,5 minute
18.	Inspecting the lasting result	R	Q	0,5 minute
				12,5 minute

Source: Internal company data

From the table above, it is known that the process diagram for shoe production in the lasting line consists of 18 activities. Based on Table 7, which lists the activities in the shoe production process on the lasting line, the sequential activities result in the following activity network diagram:

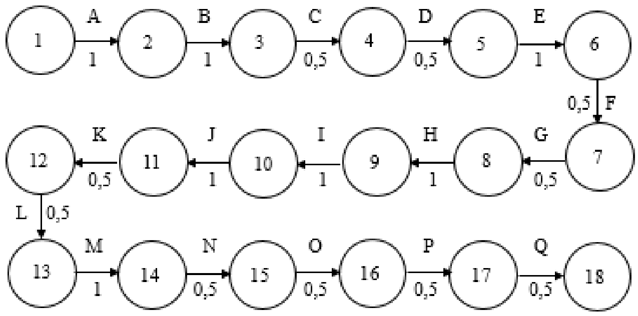

Figure 12. Activity Network Diagram Lasting Production

Based on the activity network diagram of the shoe product in the lasting line, it is identified that there are 18 work activities with a total time of 12.5 minutes per shoe.

Process Decision program Chart

The Process Decision Program Chart (PDPC) is a useful tool that helps determine the processes used to achieve the desired outcomes by evaluating possible events and outcome variations. The PDPC is a method used to identify potential problems and to define preventive actions within a given plan.

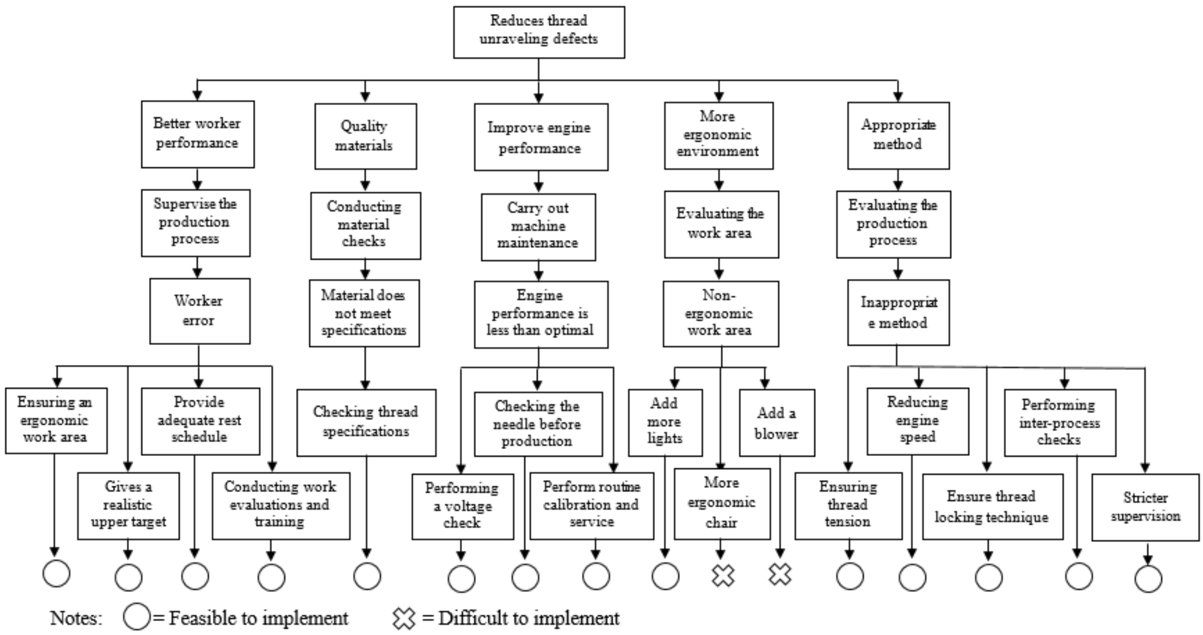

Figure 13. Process Decision Program Chart Sewing Production

Based on Figure 13 above, the results show that out of 16 proposed improvements, 14 are feasible to be implemented in the company, as indicated by the circle symbol. These include improvement proposals related to manpower, materials, machines, methods, and the

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environment. Proposed improvements to enhance worker performance include ensuring an ergonomic work environment, providing sufficient break schedules, setting realistic upper production targets, scheduling monthly performance evaluations, and offering training for less-skilled workers. Improvements aimed at enhancing machine performance include regularly checking machine tension during upper production, ensuring needles are checked before use, properly calibrating machines, and adhering to regular maintenance schedules. To reduce defects caused by materials, improvements involve inspecting thread quality before production and ensuring thread compatibility with the upper material. To improve environmental conditions for better ergonomics, it is recommended to increase lighting in the work area. Lastly, method-related improvements include applying proper thread locking techniques, adjusting thread tension according to stitch type, enforcing stricter supervision of SOP adherence, reducing stitching speed in curved or intricate areas, and forming teamwork to ensure good results across processes. Meanwhile, two proposed improvements are considered unfeasible for implementation in the company, as indicated by the cross symbol. These relate to ergonomic workplace enhancements: installing additional blowers or ventilation and providing ergonomic chairs to improve worker comfort.

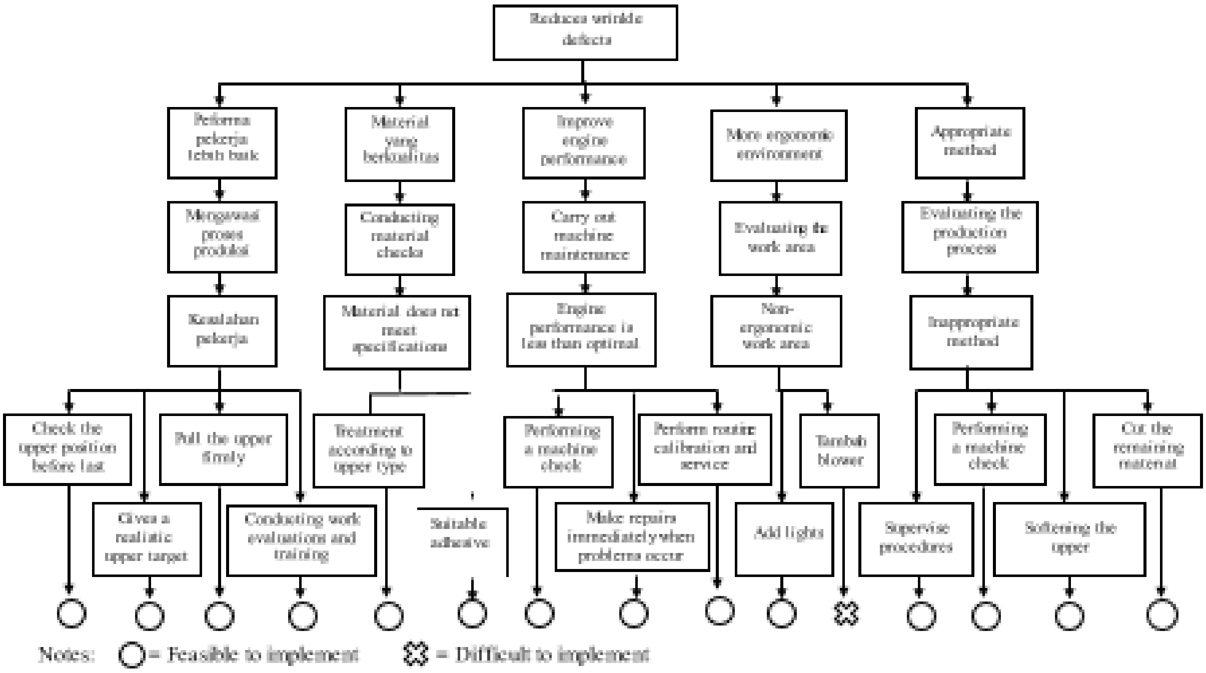

Figure 14. Process Decision Program Chart Sewing Production

Based on Figure 14 above, the results indicate that out of 15 proposed improvements, 14 are considered feasible to be implemented in the company, as indicated by the circle symbol. These consist of improvement proposals related to manpower, materials, machines, methods, and the work environment. The proposed improvements to enhance worker performance include: checking the position of the upper before pressing it onto the last, pulling the upper tightly during the lasting process, setting realistic targets, scheduling monthly performance evaluations, and providing training for less-skilled workers. To improve machine performance, proposed actions include checking the machine before use, immediately addressing any issues detected, properly calibrating machines, and conducting regular maintenance. To reduce defects caused by materials, improvements involve ensuring proper treatment according to the type of upper material and selecting adhesives that are suitable for the upper material type. To improve environmental conditions for better ergonomics, it is suggested to increase lighting in the work area. Lastly, method-related improvements include enforcing stricter supervision to ensure lasting procedures follow SOPs, checking the

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temperature, time, and pressure on the lasting machine, softening or heating the upper when needed, and trimming or folding excess upper material. Meanwhile, one proposed improvement is considered unfeasible for implementation in the company, as indicated by the cross symbol. This pertains to an ergonomic workplace improvement, specifically the proposal to add a blower or ventilation system.

Root Cause Analysis (5W1H)

The 5W-1H method is a structured approach to problem-solving that serves as a foundation for corrective actions by identifying and analyzing each key contributing factor. This method addresses what happened, why it occurred, where improvements are needed, when the actions should be taken, who will be responsible, and how the improvements will be implemented. By applying this method, companies can develop targeted and effective solutions to address root causes. The following section presents the proposed improvement actions based on the 5W-1H analysis.

Table 8. 5W1H Analysis Sewing Production

Occurrence Time (*when*)	**Defect What (*what*)**	**Defect Sources (*where*)**	**Root Cause (*why*)**	**Responsible Party (*who*)**	**Corrective Action (*how*)**
During the Production Process	Loose threads, uneven or messy stitching and hole	Human	Workers rushing during sewing, lack of attention, insufficient skill, and failure to lift the presser foot when rotating material.	Sewing line supervisor & Production head	• Provide realistic targets to avoid excessive rushing. • Since production is sequential, establish effective teamwork for cross-process inspection. • Supervisors should enforce stricter oversight to minimize defects. • Conduct performance evaluations and provide training for less skilled workers.
		Machine	Infrequent maintenance, improper calibration, worn components due to poor upkeep, unstable or misadjusted machine settings, sharp presser foot causing tears.	Production head, Production manager, & Technician	• Perform regular machine calibration and servicing. • Inspect machines before use. • Segregate frequently problematic machines to avoid production disruptions.
		Material	Low-quality thread not meeting specifications.	Supervisor & QC team	• Inspect thread before use, ensure compliance with shoe upper material specifications. • Implement proper storage methods to prevent quality degradation.

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		Method	Workers not following SOPs, incorrect sewing procedures, improper thread tension adjustment, excessive sewing speed, and errors in curved stitching.	Supervisor & Production head	• Strengthen oversight of sewing procedures. • Set appropriate thread tension for stitch types. • Workers should inspect stitches while trimming excess thread.
		Environment	Hot workspace, inadequate lighting, and uncomfortable seating.	Production head & Production manager	• Improve lighting to reduce eye strain • install blowers for ventilation, and provide ergonomic seating to prevent back pain and fatigue.

Table 9. 5W1H Analysis Lasting Production

Occurrence Time (*when*)	**Defect What (*what*)**	**Defect Sources (*where*)**	**Root Cause**	**Responsible Party**	**Corrective Action**
			(*why*)	**(*who*)**	**(*how*)**
During the Production Process	Wrinkled, lack of precision and incorrect shape	Human	Workers rushed during the process, lacked skill, were inattentive when tightening parts (toe, heels, waist), failed to properly align the upper before pressing the last, and neglected to verify the center line and markings.	Production Head & Supervisor	• Set realistic production targets to prevent rushed work. • Ensure workers carefully check the upper position before pressing the last and pull it firmly after alignment. • Improve teamwork for cross-process verification due to sequential production. • Strengthen supervisor oversight to minimize defects.
		Machine	Infrequent machine maintenance, improper calibration, and component wear due to poor upkeep.	Production Head, Production Manager, Technician	• Conduct regular machine calibration and servicing. • Perform proper machine checks and adjustments before use.

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					• Apply lubricant as needed. • Promptly repair malfunctioning machines and replace lighting to ensure proper upper alignment.
		Material	Incorrect treatment for upper material and unsuitable adhesive with low bonding strength.	Production Manager, Production Head, Supervisor, QC	• Verify treatment compatibility with upper material before mass production. • Select adhesives with optimal bonding performance. • Establish SOPs for proper upper material treatment.
		Method	Workers deviated from SOPs, skipped checks (temperature, time, pressure) on the lasting machine, omitted softening for certain materials (e.g., leather), and failed to trim excess upper material.	Production Head & Supervisor	• Enforce stricter procedural compliance. • Inspect machines before operation. • Monitor softening application for required materials. • Ensure trimming/folding of excess upper material.
		Environment	Hot working area with inadequate lighting.	Production Head & Production Manager	• Improve lighting to reduce operator eye strain. • Install additional blowers to mitigate heat discomfort.

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Based on Table 8 and table 9 above, the causes of shoe product defects in the sewing and lasting lines have been identified, along with appropriate improvement methods that the company can implement to minimize defects. From the overall improvement proposals using the 5W1H method, it is evident that most defects can be reduced through technical and managerial actions. Emphasis on compliance with work procedures, regular machine maintenance, and the creation of an ergonomic work environment will significantly help in lowering the defect rate. The implementation of these proposed improvements is expected to serve as a strategic foundation for enhancing the quality of shoe production within the company.

Table 10. Improvement Suggestions for the Sewing Production Line

factor	Problem specific	Improvement
man	The worker is fatigued and performing tasks hastily	Set realistic targets when using cycle time, and provide a minimum allowance of 5% to account for the worker's personal needs
	Lack of sewing skills	Regular evaluations of workers should be carried out to assist in determining the appropriate placement of operators at each workstation. Training programs should also be implemented to enhance operator skills
	Not focused / not thorough	Establish stricter supervision measures, with supervisors conducting regular checks on workers' focus and attentiveness
method	Improper sewing procedure	Develop a Standard Operating Procedure (SOP) outlining the sewing techniques to be applied in shoe production, accompanied by visual representations of the stitch types to be used. Conduct a pre-production briefing for all workers
	Improper sewing technique applied	Stitching quality shall be monitored either by sampling or full inspection during the production process, conducted by supervisors or the quality control (QC) team
	Lack of inspection between production stages	Each operator must conduct self-inspection at defined production intervals or after completing a specified quantity of units.
	Non-compliance with the established Standard Operating Procedures (SOPs)	Monitoring and disciplinary actions shall be taken when any worker is found to be in violation of the established Standard Operating Procedures (SOPs)
mechine	Machine parts show signs of wear and tear	Calibrations shall be scheduled routinely, and component replacements must be carried out within the timeframes specified by the technician
	Machine jamming occurs	Inspections shall be conducted at least once per week, and routine servicing must be carried out regularly
	Improper machine settings and dull needl	Machine checks—including tension, speed, needle, pulley, and other critical components—must be performed each morning and after breaks before the machine is operated. Lubrication should be applied as needed to prevent machine jamming

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Material	Thread breaks easily or does not meet specification	Establish standards for the thread to be used in production and conduct inspections upon thread arrival and before use. Apply proper storage methods to maintain thread quality
environment	Work area is too hot.	Install blowers or create proper ventilation to prevent the work area from becoming too hot, allowing workers to stay more focused.
	Insufficient lighting	Install LED lighting at each sewing workstation to minimize eye fatigue and improve visual comfort for operators during work
	Non-ergonomic chairs	Replace existing chairs with ergonomic chairs that feature supportive backrests and appropriate seat height to reduce worker fatigue from prolonged sitting

Table 11. Improvement Suggestions for the Lasting Production Line

factor	Problem specific	Improvement
man	The worker is fatigued and performing tasks hastily	Set realistic targets when using cycle time, and provide a minimum allowance of 5% to account for the worker's personal needs
	Lack of skills in last fitting or machine operation	Conduct regular evaluations of workers, as this can help determine the appropriate placement of operators at workstations. Provide training and coaching for new workers to improve their skills
	Not focused / not thorough	Establish stricter supervision measures, with supervisors conducting regular checks on workers' focus and attentiveness
method	The material softening and pre-forming steps were omitted prior to the lasting process	Create an SOP for the lasting method, identify the materials that require softening before mass production, and provide a worker briefing before starting production to ensure tasks are performed according to instructions
	overlasting	Specify the maximum pressure and time limits in the SOP according to the type of upper materia
	Manual adjustments during the lasting process are not carried out at individual workstations	Operators shall conduct self-inspection of their completed work, or the subsequent workstation operator shall perform an inspection before proceeding to the next process step. Any defects or errors found more than three times must be reported immediately
	Workers do not comply with the established SOPs	Supervise and issue warnings when workers are found not complying with the established SOP
mechine	Machine components are worn out	Schedule regular calibration and replace components within the time frame specified by the technician. Apply lubricant when necessary
	Suction or heater function is suboptimal	Conduct inspections at least once a week, clean the vacuum channels and heating elements regularly every week, and perform routine maintenance

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	Center line markers are loose, machine lights are off, and machine performance is suboptimal	Machine checks and trial runs—including temperature, pressure, precision, timing, and other key parameters shall be conducted in the morning and after breaks prior to machine operation
Material	The adhesive used is not compatible with the material, resulting in poor bonding	Set clear standards for the adhesive to be used in the production process, and perform adhesive trials to ensure compatibility and performance before proceeding with mass production
	Inappropriate treatment is applied to the upper material	Create an SOP for material treatment: softening temperature, heating duration, and storage room humidity
environment	Work area is too hot.	Install blowers or create proper ventilation to prevent the work area from becoming too hot, allowing workers to stay more focused.
	Insufficient lighting	Install LED lighting at each sewing workstation to minimize eye fatigue and improve visual comfort for operators during work

Conclusion

Quality control of shoe products can be achieved by improving the five factors that contribute to product defects: manpower, machines, methods, materials, and environment. Improvement activities have been identified to minimize defects, consisting of 20 specific activities for the sewing line and 19 activities for the lasting line. PDPC analysis revealed that the majority of the proposed improvements are considered feasible, with 18 out of 20 for the sewing line and 18 out of 19 for the lasting line. Improvement proposals that are not feasible in the short term are due to financial limitations. Based on the results of analysis using the 5W1H method (What, Why, Where, When, Who, and How), several corrective actions were designed, including: Adjustment of work targets**,** training on sewing and lasting techniques**.** routine machine calibration and maintenance**,** selection of thread and adhesive appropriate to the upper material**,** and mprovement of workplace ergonomics**.** These improvement proposals are considered realistic and relevant to actual field conditions, and they are expected to significantly reduce defect rates if implemented consistently.

These steps are expected not only to reduce product defects but also to enhance production efficiency and the company's competitiveness. Future research is advised to evaluate the long-term impact of these improvements and to consider advanced quality control methods such as Six Sigma or FMEA for more comprehensive and measurable outcomes.

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