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Implementation of 5s and kaızen methods for developing a novel wage assessment method in a steel construction factory: an application in Turkey

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ABSTRACT

The study aims to implement the 5S (seiri, seiton, seiso, seiketsu, and shitsuke) method and KAIZEN for emphasizing the troubles and defective products, establishing work standards, implementing fair wage assessments based on job analysis and job evaluations in a steel construction factory. By the way more objective wage assessment method is developed and workers' unrest can be resolved fairly. 5S and KAIZEN studies have been applied for 2 years in a steel construction factory. Then the evaluation of success factors within the internal structure of wage brackets utilized last year's 5S scores to enhance employees' confidence in the objectiveness of the wage system assessment. A reformer method for assessing wages has been created and put into practice, integrating both lean manufacturing principles and a job analysis and evaluation system. The framework has been tested and implemented only for a steel construction factory. In the future, studies could be conducted to assess different sector factories. The proposed framework has been successfully implemented in a medium-large scale manufacturing factory. A novel wage assessment framework that involves lean application studies integrated into the job evaluation method has been proposed in a medium-large scale manufacturing factory.

1. Introduction

Amidst globalization, businesses must continually enhance their competitive skills to endure. Investing in human resources, the foremost asset of enterprises, and leveraging it efficiently is pivotal for success in today's market, where profitability often hinges on cost reduction [1]. Boosting productivity and performance, albeit challenging in many businesses, is paramount. Among the potent tools for competitive success, 5S and KAIZEN stand out. 5S, a "Workplace Organization Process," optimizes workstations by streamlining access to tools, materials, and information, a crucial step toward lean production [2], [3]. It focuses on decluttering workspaces, standardizing processes, and facilitating material accessibility, thereby enhancing operational efficiency [3].

Human resource management, recognizing employees as the cornerstone of enterprise value, extends beyond traditional administrative tasks to encompass specialized functions. Viewing humans as the most valuable asset [4], HRM integrates tools like 5S, which reinforces this ethos and translates it into tangible results [5]. The connection between sustained operational excellence and employee conduct highlights the importance of managing human factors effectively during lean implementations

[6]. Utilizing 5S and KAIZEN as performance measurement tools aims to foster employee commitment, thereby maximizing operational efficiency and cultivating a sense of ownership among employees [7].

Numerous studies in the literature explore lean production [8], with this section highlighting some notable findings. While many valuable studies exist beyond those presented here, space constraints limit their inclusion. Obeidat et al. [9] researched the V436 sewing line, employing Value Stream Mapping (VSM) to identify and analyze five types of waste: faults, stock, superfluous production, transport, and off time. By implementing lean manufacturing techniques such as assembly balancing, facility layout, and onsite quality, they achieved significant reductions in flow time (43%) and production waste (96%). Chaple et al. [10] investigated Lean Manufacturing principles and barriers to their implementation in Indian manufacturing industries. Their findings underscore the importance of analyzing trends in lean manufacturing for further research. In a practical application, Chikhalikar [11] focused on implementing lean practices in an engine manufacturing unit in India, emphasizing the significance of understanding lean tools and time management for effective implementation. Additionally, Kumar and Kumar [12] found the relevance of Lean Manufacturing elements in the Indian manufacturing sector, outlining the benefits gained and barriers encountered. Their research emphasizes the dual outcomes of cost reduction benefits and detrimental effects on areas such as physical and mental health, societal welfare, and product quality.

Faishal et al. [13] employed the 5S method, VSM, and Standard Operating Procedures (SOP) to enhance the quality of coconut shell briquette products, aiming for a projected 50% reduction in defects. Karim et al. [14] conducted a study aimed at devising an efficient approach for implementing lean manufacturing strategies. Their methodology encompassed detailed analysis of production and process specifics, fostering Lean teamwork, and evaluating performance variables. By integrating VSM with Method Time Measurement (MTM), they proposed a novel method to diminish lead time and gauge productivity, aligning with Lean principles and standardized procedures. Salem et al. [15] undertook a study to assess the level of awareness regarding lean principles, benefits, and challenges across various industrial sectors in Qatar. Their investigation aimed to gauge recognition levels of fundamental concepts, principles, tools, and techniques. Data was collected through an online survey conducted across 333 organizations, representing diverse sectors including petroleum, institutions, and service industries. Findings suggest that there is a need for heightened awareness of lean thinking within Qatar's industries to strategically enhance current practices and remain competitive in the global arena. Neha Verma and her colleagues [16] conducted a study aimed at tackling waste-related issues, such as equipment shortages and bottleneck challenges, during the application of lean manufacturing in small-scale industries. Their objective was to streamline production processes by eliminating rejections, reducing inventory and waiting times, and optimizing installation and additional activities. Rather than investing in new machinery or expecting increased operator speed, the focus was on modifying procedures and layouts to facilitate smoother product flow during production.

Ahlstrom [17] explored the existence of a specific sequence of applications within lean manufacturing, akin to the approach proposed by Im and Lee. Through his research, Ahlstrom aimed to uncover answers to this inquiry, conducting a study within a company that had implemented lean manufacturing practices over 2.5 years. The findings revealed diverse rankings in the application of lean manufacturing principles.

In lean thinking, waste encompasses any element for which the customer is unwilling to pay an additional price, offering no added value beyond its essential purpose to the product or service user. This includes various forms of wastage such as errors, overproduction, excess inventory, waiting times, unnecessary tasks, movements, and transportation. The goal is to eradicate these forms of waste across all stages of product or service creation, from design to shipment. By doing so, the aim is to lower costs, enhance client happiness, improve resilience in responding to market dynamics, expedite cash flow, and boost firm profitability [18], [19].

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The effective implementation of 5S can yield numerous benefits [20], including enhanced workplace efficiency, organization, cleanliness, productivity, and safety; improved working conditions and employee morale; clearer visibility of problems; active involvement of employees in daily tasks; heightened productivity, flexibility, quality, safety, and motivation among staff; decreased costs, unproductive time, space, and movements; and minimized losses associated with failures and downtime.

In the literature on Job Evaluation Technique, it is believed that Frederick W. Taylor initiated work evaluation through time and motion studies in America. The earliest endeavors in this field were conducted by E. O. Griffenhagen in 1909 in Chicago, focusing on municipal services. Griffenhagen subsequently joined the Common-Wealth Edison Company in 1912, marking one of the initial industrial applications of job evaluation. By 1914, Harry E. Hapf categorized white-collar workers in banks and insurance companies. A study conducted in 1916 revealed that job appraisal studies had objectives beyond wage determination [21]. The challenges in acquiring and training employees, coupled with the necessity of wartime labor during World War I, heightened managerial interest in staff management [22]. Consequently, the assessment of jobs for establishing fair wages began to garner modest attention.

Until 1926, four methods had emerged for job evaluation. Initially, the relative complexities of the work or its alignment with enterprise values were used. Subsequently, the "Rating" or "Classification" method, developed at the Carnegie Technology Institute's Staff Survey Office and implemented in six or seven enterprises in 1922, gained traction. In 1925, Merrill R. Lott introduced the "Point Method," which involved breaking down jobs into smaller sections and assigning a score value to each section. Eugene J. Benge endeavored to introduce the point method at the Rapid Transit Company in Philadelphia. Nonetheless, in 1926, a new strategy known as the "Factor Comparison Method" emerged. This approach assigns wage values to individual factors, as opposed to the "Point Method," which assigns score values. Key jobs are identified and ranked based on these factors, establishing wage values for jobs accordingly. The values of other jobs are then ranked about these key positions. Together, these methodologies are categorized under "Job Evaluation" [23]. During World War II, job evaluations were conducted in England, followed by similar endeavors in France in 1948 and in West Germany and Sweden in 1951 [24]. In the literature review conducted, no research has been found that integrates job evaluation techniques with any lean manufacturing tool. As far as our knowledge extends, there has been no study addressing this particular issue. This gap in the literature underscores the significance of the present study, which could serve as a valuable guide for researchers seeking to explore this intersection.

The research objective is to implement the 5S (seiri, seiton, seiso, seiketsu, and shitsuke) method and KAIZEN for emphasizing the troubles and defective products, establishing work standards, implementing fair wage assessments based on job analysis and job evaluations in a steel construction factory. The research contribution of this study to the literature is to combine lean manufacturing methods with job evaluation methods. In addition, this combination is an important appendage to human resources literature.

The remainder of the paper is organized as follows. In Section 2, a literature review on 5S and KAIZEN studies in different fields is given. In Section 3, material and methodology are presented with applications of 5S, KAIZEN, job evaluations, and wage curves. In Section 4, the results and discussion of the study are given for a case study and Section 5 presents conclusions and future works.

2. Methodology

In this study, we assessed the manufacturing operations within the steel construction factory under examination, employing both work analysis and lean manufacturing tools. The company grapples with substantial hurdles involving low productivity and performance levels. Instances were noted where the man-hour/ton rates for completed projects surpassed the expected values established by the production department. Additionally, workers have engaged in work slowdowns or stoppages due to dissatisfaction with wage increases, stemming from perceived injustices among workers or discrepancies between promised and actual compensation levels. Furthermore, the work environment was characterized by uncleanliness, disorder, and inadequate occupational safety measures.

To address these challenges, the implementation of 5S tools was initiated as the first step. To do so, balanced 5S teams were formed based on the skills and experience of workers. Concurrently, KAIZEN training sessions were provided to employees, accompanied by setting objectives for these initiatives. At the monthly conclusion, the achievement of these objectives was assessed, and points for the 5S teams were calculated. Subsequently, management conducted work analysis and evaluation studies. Based on the outcomes of these assessments, wage adjustments were determined, increasing by the points earned by the 5S teams for each worker. The 5S and KAIZEN methodologies were introduced to all company employees, followed by the explanation of analysis and evaluation of work, point computation, and wage system applications. Ultimately, a novel approach to wage increments based on 5S team points was proposed. The steps of this process are outlined in Fig 1.

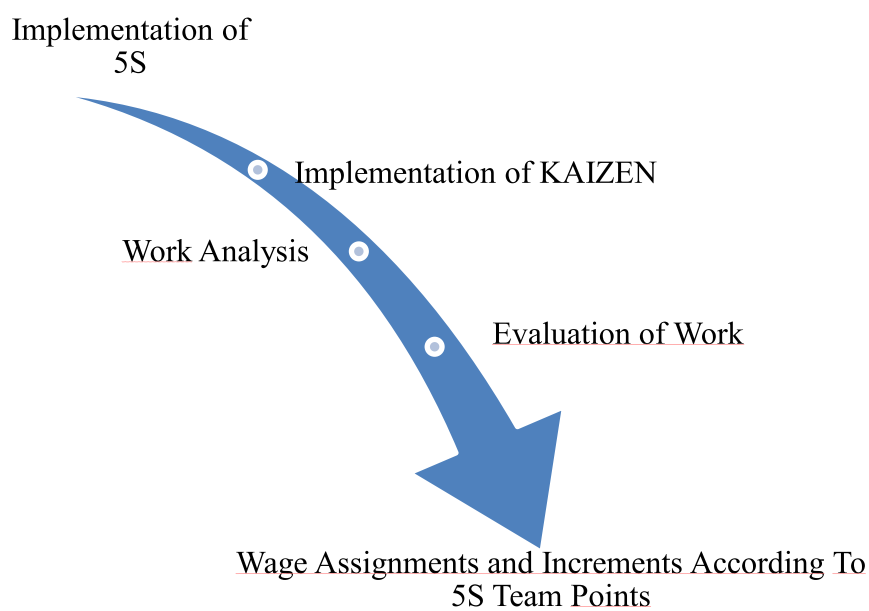

Fig. 1. Implementation process of this paper

2.1. Evaluation of Performance with 5S

The factory where our application is conducted currently manufactures wind tower segments, mechanical equipment for HEPP projects, steel structures, and various enclosed pressure containers (such as LPG tanks, steam boilers, etc.) on a site totaling 17,000 m2, with 7,000 m2 indoors and 10,000 m2 outdoors, located in Gaziantep, Turkey. The company aims to reduce costs and instill a culture of continuous improvement, prompting the necessity for process innovation. Despite its apparent simplicity, implementing this system in practice may pose challenges, as its success heavily relies on employee acceptance, the alteration of their behaviors and mindsets, along the dedication of senior management [25]. Given that the production is project-based in a job shop environment, measuring productivity change before and after implementing 5S proves difficult due to the diverse nature of jobs conducted, with no consistent task performed continuously.

Factory management suggests team leader candidates (TLC), who then undergo interviews conducted by human resources. Upon the final approval of these TLCs, teams are formed with each comprising between 3 to 10 workers. However, due to the interconnected nature of certain operations, some teams exceed the limit by 1 or 2 additional workers. Every team is allocated a particular work

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zone, where their duties include maintaining cleanliness, organization, ergonomic considerations, and tasks related to the 5S methodology within that assigned space.

Following the selection of a pilot region and gaining experience in this area, the implementation of 5S was expanded to encompass all production units within the company. The criteria for selecting the pilot region included a short application duration and experienced workers. As such, the upcut shear and punching machine areas, with dimensions of 1250 m2, which also incorporate areas for raw material and semi-finished product storage, were selected. However, all workers in these areas were grouped into a single team to collectively oversee the entire designated region. The effectiveness of all applications was tested within this region, with adjustments made based on feedback gathered through checklists for 5S evaluation, suggestion forms, and cleaning schedules.

To maintain consistency and adherence, comprehensive training on 5S principles is provided to all employees, enhancing their awareness of the matter. Evaluation of performance is carried out utilizing a 10-question, 100-point 5S audit questionnaire, with departments subject to regular audits and continuous monitoring. Efforts are directed towards achieving an optimal 5S score of 100 points in alignment with the targets established following the initial audit. These procedures are outlined in Fig. 2 for clarity.

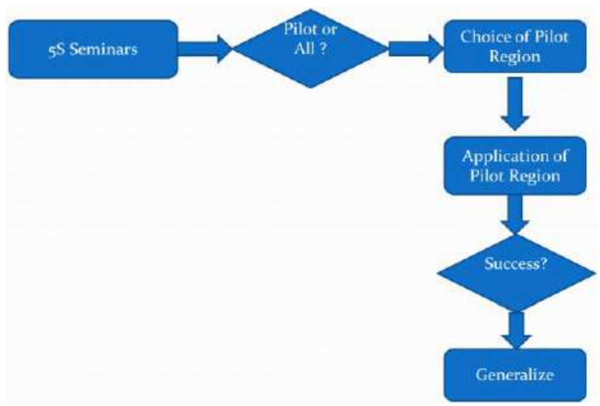

Fig. 2. Preparatory stages of the 5S method before generalization

2.2. 5S Implementation

Sorting: Initially, a comprehensive assessment was conducted on each workstation, analyzing the arrangement of equipment and identifying the necessary tools and documents for performing common tasks. These issues were found to impact productivity and, in some instances, pose significant health risks. To address this, 5S tags were utilized to distinguish between essential and non-essential items. Error tags were employed as labels to indicate items slated for sorting, along with the rationale behind their sorting and the intended outcome of the process. The authority for attaching and removing error tags varied depending on organizational protocols (Refer to Table I). When the sorting criteria changed based on the value of the material being sorted, decisions regarding the disposition of tagged items were made using equivalent standards. Under this framework, red labels were employed to designate materials targeted for removal from the work area during the sorting phase, signifying necessary actions. Conversely, materials and equipment, were identified using yellow labels, earmarked for retention in the area during sorting, but requiring repair, refurbishment, or review. Fig 3 illustrates the existing (before) and proposed workplace layouts for sorting implementation.

Table 1. Authorization for the removal of materials labeled with error tags.

Material Worth	Authorization to Remove Tagged Material
From 0 to 100 euros	Worker in the team (Employee)
From 100 euros - 1,000 euros	Foreman - Expert
1,000 € or higher	Manager

Fig. 3. Implementation of sorting

Implementation of Organization: The goals of the organization phase include achieving a visually organized workplace, optimizing planning and layout, and enhancing productivity by reducing time spent searching for materials. Storage decisions are based on pertinent considerations. After analyzing the existing condition of the shop floor, assessment checklists were created for each workstation, delineating essential areas for enhancement throughout all 5S phases. In a collaborative brainstorming session with the team, the evaluation checklist underwent a comprehensive review, and corrective measures were suggested to tackle identified issues. Fig. 4 illustrates the existing and proposed workplace layouts for the organization phase.

Implementation of Shine: The primary objective of sanitation is to eliminate waste, soil, and external particles to establish a tidier and safer work environment. Sanitation emerged as a concern, with observed deficiencies in inspection standards within workspaces and prevalent dirtiness in certain storage areas, components, and flooring. While teams undertake cleaning tasks, their workflow typically begins with horizontal surfaces, proceeds to vertical surfaces, and concludes with the interiors of shelves and cabinets. This systematic approach ensures the separation of necessary and unnecessary materials, resulting in a tidy and hygienic work environment. Moreover, it minimizes the presence of potential hazards such as materials, oil, water, dust, and tools that could lead to accidents or reduced productivity within the work area. Fig. 5 illustrates the existing and proposed workplace layouts for implementing the Shine phase.

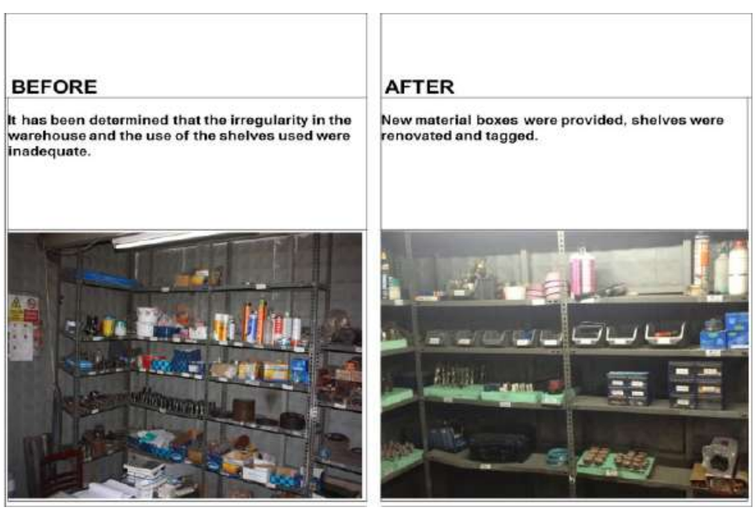

Fig. 4. Implementation of organization

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BEFORE	AFTER
Scraps of waste and unnecessary material stack wiev is seen in the photo.	As a result of the 5S application activities, the scrap and materials were separated from each other to enlarge the working area and to use the necessary material and area more efficiently.
	

Fig. 5. Shine Implementation

Standardization implementation: Standardization aims to establish guidelines and criteria for maintaining cleanliness and orderliness. To achieve this, it's essential to have clear definitions for roles and responsibilities and be repeatedly upheld. Achieving this can be facilitated by employing identification labels, visual cues, color-coded systems, and checklists [25]. For instance, Table 2 displays the cleaning schedule followed by a team, ensuring that tasks are carried out systematically and consistently.

Execution of the Sustaining Phase: Each team undergoes weekly inspections using the checklist provided in Table 3. If a team consistently scores above 80 points over 8 weeks, their inspection frequency is reduced to monthly intervals. However, if a team scores less than 80 points in any inspection, they will switch to weekly inspections until improvements are observed. At the end of each month, the weekly scores for each team are averaged to determine 5S team points, which also serve as individual 5S points for team members. Subsequently, corrective actions are taken, including tidying, organizing, cleaning, standardizing, and implementing control measures at workstations. Following this, the evaluation checklist becomes a routine task, fostering a culture of continuous improvement and ensuring the sustainability of the final 5S step: sustain.

This implementation aims to categorize semi-finished products during operations, identify, sort, and eliminate unnecessary materials, establish stocking methods for intermediate stock areas, define cleaning protocols to minimize equipment failures, promote environmental cleanliness to enhance worker motivation and cultivate sustainable habits. Procedures have been put in place, and the advantages of implementing 5S in operations have been clarified, thus guaranteeing a well-organized and disciplined 5S program.

The steps involved in the 5S methodology are comprehensively illustrated in Fig. 6. This figure provides a clear and concise summary of each stage: Seiri (Sort), Seiton (Set in Order), Seiso (Shine), Seiketsu (Standardize), and Shitsuke (Sustain). By visualizing these steps, Fig. 6 effectively encapsulates the process of organizing and maintaining a productive and efficient workspace. Each phase is depicted with its key actions and objectives, highlighting the systematic approach of the 5S methodology to foster a disciplined and orderly working environment.

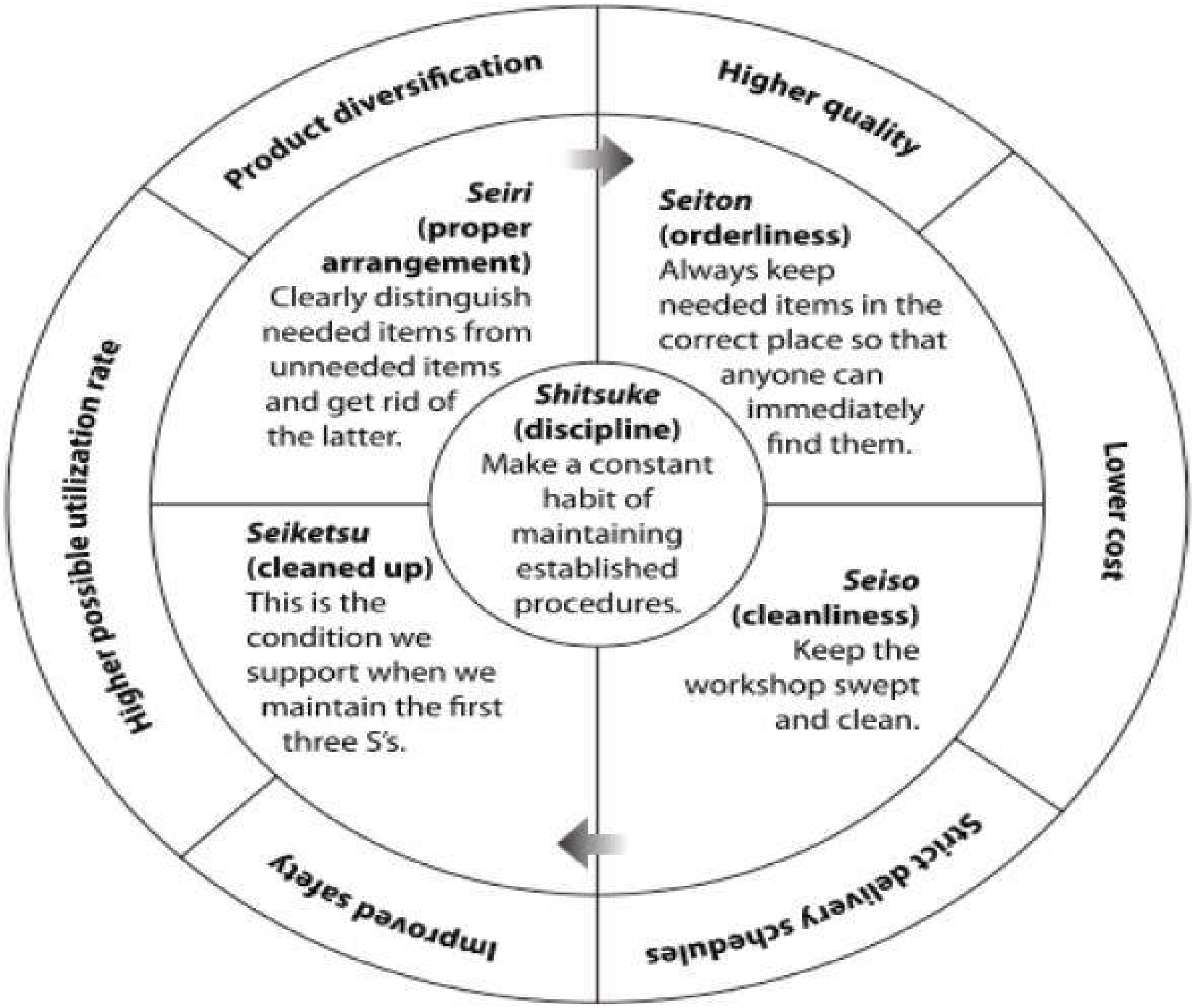

Fig. 6. Framework of 5S Investigation - Summary of the 5S Phases [26]

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Table 2. Cleaning plan

PLAN OF CLEANING FOR THE 1st TEAM

DATE:

								WEEK 1						WEEK 2						WEEK 3						WEEK 4						WEEK 5					
PLACE TO CONTROL		STANDART	CLEANING & CONTROL METHOD	REQ. TOOL & MATERIAL	ABNORMAL ACTION	CONTROL FREQUENCY	RESPONSIBLE	MON	TUE	WED	THU	FRİ	SAT	MON	TUE	WED	THU	FRİ	SAT	MON	TUE	WED	THU	FRİ	SAT	MON	TUE	WED	THU	FRİ	SAT	MON	TUE	WED	THU	FRİ	SAT
DAILY CLEANING CONTROLS																																					
A	WELD GRINDING AREA	Don't let undefined materail and slag	Visual Inspection	Spade, sweep		16.45 16.55	STAFF 1																														
B	MOUNTING STAND	Don't let undefined materail, No stamped plates etc.	Visual Inspection	Spade, sweep		16.45 16.56	STAFF 2																														
C	MECHANICAL APPARATUS	Arrange in sequence and clean with a swab.	Visual Inspection	Swob		16.45 16.57	STAFF 3																														
D	WORKBENCH	Clean up dust and spiral shavings.	Visual Inspection	Spade, sweep		16.45 16.58	STAFF 3																														
WEEKLY CLEANING CONTROLS																																					
E	INTERRIORS OF COLUMNS AND COLUMN SPACES	Don't let undefined materail and dust	Visual Inspection	Spade, sweep		FRIDAY 14.10 14.30	STAFF 2	WEEK 1						WEEK 2						WEEK 3						WEEK 4						WEEK 5					
F	MACHINE PARK	Don't let undefined materail and dust	Visual Inspection	Spade, sweep		FRIDAY 14.10 14.40	STAFF 3	WEEK1						WEEK 2						WEEK3						WEEK4						WEEK 5					
CLEANING CONTROL PER 6 MONTHS																																					
G	COLUMNS AND WALLS	Wipe off Colomns and walls	Visual Inspection	Swob, Tin basket		THIRD WEEK OF FEBRUARY AND AUGUST	ALL STAFF	1.												2.																	

Table 3. 5S evaluation checklist

				F-YST-003/02 (1)
5S INSPECTION FORM				
Place of Inspection ; Team Leader : Auditors : Audit Day : Last Audit Day :		1. Sorting Score (max 10) ; 2. Arrangement Score (max 40) : 3. Cleaning Score (max 20) : 4. Standardization Score (max 10) : 5. Discipline Score (max 20) : Total Score : Last Audit Score :	10 40 20 10 20 100	
	QUESTIONS	**FINDINGS**	**NO of FINDINGS**	**POINT**
1. STEP : SORTING				
1	Have superfluous components been eliminated from the site? All items present should pertain directly to the tasks being carried out. We need to inquire whether elements lacking a specific purpose, such as those in the drawer interior, are pertinent to the work. Additionally, it's crucial to assess whether there's an excess of materials beyond the necessary quantity specified for that location, for instance, if there are three water gauges instead of the required one.			10
2. STEP: ARRANGEMENT - DEFINITION				
2	Has everything on the site been clearly designated (including the interior of the locker)? The placement of all essential elements at the site must be explicitly defined. Equipment should be positioned according to location guidelines, and appropriate identifications such as labels or templates must be utilized.			10
3	Are the location descriptions adhered to? (including the interior of the locker) Specifications regarding lines, labels, and quantities must be followed diligently. No elements should exceed or fall outside the designated lines, and there shouldn't be any items inconsistent with the definitions and quantities stated on the labels. Additionally, items should not be mixed within containers. All materials must be intact and positioned in their designated places.			10
4	Have shading techniques been employed in the depiction of machine equipment and hand tools? The location of the equipment should be represented by drawing the shape of each piece.			10
5	Does the layout in the workspace prioritize occupational safety and ergonomics? All required personal protective equipment (PPE) must be specified, warning signs must be clearly marked, and equipment arrangement should consider ergonomic principles. For instance, ensuring drawers are easy to open and close, providing warnings for slippery floors, avoiding stacking heavy materials at excessive heights, keeping walkways and emergency exit doors clear of obstacles, and ensuring materials do not exceed weight capacity on stands, with tonnage capacities clearly defined.			10
3. STEP: CLEANING - TIDYNESS				
6	Is machinery, equipment, trolleys, and cabinets clean, painted, and free from damage? Are the labels and signs clean and legible? Is waste disposed of in the correct locations? Broken glass, spilled paint, damaged tables, chairs, etc., should be avoided. Labels, tapes, and paints should be clean and devoid of wear. Paper waste should be disposed of in paper waste bins, plastics in plastic waste bins, and so forth. Domestic waste should not be disposed of in wire waste bins due to the risk of fire. Spiral grindings should not be disposed of in regular trash or waste bins.			10
7	Has the work area been cleaned and tidied up? Have measures been implemented to address sources of dirt? Are the essential cleaning supplies accessible? Is there an up-to-date cleaning plan in place? Is the cleaning of communal areas clearly outlined? The rest area, work area floor, lower sections of walls, cabinets, tool boards, and tool leader area should all be kept clean. Necessary cleaning materials must be readily available. The cleaning plan should include standards, methods, equipment, frequency, timing, and assigned responsibilities, and it should be consistently updated. Cleaning responsibilities should encompass shared tasks, including the upkeep of communal areas.			10
4. STEP: STANDARDIZATION				
8	Are there any conditions within the workspace that fail to meet established standards? Are the tapes, paints, labels, and signs used in accordance with specified standards? Do the documents present in the work area adhere to these standards? Identification methods must align with established standards, and there should be no definitions or regulations in the workspace that deviate from these standards. The site should not include outdated or obsolete documents that do not conform to our document system.			10
5. STEP: DISCIPLINE - IMPROVEMENT				
9	Is the team leader executing a structured audit system to uphold and enhance workplace organization? Defined audits need to be conducted, and the outcomes should be displayed on the team board. The published audit results must be exhibited on the team board, shared with team members, and task distribution planning needed to address the identified actions among team members should be arranged.			10
10	Are actions identified regarding non-conformities monitored using follow-up lists? Any deficiencies observed in the field should be documented in the action follow-up lists along with the responsible parties and target completion dates. Past actions should be resolved, and there should be no outstanding actions from more than one week ago. For example, actions planned in January should not be present in the follow-up lists of an April audit.			10
			Audit Score:	100
Statements:				

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2.3. Application of kaizen

Kaizen embodies continuity, necessitating continuous efforts from workers to enhance processes. Employees should consistently provide suggestions and innovations to address challenges. Rather than investing money in solutions, the emphasis should be on investing in ideas. Therefore, the Kaizen suggestion system significantly contributes to the significant achievements of our 5S initiative. Within our organization, concrete improvement suggestions proposed by employees are recorded in Kaizen documentation, and their ideas are incentivized according to the degree of improvements implemented by management (see Table 4). Statistical analysis is conducted on the quantity of suggestions per employee, and the influence of employees' suggestions on overall company enhancement, along with their execution of Kaizen projects, is closely monitored.

Table 4. Kaizen Suggestions Categorization and Incentive Program

Classes	1st Class	2nd Class
KAIZEN Categories	Simplicity	Near Miss(KRK)
	In-Process Quality	5S
	Autonomous Maintenance	Ergonomics
Prizes	20 TL / KAIZEN	5 TL/ KRK KAIZEN
	QGC for Best KAIZEN	10 TL/ 5S & Ergonomics Kaizen
		QGC for Best KAIZEN

Suggestions are grouped into six categories and are subject to worker voting for the selection of the best suggestions, organized into two classes. The categories for the first class include Simplicity, In-Process Quality, and Autonomous Maintenance, while the second class includes Near Miss (KRK), 5S, and Ergonomics. Simplicity suggestions entail streamlining and expediting existing tasks performed by workers. In-process quality suggestions involve addressing recurring quality issues that necessitate process interruptions and prolong cycle times. Autonomous Maintenance suggestions focus on preventing machine malfunctions, reducing maintenance downtime, and enhancing machine capabilities, productivity, or utility. Near Miss (KRK) suggestions aim to avert workplace accidents, minimize wasted time and movements, and reduce material overconsumption, among other things. 5S suggestions aim to maintain cleanliness in the work area or ensure the easy and efficient organization of work and storage spaces. Ergonomic suggestions strive to establish improved ergonomic work environments for employees. The number of suggestions per employee undergoes statistical evaluation, and the impact of employees' suggestions on the overall improvement of the company, as well as the implementation of Kaizens, is tracked. Monetary rewards to incentivize workers are detailed in Table 5.

Table 5. Total Compensation for Kaizen Suggestions

Date	Factory-2 Kaizen Wages (TL)	Factory-1 Kaizen Wages (TL)
6th-8th months of 2015	1,760	1,490
9th-11th months of 2015	1,345	1,150
12th 2015-2nd 2016	410	240
3rd month of 2016	280	380
4th month of 2016	280	240
5th-6th months of 2016	160	360
Total	4,235	3,860
Average	222	203
Quarter Gold Coins (QGC)	12 QGC	12 QGC

2.4. Job analysis and evaluation

A questionnaire is employed alongside observation and job analysis techniques through interviews concurrently. In the questionnaire survey, analysts complete essential sections and gather information from workers. Subsequently, feedback is solicited from higher management levels. The evaluation of the jobs utilizes the point method, incorporating the Analytical Hierarchy Process (AHP), a multifaceted decision-making tool. Job evaluation utilizing AHP represents a relatively novel approach for determining job significance.

The work analysis form comprises four primary sections: Task Information, Minimum Necessary Job Attributes, Organizational Relations, and Effort Required for the Task. Task Information offers a concise overview of the tasks involved, featuring brief and precise descriptions detailing how the job is performed. Minimum Necessary Job Attributes delineate the essential requirements of the role, distinct from job descriptions, which pertain to the job itself, whereas specifications pertain to the characteristics of the individual occupying the role. In line with guidance from the Project Chief, visits were made to the Mechanic Workshop, Electrical Workshop, and Chipping Production Workshops for job analysis purposes. The survey method was employed concurrently with interviews to gather information, supplemented by observation. A comprehensive list of all jobs and the corresponding workforce distribution within the factory is presented in Table 6. While there is no statistical dependency or correlation analysis conducted, the tabulated data merely serves to provide additional context to readers and does not directly impact subsequent stages of our study. Job descriptions are formulated through the utilization of a work analysis form. Work Analysis form is acting as an intermediatory, and is filled out during the interview phase.

For job evaluation, AHP analyses are conducted to ascertain the importance weights for both main and sub-factors. Utilizing the 1-9 AHP scale [27] as stipulated in the point method, points for all factors and factor degree points have been computed according to the Analytical Hierarchy Process methodology. In this approach, factor degrees are categorized as perfect, good, medium, weak, and bad, respectively. Degree weight points are determined by normalizing the corresponding matrix, such as Perfect= 0.503, Good= 0.260, Medium= 0.134, Weak= 0.068, Bad= 0.035. These calculations are detailed in Table 7. During this phase, based on job descriptions, the points for main factors and sub-factors of each job using the AHP technique have been computed, as demonstrated in Table 7. Subsequently, these points have been aggregated, yielding the total points for each job, as illustrated in Table 8.

Table 6. The quantity of job roles and individuals subjected to work analysis within the factory premises.

#	Jobs	The count of employees
1	Plant Director	1
2	Project Manager	1
3	Manufacturing Manager	3
4	Warehouse manager	1
5	Quality Assurance Manager	1
6	Assistant warehouse manager	2
7	Draftsman	1
8	Software Technician	1
9	Supervisor of Mechanics	2

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10	Master of Mechanical Repairing	1
11	Master of Electrical Repairing	1
12	Erection Specialist	1
13	Bending Technician	2
14	Turning Technician	11
15	CNC Technician	2
16	Technician of Milling	2
17	Operator of Sandblasting & Dyeing	2
18	Painting Technician	1
19	Welding Operator	25
20	Cleaning Staff	2

2.5. Developing a salary system using job evaluation points

Numerous job evaluation methods exist, primarily categorized into two groups: qualitative and quantitative methods. In our pursuit of fairness and transparency, we aimed to choose an objective approach from these methods. Among them, the Point Method [28] is widely regarded as the most objective. Hence, we opted to utilize this method for our evaluation process. Establishing a healthier and more straightforward relationship between wages and work value is achievable through the scoring of work in terms of points, which are essentially the values in the point method. Once this relationship is established, the resulting mathematical outcome often manifests as a linear or curved line. The least-squares method, a mathematical technique, is commonly employed to establish this correlation. By employing this method, the fundamental wage curve is determined. In the coordinate system (*x*, worker) used for plotting the wage line or curve, the work point is indicated on the *x-axis*, while the work wage (hourly, daily, monthly) is depicted on the worker axis. Through the utilization of the point method, job wages are delineated through the following stages.

Table 7. The scores of factors and sub-factor degrees

Main factors and sub-factors	**Weights (obtained from AHP)**	**Points**	**Factor degree points**				
			1	**2**	**3**	**4**	**5**
1- Skill	0.503	**503**					
Education	0.495	249	17.00	31.00	63.00	127.00	249.00
Experience	0.194	98	7.00	12.00	25.00	50.00	98.00
Private ability	0.185	93	6.00	11.00	23.00	47.00	93.00
Communication	0.086	43	3.00	5.00	11.00	22.00	43.00
Basic Knowledge	0.040	20	1.00	3.00	5.00	10.00	20.00
2- Responsibility	0.134	**134**					
Human	0.634	85	6.00	10.00	21.00	43.00	85.00
Documentation	0.260	35	2.00	4.00	9.00	18.00	35.00
Machine	0.106	14	1.00	2.00	4.00	7.00	14.00
3- Mental Effort	0.260	**260**					
Coordination	0.503	131	9.00	16.00	33.00	67.00	131.00

Attention	0.260	68	5.00	8.00	17.00	35.00	68.00
Memory	0.134	35	2.00	4.00	9.00	18.00	35.00
Observation	0.068	18	1.00	2.00	5.00	9.00	18.00
Control	0.035	9	0.60	1.00	2.00	5.00	9.00
4- Body Effort	0.068	**68**					
Standing	0.633	43	3.00	5.00	11.00	22.00	43.00
Moving	0.260	18	1.00	2.00	5.00	9.00	18.00
Sedentary	0.107	7	0.40	1.00	2.00	4.00	7.00
5-Environmental Conditions	0.035	**35**					
Working conditions	0.750	26	2.00	3.00	7.00	13.00	26.00
Workplace risks	0.250	9	0.50	1.00	2.00	5.00	9.00

Table 8. Computed points for positions

No	Jobs	Points
1	Plant Director	648
2	Manufacturing Manager	638
3	Project Manager	549
4	Supervisor of Mechanics	504
5	Quality Assurance Manager	487
6	Draftsman	335
7	Warehouse Manager	325
8	Welding Operator	323
9	Software Technician	318
10	Bending Technician	284
11	Assistant of Warehouse Manager	277
12	Master of Electrical Repairing	270
13	Erection Specialist	250
14	Master of Mechanical Repairing	246
15	Technician of Milling	245
16	CNC Technician	239
17	Turning Technician	238
18	Operator of Sandblasting & Dyeing	203
19	Painting Technician	197
20	Cleaning Staff	154

2.5.1 Plotting the wage curve for organization

The least squares method was utilized to plot the wage curve for the organization.

1. For the linear wage model, (1)-(2) are employed to determine the linear wage equations.

$$\sum Worker = b.\sum x + a.N \tag{1}$$

$$\sum yx = b. \sum x2 + a .\sum x \tag{2}$$

Here, x represents scores, worker prices, and N denotes the total number of available jobs. The formula resulting from these calculations is represented by (3).

$$Worker = a + bx \tag{3}$$

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2. Equations (4)-(5) are utilized to derive curved wage equations for the parabolic wage model.

$$\sum 1/Worker \; = \; b.\sum x \; + a.N \tag{4}$$

$$\sum \text{x / Worker} = \text{b.} \sum \text{x2} + \text{a.} \sum \text{x} \tag{5}$$

Here, *x* denotes scores, worker prices, and N represents the total number of available jobs. The formula resulting from these calculations is illustrated in (6):

$$Worker\ wage \; = \; 1\,/\,(a \; + \; bx) \tag{6}$$

In this study, we employed the parabolic wage model. Here, as the score increases, it is observed that the coefficient *b* must be negative to reflect the increase in wages. Using (4) - (5), wages were calculated as outlined in Table 9. The wages listed in Table 9 are the outcome of the job evaluation conducted within the company, where jobs falling within the specified point range are multiplied by the monthly working hours. During these wage calculations, actual sector data and trade union guidelines are taken into consideration. Subsequently, in order to establish base wages, a wage parabola needs to be constructed. Given the absence of linear wage curves in business environments, wage curves serve as graphical representations depicting the wage variation of jobs at specific point intervals. Equation (8) is utilized to plot the wage parabola, thereby obtaining base values for the wages.

Determining the "r" value for White-Collar Workers in Table 9.

The factory management established the maximum and minimum wage values at 15,000 TL and 2,400 TL respectively. Within the white-collar job classification, there are a total of 7 jobs. Thus, the r-value of a geometric sequence is computed as shown in (7) below:

$$r = \sqrt[n-1]{\frac{a_n}{a_1}} = \sqrt[7-1]{\frac{15.000}{2400}} = 1.357208808 \tag{7}$$

Determining the "r" value for Blue-Collar Workers in Table 9.

The factory management established the maximum and minimum wage values at 3,195 TL and 1,270 TL respectively. Within the blue-collar job classification, there are a total of 13 jobs. Thus, the r-value of a geometric sequence is computed as illustrated in (8) below:

$$\mathrm{r} = \sqrt[n-1]{\frac{a_n}{a_1}} = \sqrt[13-1]{\frac{3.195}{1.270}} = 1.079913396 \tag{8}$$

2.5.2 Equation representing the wage curve for white-collar workers

By employing (4) and (5), the Linear Wage curve equation for white-collar staff is denoted by (9) and (10). Consequently, the value of a is determined to be 5.68 x 10^{-4}, and the value of *b* is -7.83 x 10^{-7}

$$7a \; + \; 3.300\,b = \; 0.001396 \tag{9}$$

$$3.300\ \text{a}+1.684.157\ \text{b}= 0.557451 \tag{10}$$

Subsequently, these values are inserted into (6), resulting in the wage curve depicted in Fig.7. This curve is defined by (11).

$$Worker\ wage \; = \; 1\,/\,(5.68.10 - 4 - \; 7.83.10 - 7\,x\,) \tag{11}$$

Table 9. Determining wages based on the evaluation points of work.

Categories of worker	Job Name	Score (X)	Wage Proposal based on Geo. Seq. (*r*=1,3572) (Worker)	X^2	*XY*	*1/Worker*	*X/Worker*
White Collar	Plant Director	648	15,000	419,904	9,720,000	0.0000667	0.0432
	Manufacturing Manager	638	11,052	407,044	7,051,236	0.0000905	0.0577266
	Project Manager	549	8,143	301,401	4,470,646	0.0001228	0.0674178
	Quality Assurance Manager	487	6,000	237,169	2,922,000	0.0001667	0.0811667
	Draftsman	335	4,421	111,890	1,478,770	0.0002262	0.0756644
	Warehouse Manager	325	3,257	105,625	1,058,623	0.000307	0.0997759
	Software Technician	318	2,400	101,124	763,200	0.0004167	0.1325
	Total	**3,000**	**50,273**	**1,684,157**	**27,464,475**	**0.001396**	**0.557451**
Blue Collar	Supervisor of Mechanics	504	3,195	254,016	1,610,280	0.000313	0.1577465
	Welding Operator	323	2,959	104,329	580,108	0.0005568	0.1798441
	Bending Technician	284	2,740	80,656	582,200	0.0004878	0.1385366
	Assistant of Warehouse Manager	277	2,537	76,729	472,285	0.0005865	0.1624633
	Master of Electrical Repairing	270	2,349	72,900	560,250	0.0004819	0.1301205
	Erection Specialist	250	2,175	62,500	470,000	0.0005319	0.1329787
	Master of Mechanical Repairing	246	2,014	60,516	461,250	0.0005333	0.1312
	Technician of Milling	245	1,865	60,025	437,080	0.0005605	0.1373318
	CNC Technician	239	1,727	57,121	382,400	0.000625	0.149375
	Turning Technician	238	1,599	56,644	361,284	0.0006588	0.1567852
	Operator of Sandblasting & Dyeing	203	1,481	41,209	293,335	0.000692	0.1404844
	Painting Technician	197	1,371	38,809	284,665	0.000692	0.1363322
	Cleaning Staff	154	1,270	23,716	197,582	0.0007794	0.1200312
	Total	**3,430**	**27,284**	**989,170**	**6,692,719**	**0.007499**	**1.87323**
	General Total	**6,730**	**77,557**	**2,673,327**	**34,157,194**	**0.008896**	**2.430681**

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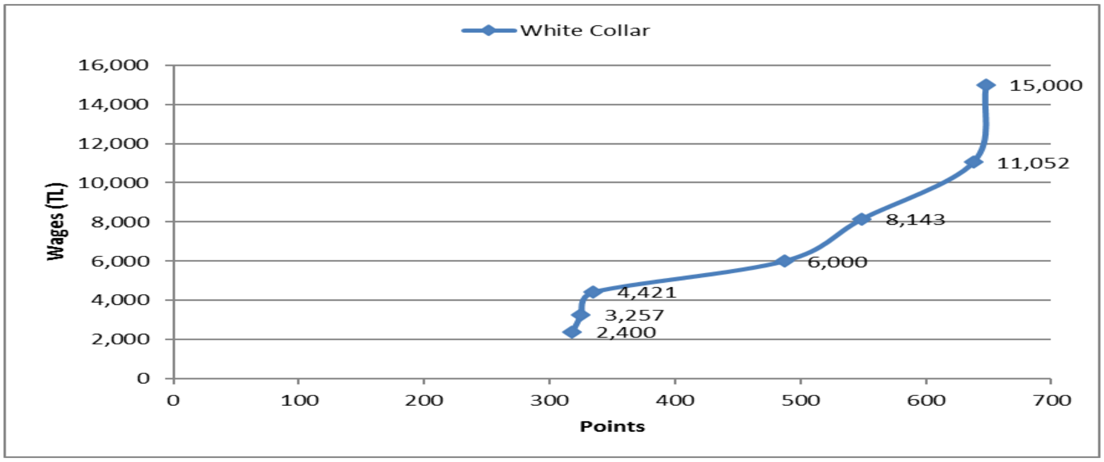

Fig. 7. The wage curve for white-collar staff

2.5.3. Equation depicting the wage curve for blue-collar workers

The wage curve for blue-collar workers is determined using (4) and (5), resulting in (12) and (13). Consequently, the regression coefficients are calculated to be a = 9.07x10[4] and b = -1.25x10[-6].

$$13a + 3{,}430\, b = 0.007499 \tag{12}$$

$$3{,}430\, a + 989{,}170\, b = 1.873230 \tag{13}$$

Upon substituting the coefficients into (6), the wage curve for blue-collar staff is represented in Fig. 8. The equation defining the wage curve for blue-collar staff is provided in (14).

$$Worker = 1 \,/\, (9.07.10 - 4 - 1.25.10 - 6\,.\,x) \tag{14}$$

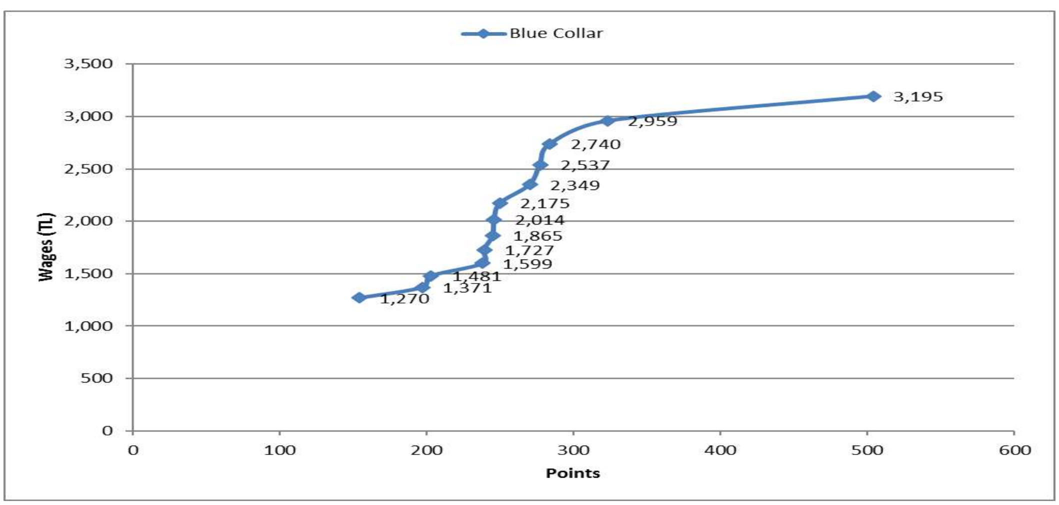

Fig. 8. The wage curve for blue-collar staff

2.6. Wage increment based on Lean Management 5S Team Point

This approach facilitates salary increases based on the effectiveness of teams in implementing the 5S methodology of lean management. Within the core operations of the company, wage adjustments are determined in accordance with the success of the 5S implementation, and 5S evaluation forms are utilized for this purpose. Over a specified timeframe, evaluations are conducted, establishing fundamental principles governing the relationship between employee wages and the team's performance. Specifically, the average 5S evaluation points for each team are calculated every six months. The additional earnings, based on the average 5S evaluation points, are outlined in Table 10. These supplementary earnings ratios are established in collaboration with factory management, which comprises a board of members. Consequently, these wage increments are added to employees' base salaries as monthly additional earnings, without deduction for the duration of their employment. However, if an employee is not part of any 5S team, if their team's 5S performance score falls below 71, or if they are assigned to a different position, the additional earnings are not disbursed. It is noteworthy that this practice is not stipulated as a condition in the employment contract and has been endorsed by the employees.

Table 10. Ratios based on Performance are applied in addition to team 5S scores.

5S Point Range	Additional Earning (%)
0-70	0%
71-79	3%
80-89	5%
90-95	7%
96-100	10%

3. Results and Discussion

While the quantifiable benefits of this approach may not be readily apparent, several advantages have been discerned, including decreased risk of workplace accidents, enhanced working conditions, heightened employee engagement and improved overall work demeanor, well-structured workstations, maximized storage efficiency, reduced employee movements, and minimized unproductive periods. Various enhancements are depicted in Fig. 9.

Fig. 9. Examples illustrating the conditions before and after the implementations

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Moreover, the existing condition of workstations proved highly beneficial in pinpointing issues and fostering additional enhancements in the manufacturing process, proving invaluable during the implementation of VSM. The set objective for workers regarding KRK suggestions was 0.4 times the number of team members, while for executed KRK suggestions, it was 0.3 times the number of team members per month. The one-year performance of teams is illustrated in Fig. 10.

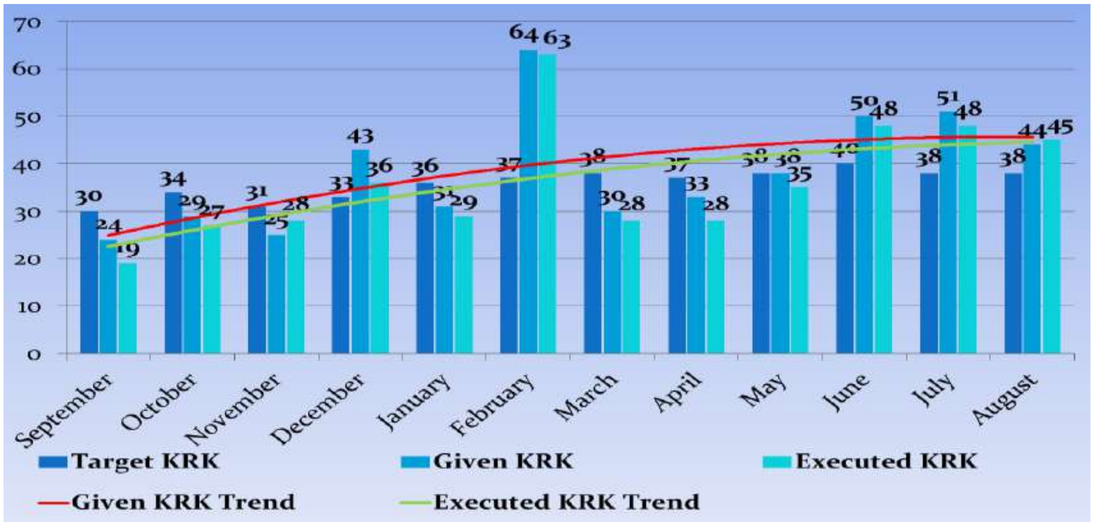

Fig. 10. Graph depicting the annual distribution and trend of KRK

The targeted workforce for other specified Kaizen suggestions was determined as equal to the number of team members, while for implemented Kaizen suggestions, it was set at half the number of team members per month. The annual performances of the teams in Field 1 and Field 2 are depicted in Fig. 11, showing the distribution and trend of other Kaizen suggestions in each field.

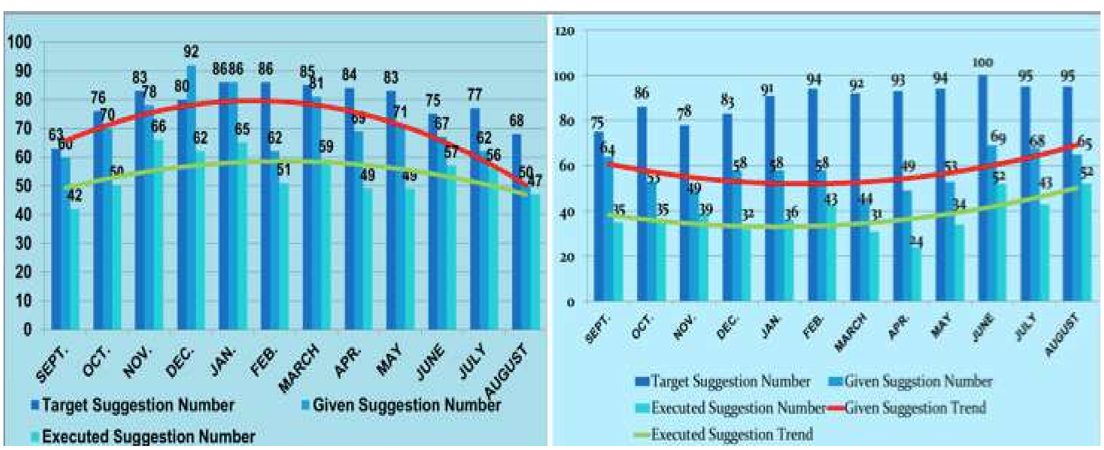

Fig. 11. The distribution and trend graph of other Kaizen suggestions in Field-1 and Field-2

The one-year trend graph depicting changes in occupational injuries, facilitated by 5S and Kaizen seminars and implementations, is illustrated in Fig. 12.

Fig. 12. Numbers and trend of occupational injury.

Initially, team leader candidates were identified by the factory management. Those candidates who attained more than 70 points within a six-month period were appointed as team leaders. Subsequently, they received a team leadership compensation of 250 ₺ per month. Over the course of one year, most of the color indicators in Table 13 transitioned to blue or green. However, in the 6th and 12th months, red boxes are observed. This occurrence coincides with periods of salary increases, during which any discontent among team leaders was manifested through reduced performance. This served as one of the motivating factors behind conducting this study. In Tables 13 and 14, boxes are colored according to reference Table 12.

Table 12. Box color notation of Table 13 and Table 14

Range of Scores	Color
91-100	Green
81-90	Blue
71-80	Yellow
61-70	Orange
0-60	Red

Table 13. Team 5S scores over twelve months

CREWS		CREW MEMBERS	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.
PRODUCTION-ASSEMBLY	CREW-1	11	90	86	78	59	79	77	81	77	85	98	90	87
	CREW-2	10	BECAME TLA ON DEC.			66	83	75	69	78	90	97	95	92
	CREW-3	4	BECAME TLA ON NOV.		95	70	87	78	78	86	90	95	97	92
	CREW-4	9	95	81	86	87	85	83	83	95	90	92	92	86
	CREW-5	8	67	66	64	67	78	72	82	87	70	71	93	75
	CREW-6	8	BECAME TLA ON DEC.			59	92	85	85	97	90	97	97	90
	CREW-7	9	BECAME TLA ON DEC.			69	69	69	76	73	87	90	95	95
	CREW-8		BECAME TLA ON JUNE.									67	74	70
WELDING	CREW-9	12	BECAME TLA ON APR.							67	70	70	90	92
	CREW-10	12	BECAME TLA ON APR.							69	69	95	97	84
CUTTING & BENDING	CREW-11	8	90	72	76	71	86	79	82	75	76	74	82	95
SUPPORT UNITS	CREW-12	8	BECAME TLA ON OCT.	76	92	87	67	75	75	74	67	72	69	67
MAINTENANCE	CREW-13	4	BECAME TLA ON APR.							69	71	93	81	76
MACHINING	CREW-14	7	76	67	69	80	67	74	72	70	77	59	72	67
										AVRG	79	84	87	83

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3.1. New wages based on work analysis and 5S scores

For each predetermined job, work analyses are conducted, and their points and corresponding wages are determined using the point method and geometric distribution. Subsequently, wage adjustments are made for individual workers based on their average 5S points over a six-month period. During these six months, teams of workers may be altered by team leaders to accommodate fluctuations in labor requirements, thus rendering the average team points independent of their prior team affiliations. Consequently, the revised wage calculations for our case study are outlined in Table 15.

Table 14. Partial representation of 6-month individual 5S scores

	Worker	May	June	July	August	September	October	6 months average
1	WORKER-1	73	77	81	76	76	78	77
2	WORKER-2	82	77	76	76	76	73	77
3	WORKER-3	66	75	63	60	60	65	65
4	WORKER-4	79	65	69	58	70	81	70
5	WORKER-5	67	86	81	93	83	96	84
6	WORKER-6	72	64	73	60	69	74	69
7	WORKER-7	77	63	63	72	74	74	71
8	WORKER-8	81	86	90	92	81	82	85
9	WORKER-9	69	83	72	77	80	83	77
10	WORKER-10	70	78	79	67	85	78	76
11	WORKER-11	65	71	71	70	77	90	74
12	WORKER-12	74	62	68	On Duty	77	77	72
13	WORKER-13	71	83	83	On Duty	77	78	78
14	WORKER-14	69	64	78	75	83	81	75
15	WORKER-15	83	86	92	87	80	97	88
16	WORKER-16	79	86	82	80	85	68	80
17	WORKER-17	68	72	70	69	76	85	73
18	WORKER-18	70	78	82	90	94	88	84
19	WORKER-19	88	98	98	85	91	97	93
20	WORKER-20	73	76	80	65	83	70	75

Table 15. New wage computations integrating the findings from work analysis and 5S scores.

Worker No	*Job*	*Category*	*Job score*	*Actual wage based on job evaluation results (₺)*	*5S Team Score (6 Month Av.)*	*Wage increment based on present 5S team score (%)*	*Total new wage (₺)*
1	Plant Director	**White Collar**	648	15,000	-	-	15,000
2	Manufacturing Man.		638	11,052	-	-	11,052
3	Manufacturing Man.		638	11,052	-	-	11,052
4	Project Manager		549	8,143	-	-	8,143
5	Project Manager		549	8,143	-	-	8,143
6	Draftsman		335	4,421	-	-	4,421
7	Draftsman		335	4,421	-	-	4,421
8	Warehouse Man.		325	3,257	-	-	3,257
9	Software Technic.		318	2,400	-	-	2,400
10	Quality Assr. Man.		487	6,000	-	-	6,000
11	Quality Assr. Man.		487	6,000	-	-	6,000
12	Supervisor of Mechan.	**Blue Collar**	504	3,195	-	-	3,195
13	Supervisor of Mechan.		504	3,195	-	-	3,195
14	Supervisor of Mechan.		504	3,195	-	-	3,195

15	Mast. of Elect. Rep.		270	2,349	78	3%	2,419
16	Mast. of Mec. Rep.		246	2,014	78	3%	2,074
17	Cleaning St.		154	1,270	82	5%	1,334
18	Cleaning St.		154	1,270	84	5%	1,334
19	Cleaning St.		154	1,270	80	5%	1,334
20	Cleaning St.		154	1,270	69	0%	1,270
21	CNC Technician		239	1,727	65	0%	1,727
22	Technic. of Milling		245	1,865	67	0%	1,865
23	Technic. of Milling		245	1,865	63	0%	1,865
24	Technic. of Milling		245	1,865	65	0%	1,865
25	Technic. of Milling		245	1,865	64	0%	1,865
26	Technic. of Milling		245	1,865	65	0%	1,865
27	Technic. of Milling		245	1,865	64	0%	1,865
28	Turning Technician		238	1,599	68	0%	1,599
29	Turning Technician		238	1,599	69	0%	1,599
30	Turning Technician		238	1,599	79	3%	1,647
31	Turning Technician		238	1,599	66	0%	1,599
32	Turning Technician		238	1,599	67	0%	1,599
33	Turning Technician		238	1,599	84	5%	1,679
34	Turning Technician		238	1,599	62	0%	1,599
35	Turning Technician		238	1,599	83	5%	1,679
36	CNC Technician		239	1,727	77	3%	1,779
37	Bending Technician		284	2,740	74	3%	2,822
38	CNC Technician		239	1,727	78	3%	1,779
39	CNC Technician		239	1,727	70	0%	1,727
40	Cleaning St.		154	1,270	75	3%	1,308
41	Painting Tec.		197	1,371	77	3%	1,412
42	Cleaning St		154	1,270	68	0%	1,270
43	Cleaning St		154	1,270	69	0%	1,270
44	Painting Tec.		197	1,371	79	3%	1,412
45	Painting Tec.		197	1,371	72	3%	1,412
46	Welding Op.		323	2,959	83	5%	3,107
47	Welding Op.		323	2,959	83	5%	3,107
48	Welding Op.		323	2,959	78	3%	3,048
49	Welding Op.		323	2,959	83	5%	3,107
50	Welding Op.		323	2,959	73	3%	3,048
51	Welding Op.		323	2,959	68	0%	2,959
52	Welding Op.		323	2,959	81	5%	3,107
53	Welding Op.		323	2,959	73	3%	3,048
54	Welding Op.		323	2,959	77	3%	3,048
55	Welding Op.		323	2,959	78	3%	3,048
56	Welding Op.		323	2,959	70	0%	2,959
57	Welding Op.		323	2,959	78	3%	3,048
58	Welding Op.		323	2,959	81	5%	3,107
59	Welding Op.		323	2,959	78	3%	3,048
60	Welding Op.		323	2,959	76	3%	3,048
61	Welding Op.		323	2,959	71	3%	3,048
62	Welding Op.		323	2,959	77	3%	3,048
63	Welding Op.		323	2,959	74	3%	3,048
64	Welding Op.		323	2,959	75	3%	3,048
65	Welding Op.		323	2,959	74	3%	3,048
66	Welding Op.		323	2,959	75	3%	3,048
67	Welding Op.		323	2,959	76	3%	3,048
68	Welding Op.		323	2,959	80	5%	3,107
69	Welding Op.		323	2,959	81	5%	3,107
70	Welding Op.		323	2,959	78	3%	3,048
71	Welding Op.		323	2,959	74	3%	3,048
72	Welding Op.		323	2,959	78	3%	3,048
73	Welding Op.		323	2,959	76	3%	3,048
74	Welding Op.		323	2,959	74	3%	3,048

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75	Welding Op.		323	2,959	71	3%	3,048
76	Welding Op.		323	2,959	72	3%	3,048
77	Welding Op.		323	2,959	69	0%	2,959
78	Welding Op.		323	2,959	79	3%	3,048
79	Welding Op.		323	2,959	86	5%	3,107
80	Welding Op.		323	2,959	78	3%	3,048
81	Welding Op.		323	2,959	75	3%	3,048
82	Welding Op.		323	2,959	72	3%	3,048
83	Erection Specialist		250	2,175	84	5%	2,284
84	Erection Specialist		250	2,175	88	5%	2,284
85	Erection Specialist		250	2,175	85	5%	2,284
86	Erection Specialist		250	2,175	82	5%	2,284
87	Erection Specialist		250	2,175	82	5%	2,284
88	Erection Specialist		250	2,175	88	5%	2,284
89	Erection Specialist		250	2,175	92	7%	2,327
90	Erection Specialist		250	2,175	78	3%	2,240
91	Erection Specialist		250	2,175	82	5%	2,284
92	Erection Specialist		250	2,175	74	3%	2,240
93	Erection Specialist		250	2,175	93	7%	2,327
94	Erection Specialist		250	2,175	88	5%	2,284
95	Erection Specialist		250	2,175	88	5%	2,284
96	Erection Specialist		250	2,175	77	3%	2,240
97	Erection Specialist		250	2,175	79	3%	2,240
98	Turning Technician		238	1,599	74	3%	1,647
99	Turning Technician		238	1,599	78	3%	1,647
100	Turning Technician		238	1,599	79	3%	1,647
101	Turning Technician		238	1,599	80	5%	1,679
102	Turning Technician		238	1,599	85	5%	1,679
103	Turning Technician		238	1,599	80	5%	1,679
104	Turning Technician		238	1,599	88	5%	1,679
105	Turning Technician		238	1,599	80	5%	1,679
106	Turning Technician		238	1,599	83	5%	1,679
107	Turning Technician		238	1,599	78	3%	1,647
108	Turning Technician		238	1,599	84	5%	1,679
109	Cleaner St.		154	1,270	78	3%	1,308
110	Cleaner St.		154	1,270	80	5%	1,334
111	Cleaner St.		154	1,270	79	3%	1,308
112	Cleaner St.		154	1,270	77	3%	1,308
113	Cleaner St.		154	1,270	79	3%	1,308
114	Cleaner St.		154	1,270	88	5%	1,334
115	Cleaner St.		154	1,270	70	0%	1,270
116	Cleaner St.		154	1,270	75	3%	1,308
117	Cleaner St.		154	1,270	75	3%	1,308
118	Cleaner St.		154	1,270	74	3%	1,308
119	Cleaner St.		154	1,270	77	3%	1,308
120	Cleaner St.		154	1,270	80	5%	1,334
121	Cleaner St.		154	1,270	79	3%	1,308
122	Cleaner St.		154	1,270	69	0%	1,270
123	Cleaner St.		154	1,270	76	3%	1,308
124	Cleaner St.		154	1,270	70	0%	1,270
125	Cleaner St.		154	1,270	76	3%	1,308
126	Cleaner St.		154	1,270	80	5%	1,334
127	Cleaner St.		154	1,270	82	5%	1,334
128	Cleaner St.		154	1,270	72	3%	1,308
129	Cleaner St.		154	1,270	68	0%	1,270
130	Cleaner St.		154	1,270	79	3%	1,308
131	Cleaner St.		154	1,270	72	3%	1,308
132	Cleaner St.		154	1,270	77	3%	1,308
133	Cleaner St.		154	1,270	81	5%	1,334
134	Cleaner St.		154	1,270	77	3%	1,308

135	Cleaner St.		154	1,270	76	3%	1,308
136	Cleaner St.		154	1,270	74	3%	1,308
137	Cleaner St.		154	1,270	71	3%	1,308
138	Cleaner St.		154	1,270	75	3%	1,308
139	Cleaner St.		154	1,270	75	3%	1,308
140	Cleaner St.		154	1,270	74	3%	1,308
141	Cleaner St.		154	1,270	70	0%	1,270
142	Cleaner St.		154	1,270	77	3%	1,308
143	Cleaner St.		154	1,270	72	3%	1,308
144	Cleaner St.		154	1,270	78	3%	1,308
145	Cleaner St.		154	1,270	75	3%	1,308

3.2. Comparison of results with the previous studies

Equal pay legislation mandates thorough scrutiny of job evaluation procedures, sometimes extending to legal proceedings. Furthermore, emerging principles emphasize the importance of transparent and unbiased development and implementation of job evaluation programs. A distinction drawn by the European Court lies between analytical and non-analytical methods. Analytical frameworks involve breaking down tasks into constituent elements for comparative analysis, while non-analytical approaches assess the relative value of jobs as whole entities. Formal methods, particularly analytical schemes, are deemed to offer greater transparency and reduced susceptibility to bias. Nevertheless, it is acknowledged that no plan can achieve complete objectivity, as the entire process hinges on evaluators' subjective judgments influenced by their backgrounds, experiences, and attitudes [28].

By the mid-1980s, around 75% of American companies employed job evaluation methods [29]. Yet, in the last twenty years, there has been a surge in the customization of employment dynamics, accompanied by a decline in union presence across many Western nations. Employers have been urged to adopt greater flexibility and entertain significant alterations in their employment methodologies. Job evaluation is now often depicted as bureaucratic, rigid, reinforcing hierarchical structures, and disconnected from contemporary demands. Lawler contends that in swiftly evolving, fiercely competitive landscapes, compensation frameworks should prioritize growth, development, and performance, particularly in industries reliant on cutting-edge technology and employee expertise [30], [31]. He posits that this process is impeded by job evaluation, as it depersonalizes individuals by reducing them to a list of tasks rather than recognizing their unique qualities or capabilities.

These perspectives held sway, leading to increased importance placed on compensating individuals based on their skills, knowledge, and performance. Surprisingly, job evaluation experienced a resurgence in popularity in numerous countries, despite falling out of favor during the 1980s and early 1990s.

Job evaluation is poised to undergo further transformations, yet its extinction seems improbable. The expectation for equitable treatment among employees persists. Even amidst the era of flexibility and individualism, it remains the most dependable means to establish a wage framework perceived as rational and equitable by both employees and their managers [32].

Our study introduces a novel avenue of flexibility for job evaluators. By incorporating both team and individual metrics into job evaluation methodologies, all crucial performance indicators (such as value addition, 5S and KAIZEN initiatives, occupational safety measures, absenteeism rates, etc.) can be factored into wage and bonus calculations. Additionally, job evaluation points can serve as the basis for base wages, while the results of lean manufacturing assessments can determine individual fee supplements. This approach

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enhances objectivity in wage equity. Crucially, the key to this lies in ensuring the measurability of key performance indicators.

5. Conclusion

In this investigation, 5S and KAIZEN methodologies were implemented within a steel construction facility. Initially, job evaluation criteria were identified as responsibility, skill, mental effort, physical effort, and environmental conditions. Under these primary factors, eighteen sub-criteria were assessed and assigned scores. Our scoring principle adhered to the notion of assigning scores based on the expertise of individuals who perform the tasks. The criteria were weighted based on input from department managers involved in the job evaluation process. Following weighting, the grade scores for each criterion were calculated using the Analytic Hierarchy Process (AHP) method. Subsequently, the job evaluation system derived from these steps was implemented utilizing observation and interview techniques. Job scores were generated through the job evaluation process, leading to the classification of work into 20 distinct groups as requested by business managers.

The lean production techniques of 5S and KAIZEN were employed to assess and contrast employee performance. These tools facilitated improved organization and cleanliness within the organization, fostering a sense of ownership among employees and enhancing performance outcomes. Performance assessments were conducted based on the results obtained from these tools. To mitigate potential dissatisfaction among employees, the wage system was intricately linked to performance levels. Consequently, performance levels in job evaluations were factored into the evaluation process and integrated into the wage model.

Consequently, an innovative wage structure has been devised, incorporating performance ratings derived from the implementation of lean production tools such as 5S and KAIZEN. This unique approach integrates both job evaluation outcomes and lean manufacturing performance metrics into the wage framework, marking a pioneering advancement in lean management practices. By adopting this method, concerns among employees were addressed, ensuring equitable distribution of the labor budget while meeting managerial requirements. However, as lean manufacturing practices were exclusively applied to blue-collar personnel, the performance ratings from these initiatives were not factored into the wage calculations for white-collar workers. With the implementation of the new wage system, all remuneration became transparent and comprehensible.

This study empowered employees by granting them greater involvement in business matters and providing them with opportunities to contribute to business enhancements. Consequently, a more democratic environment was established within the factory. Prior to this study, only the expertise of white-collar workers had been leveraged to improve and manage the business; however, afterward, the potential of all staff members began to be tapped into. Through initiatives such as 5S practices, Continuous Improvement Circles (KRKs), and the implementation of Kaizen recommendations, employees found themselves working in more humane conditions, characterized by safer, cleaner, and more orderly workspaces. This positive transformation is further evidenced by the reduction in the number of occupational accidents reported by the end of the year. This study combines the realms of job analysis and evaluation with lean manufacturing concerns, a juxtaposition not previously explored. Consistent with prior research, the performance evaluation criterion is integrated into the wage evaluation system [33], [34].

Future research should explore several areas to enhance the findings of this study. Integrating additional lean production tools and considering work experience as criteria in wage assessments could improve outcomes. Alternative job analysis methods and their applicability to project-based enterprises also warrant investigation. Developing a decision support system for job evaluations and creating a more comprehensive wage system by incorporating a wider range of criteria are recommended. Additionally, applying this method to other sectors is feasible but requires significant time for cultural transformation, which could be accelerated with experienced teams and practical training.

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