e-ISSN 2798-0502

Jurnal Ekonomi, Manajemen, Akuntansi dan Keuangan Vol: 7, No 4, 2026, Page: 1-15

Reducing Costs Thru The Implementation Of The Green Value Chain and Green Kaizen

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DOI:
https://doi.org/10.53697/emak.v7i4.4144
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Received: 09-04-2026
Accepted: 09-05-2026
Published: 09-06-2026

Abstract: The research aims to demonstrate the role of the green value chain and green Kaizen in reducing costs and improving operational and environmental efficiency in industrial economic units, thru their application in the General Company for Electrical Industries on the electric heater product. The research adopted the descriptive-analytical method based on field study and analysis of the actual cost data of the product, aiming to diagnose areas of waste and the possibility of cost reduction thru the adoption of green practices and continuous improvement. The research addressed the concept of the green value chain as a framework that integrates environmental considerations into all production activities, starting from research and development, design, and manufacturing, to marketing and recycling. It also discussed the concept of green Kaizen, which focuses on continuous improvement and reducing waste in time, materials, energy, and production defects. The PDCA cycle was also applied to diagnose and address production problems and improve the efficiency of operational processes. The research concluded that the application of the green value chain contributed to achieving financial savings by restructuring some activities, replacing traditional materials with more cost-effective and efficient eco-friendly alternatives, as well as enhancing recycling activities.

Keywords: Green Value Chain, Green Kaizen, Cost Reduction.

Introduction

The world today is witnessing an increasing interest in administrative and environmental practices that contribute to achieving sustainable development and enhancing the competitiveness of institutions (Kung & Li Huang, 2012). Between the most projecting of these applies is the employment of the green value chain, which aims to participate the conservational breadth into all production and service happenings by reducing waste, excusing resource feeding, and limiting effluence (Chan & Tay, 2018). Green Kaizen is also painstaking one of the contemporary systems that rely on unremitting improvement of progressions in an biologically friendly manner, underwriting to enhancing functioning proficiency and completing sustainable monetarist savings (Aliwi et al, 2024).

Methodology

First: Research Problem

Industrial economic units face many challenges related to high production costs, increased waste of materials and energy, high quality costs, as well as growing environmental pressures resulting from pollution and industrial waste. The General Company for Electrical Industries suffers from high production costs of electric heaters due to waste of materials, energy, and time, in addition to the poor investment of industrial waste and the lack of reliance on modern methods that contribute to improving operational and environmental efficiency.

Secondly: The Importance of the Research

The importance of the research stems from the increasing significance of modern administrative and environmental trends that seek to achieve integration between cost reduction and environmental preservation. The importance of the research can be clarified as follows:

1. Highlighting the importance of the green value chain and green Kaizen as modern methods in cost management and achieving environmental sustainability.
2. Statement of the role of green practices in improving resource and energy efficiency and reducing industrial waste
3. Helping industrial economic units adopt modern methods that contribute to cost reduction, quality improvement, and enhancing competitiveness.

Third: Research Objectives

The research aims to achieve a set of objectives, the most important of which are as follows:

1. Understanding the concept of the green value chain and green kaizen and their importance in industrial economic units.
2. Statement of the role of the green value chain in reducing costs and improving environmental performance.

Fourth: Research Hypothesis

The research is based on the main hypothesis that:

Applying the green value chain and green Kaizen contributes to reducing the production costs of electric water heaters and improving operational and environmental efficiency at the General Company for Electrical Industries.

Literature Review

First: The Origin and Concept of the Green Value Chain

The perception of the charge chain occurred in the 1950s by the American trader (Mills), who aimed to add value to the economic unit by dividing its activities into primary activities that add value and other activities that do not

add value(Alkababji,2023). Porter developed this concept by dividing activities into primary activities that directly contribute to product manufacturing and supporting activities that assist the production process (Biadacz,2024).
In 1960, the concept of Filière emerged, which was adopted by the French National Institute for Agricultural Research (Institut National de la Recherche Agronomique) and applied in developing countries, focusing on agricultural activities from ploughing the land to storage and marketing stages (Gunawan et al., 2025:2). With the evolution of management and economic thought (Cherrafi et al.,2019), this concept was developed into the green value chain, which aims to manufacture environmentally friendly products by directing the economic unit's activities towards addressing environmental issues and requirements, contributing to achieving a competitive advantage (Aliwi et al, 2024:76).

Hartman and Stafford (1988) pointed out that the traditional linear value chain assumes a one-way flow of resources, while the green value chain emphasizes a closed-loop process (Ćwiklicki,2023). In this process, high-value products are prevented from becoming waste, and the disposal of recyclable materials is minimized, thus reducing pollution (Ćwiklicki et al.,2014). Simon (1992) redefined the concept of the green value chain by highlighting the principle of re-production and re-consumption, emphasizing the importance of recycling and waste management mechanisms (De Marchi et al.,2013). Simon (1992) also recommended that economic units proactively develop specialized, environmentally friendly markets and consider green demand at all stages of the green value chain(Hasan et al.,2019). Handfield et al. (1997) argue that the optimal approach for economic units seeking to adopt green initiatives is to integrate environmental management into the value chain(Hu et al.,2021). Green management concepts and practices are applied to every link in the value chain(Huiling&Dan,2020, Jonda et al.,2023) demonstrating a statistically significant positive correlation and contributing to reduced pollution and waste during operational processes (Kung & Li Huang, 2012:111).

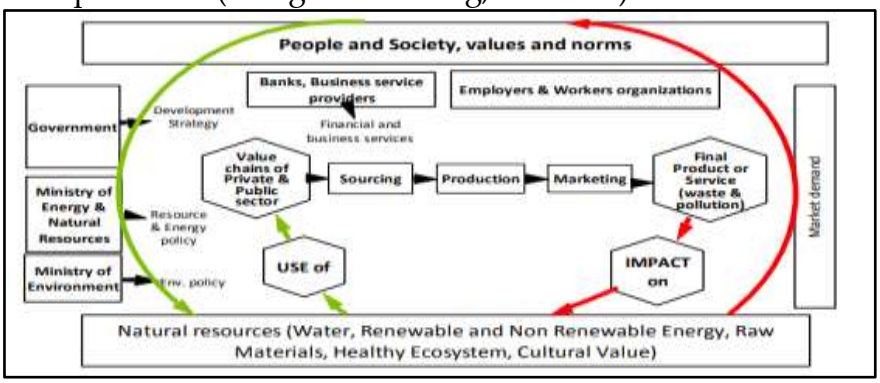

Figure 1. Green Value Chain Elements

Second: Objectives of the Green Value Chain:

The green value chain aims to achieve a set of objectives, most notably the following: (Abdulkadhim, 2023: 4):

1. The green charge chain seeks to diminish store and oomph eating and minimize surplus and litter.
2. It supports the pecuniary unit's capacity to yield green products using added innovative systems by translating patron needs into technical preparations that pronounce the complications requiring solutions, and then donating these hitches altogether to develop appropriate resolutions.
3. It enhances the wellbeing rations of the pecuniary unit's employees by renovating its happenings into biologically friendly ones.
4. It subsidizes to process reengineering, principal to concentrated waste, recovering, or the safe clearance of construction excess and used harvests.

Third: Green Value Chain Activities

The green value chain consists of seven activities, and below is an explanation of each activity:
(Mohammed and Atiyah, 2025: 471 ؛Al-Janabi, 2024: 64):

1. Green R&D
   Environmental research and development are essential elements in modern industrial activity, as strategic decisions for economic units depend on them(Kung et al.,2012). However, their management can be complex if the desired outcomes are not clearly defined(Miranda et al.,2020). Green research and development activities provide significant benefits to society and the economy by contributing to the reduction of environmental pollution and industrial emissions(Mishra,2019).
2. Green Design
   Green design is considered one of the essential activities in the green value chain, as it aims to reduce the environmental impact of the product throughout its life cycle, from the selection of raw materials to the usage stage, taking into account the possibility of recycling or reusing it when it is no longer needed(Ong et al.,2019).
3. Green Manufacturing
   Green manufacturing refers to the application of a set of procedures and technologies aimed at reducing environmental pollution resulting from production processes. This is achieved by improving resource and energy efficiency and minimizing emissions and industrial waste(Tan& Zailani,2019).
4. Green Marketing
   Green marketing encompasses a range of activities that seek to satisfy customer desires and needs without harming the environment. It objects to guide regulars toward indicating biologically friendly products and develop their ecofriendly alertness.
5. Green Distribution
   Green spreading aims to originate administration and procuring methods indoors economic units, confirming that goods reach the largest probable number of customs in safe, low-cost, and minimally biologically impactful ways.

6. Green Services
   Green amenities refer to officialdoms seeing environmental issues in their happenings while as long as services. This is completed by reducing source eating, lowering emanations, and adopting sustainable effective practices.
7. Recycling or Final Disposal
   This stage epitomizes the closing link in the green price chain. Residual surplus is either carefully predisposed of or reprocessed and reused, underwriting to waste lessening and ecofriendly protection.

Fourth: Green Kaizen

"Kaizen: The Key to Japanese Competitive Success," published in 1986, as a concept of continuous improvement that emphasizes the need to improve the production process environment within the economic unit through the participation of individuals in the improvement process (Chan & Tay, 2018). Ried and Sanders believe that the concept of process improvement according to the Kaizen philosophy applies to all activities, such as cost reduction, quality improvement, and waste reduction in all components of the system (Ried & Sanders, 2010)

That is, it works to reduce costs during the production stage of the existing product, costs that were not considered during the design stage(Hanna et al., 2019:1220).

Fifth: The PDCA Cycle

The Kaizen steps are based on the cycle developed by the statistician Deming, known as Plan-Do-Check-Act (PDCA), which is linked to the concept of quality and Total Quality Management. It has been employed within the Green Kaizen methodology to improve quality periodically through four infinitely recurring phases (Salloom & Sorour, 2021:133)

Sixth: Cost Reduction Through the Application of the Green Value Chain and Green Kaizen

The thinking of continuous perfection (Kaizen) efforts on introducing measured and everlasting perfections in all activities of the pecuniary unit, underwriting to cost lessening, quality advance, and waste saving across all system apparatuses. The business phase often entails the feeding of large quantities of constituents, energy, and rainwater, and can result in abundant environmental bearings such as the use of toxic compounds, waste group, high energy feeding, and carbon emissions. (Ghazi et al., 2023: 456)

1. Planning (Plan)
   Studying and analyzing the current situation and forecasting the requirements and changes necessary to implement improvements. This phase begins with identifying the

problem, setting objectives, and preparing an action plan, taking into account the involvement of all stakeholders.

2. Doing (Do)
   Developing performance metrics and conducting a pilot experiment under controlled conditions, with process planning, data collection, and fact analysis to develop solutions and implement changes on a small scale for testing purposes.
3. Checking (Check)
   Evaluating the results to ensure that the objectives set in the planning phase have been achieved by testing the solutions and measuring the effectiveness of the improvements.
4. Taking Action
   If the improvements are successful, the tested steps are generalized and applied more broadly, and the cycle begins again to achieve further improvement. If the desired results are not achieved, the cycle is repeated with the necessary modifications.

Result and Discussions

First: Calculating the total cost of the heater

Table 1. Calculating the cost of raw materials

N:	Name of the Material	Unit of Measurement	*F*	Cost per Unit	Total Cost
1	Tank cover	KG	2	1450	16530
2	Internal storage	KG	1	1450	32407
3	Base	KG	1	1450	4350
4	Small nozzle	pcs	3	500	1500
5	Large nozzle	KG	1	1000	1000
6	Outer body	KG	1	1050	12915
7	Top cover	KG	1	1050	3843
8	Bottom cover	pcs	1	1050	3843
9	Heater cover with indicator light	KG	1	1000	1000
10	Blue nylon cover	KG	1	1351	33.775
11	Red nylon cover	KG	1	1351	33.775
13	Cable	M	2	2500	3750
14	Tube	M	1	1500	450
15	Plug	pcs	1	250	250
16	terminal	pcs	1	100	200
17	Food-grade nylon	M	1	100	800
18	Welding wire	KG	-	974	389.6
19	Mac welding	M	-	0	0
20	Teflon	M	3	100	200
21	A chemical material	KG	/	300	21.69
22	Nit ric	KG	/	12000	1200
23	Zahy	KG	/	1000	25
24	Foam	KG	1	10000	11000
25	Screws	pcs	6	100	600
26	Insulating material	pcs	1	250	250

N:	Name of the Material	Unit of Measurement	*F*	Cost per Unit	Total Cost
27	Heater with thermostat	pcs	1	11000	11000
28	Lead wire	M	0.5	500	250
29	Thermal gauge	pcs	1	1500	1500
30	Quality control label	pcs	1	200	200
31	Mark label	pcs	1	500	500
32	Information label	pcs	1	500	500
33	Label (outer)	pcs	1	200	200
34	Label (inner)	pcs	1	200	200
35	Insulated pin terminal	pcs	2	100	200
36	Terminal	pcs	4	250	1000
38	Powdered dye	KG	1	3000	1050
39	Red air-drying dye	L	2	3000	1500
40	Thinner	L	/	1400	420
Total				64226	115111

Source: Researcher based on the company's historical data

Table 2. Labor Wages

N:	Details	Amounts
1	Salaries of workers involved in the production process	176640600
2	Number of workers involved in the production process	332
3	Average annual wage per worker	5319746
4	Number of actual production days per year	253
5	Daily wage per worker	2102
6	Actual hours worked per day	7
7	Hourly wage	300.42
8	Time required to produce a 120-liter water heater	3
9	Cost of operating the water heater	901.26

Source: Researcher based on the company's historical data

Table 3. Indirect Costs

N:	Details	Amounts	Cost of a single heater at a production level of (300) units
1	Total fixed and variable manufacturing costs	15688240	52294
2	Marketing and administrative costs	1133480	3778
3	Environmental costs	11214480	37381
	Total	28036200	93454

Source: Researcher based on the company's historical data

Therefore, the total cost = Materials cost + Labor costs + Indirect costs

209466 = 93454 + 901.26 + 115111

Applying the Green Value Chain:

First: Calculating the Traditional Value Chain

Table 4. Calculating the Traditional Value Chain

Activity	
Research and Development	**6,660,000**
Design	**12,600,000**
Manufacturing	**5,049,277,800**
Marketing and After-Sales Service	**11,370,000**
Total	**5,079,907,800**

Source: Researcher based on the company's historical data

Second: The Green Value Chain

For the determination of realizing the green value hawser at the General Establishment for Electrical Productions for its 120-liter electric marine heater, environmental deliberations are integrated into all periods of production happenings. This inaugurates with the examination, progress, and design phase, somewhere

Green Research and Development

Green examination and change represents the first period within the green value shackle. This activity encompasses steering the necessary scholarships and examination to develop the standing merchandise or create new harvests that are both sparingly and biologically efficient.

A realistic homework of the factory discovered that 80% of examination and increase costs are assigned to salaries and wages, with this subdivision employing 20 people. Bestowing to factory specialists, the examination activities and work supported

Research and Development Department Salaries

= 5,328,000

Savings in Research and Development Salaries

= 5,328,000 x 0.5 = 2,664,000

Green Design

The green enterprise phase is a decisive stage indoors the green value shackle. In this phase, the invention's industrial strategies are organized in a way that contemplates conservation aspects alongside methodological and commercial considerations. The number of workforces in this division reached (14) workers. The researcher disbelieves this number is somewhat large equaled to the standard number required to perform this activity, which is (6) workers. This signposts a surplus of labor outside this branch, which may lead to improved costs without completing added value appropriate with the capability. Therefore, some of the employees could be restructured to other sectors, or the number reduced to align with the actual requests of the activity.

Design Department Salaries and Wages

= 8,820,000

Savings in Design Department Salaries and Wages
= 8,820,000 = 8/14 x 504,000

Manufacturing

The traditional heating element was replaced with carbon nanofibers to reduce energy consumption and lower the cost from 11,000 to 9,000. Traditional thermal insulation (foam) was replaced with eco-friendly glass spacers to retain heat and reduce energy waste from 11,000 to 8,000. The traditional outer casing was replaced with recyclable aluminum to further reduce energy consumption and lower the cost from 16,530 to 13,500. The plastic top and bottom covers were replaced with eco-friendly plastic covers at a low cost of 1,500 each to reduce waste. The plastic sealing strip was replaced with eco-friendly silicone at a cost of 130, reducing waste and increasing environmental safety. These combined improvements contribute to a more sustainable and efficient heater, while reducing costs and environmental impact in the long run.

Table 6. Financial savings achieved from implementing the green value chain in the manufacturing stage

Financial savings	Cost after replacement	Current cost	Component
2,000	**9,000**	**11,000**	**Heating element (heater)**
3,000	**8,000**	**11,000**	**Thermal insulation (foam)**
3,030	**13,500**	**16,530**	**Outer casing**
2,343	**1,500**	**3,843**	**Top cover**
2,343	**1,500**	**3,843**	**Bottom cover**
70	**130**	**200**	**Sealing strip**

Green Marketing

Given that marketing activities were conducted entirely within the factory and there were no external warehouses, it was proposed to restructure this department by reducing the number of employees by 25 and redistributing them to the green services and recycling department, thus reinforcing the company's environmental commitment. The remaining employees would handle digital marketing and promotion by implementing online advertising campaigns for the green water heater, aligning with green marketing requirements and achieving greater resource efficiency.

Note that salaries and wages constitute 75% of the marketing department's activities.

11,370,000x 0.75 = 8,527,500

Cost savings = 8,527,500 x 25/(40) = 5,329,687.5

Green After-Sales Services

These services help extend product lifespan and reduce waste. With the introduction of the new product based on carbon nanofiber technology, green after-sales services become a means to enhance product value and consumer confidence. Therefore, it is essential to integrate these services with product development to ensure long-term customer relationships and strengthen the

company's competitive advantage. This activity will utilize 10 employees from the marketing department who were transferred or laid off.
Cost of the activity = 5,329,687.5 x 10/(25) = 2,131,875

Recycling

In an electric water heater factory, scrap metal, wires, plastics, and damaged packaging can be utilized instead of being discarded as waste. This contributes to reducing the costs of purchasing raw materials, lowering waste disposal costs, and achieving both environmental and economic benefits. The field study demonstrated the feasibility of establishing a simple unit for re-sorting and utilizing waste generated from production lines, as follows:

Table 7. Savings Achieved from the Recycling Stage

N:	Type of waste	Treatment Method	(Annual Savings (dinars
1	**Sheet metal scraps**	**Melting and reusing it**	**3,250,000**
2	**Wire and copper waste**	**Selling or reusing it**	**2,100,000**
3	**Plastic and plastic sheeting waste**	**Recycling it**	**1,850,000**
4	**Packaging and cardboard**	**Reusing it**	**1,200,000**
5	**Reducing waste removal costs**	**Reducing waste**	**950,000**
Total			**9,350,000**

The table shows that recycling activities generate annual savings of 9,350,000 dinars, reflecting the importance of this activity in transforming waste from a financial and environmental burden into an economic resource that contributes to the company's profitability.

Table 8. Total savings achieved from implementing the green value chain

Activity	Amount of savings (dinars)
Green Research and Development	**2,664,000**
Green Design	**5,040,000**
Green Manufacturing	**12,786**
Green Marketing	**5,329,687**
Recycling	**9,350,000**
Total Savings	**22,396,473**

Third: A detailed application of Green Kaizen to a 120-liter electric water heater factory.

This is achieved by eliminating waste in time, materials, energy, and movement, as well as production defects, leading to cost reduction, improved quality, and a reduced environmental impact. This approach is characterized by its low investment requirement; instead, it relies on organization, discipline, and employee participation in proposing practical solutions.

Following field visits and analysis of the electric water heater production stages, several waste points were identified within the factory. These included excessive operating time, poor work site organization, increased consumption of certain materials, energy losses, and production defects necessitating restarts.

Therefore, Green Kaizen was implemented according to the Plan-Do-Check-Act (PDCA) cycle, as follows:

Planning Phase (Plan)

The main problems in the water heater production line were identified as follows:

Table 9. Main Problems in the Water Heater Production Line

N	Problem	Its Impact on Cost
1	**Long unit production time**	**Increased working time and wages**
2	**Waste of foam material**	**Increased direct materials**
3	**Loss in paint and powder**	**Higher operating costs**
4	**Unnecessary machine operation**	**Increased electricity consumption**
5	**Defects in welding and assembly**	**Restarts and breakdowns**
6	**Unnecessary operator movement**	**Wasted time and reduced productivity**
7	**Inaccurate wire cutting**	**Material waste**

Implementation Phase (DO)

- Implementing the 5S System to Organize the Workplace
  The workspace was organized, unnecessary tools were sorted, and tools used daily were placed near the worker, with fixed locations designated for materials.
  Result:
  Tool search time before implementation = 12 minutes per day per worker
  After implementation = 3 minutes
  Savings = 9 minutes per day
  When applied to the production unit, a savings of 1,200 dinars was achieved per unit.
- Reduced Heater Production Time
  Implementing the Green Kaizen method reduced heater production time from 3 hours to 2.4 hours after redistributing workers and addressing bottlenecks between production stages. This resulted in a time saving of 0.6 hours per unit produced. With an hourly labor cost of 300.42 dinars, the financial savings per unit amounted to approximately 180 dinars.
- Reduced Foam Waste (Thermal Insulation)
  An increase in consumption was observed during the production process. Given that the current cost of foam material is 11,000 dinars per unit, and the waste rate was estimated at 10%, a financial saving of 1,100 dinars was achieved per unit produced.
- Implementing Green Kaizen led to a reduction in paint waste by addressing the problem of uneven spraying and utilizing and reusing leftover quantities, as waste was previously observed in the painting process. Since the cost of powder and paint is 2,550 dinars per unit, and with a 15% saving rate

achieved after improvement, the financial savings amounted to approximately 383 dinars per unit produced.

- Implementing Green Kaizen led to rationalizing electricity consumption by switching off non-operational machines and operating them only when needed. The estimated savings in electricity costs reached approximately 1,500 dinars per unit produced, contributing to reduced operating costs and enhanced production efficiency and environmental sustainability.
- Reducing Production Defects (Welding and Assembly): Implementing Green Kaizen led to a reduction in returned units and rework through worker training and the establishment of inspection and control points during production phases. This facilitated the early detection and correction of errors. Previously, the returned unit rate was 4%, with the estimated cost of rework being 2,500 dinars per unit. Therefore, a financial saving of 2,500 dinars per unit produced was achieved, contributing to reduced quality costs and improved production efficiency.
- Reducing Unnecessary Worker Movement: Implementing Green Kaizen reduced unnecessary movement within the production line by rearranging workstations and bringing materials and tools closer to the worker.
- Reducing Wire Loss and Inaccurate Cutting: Implementing Green Kaizen led to a reduction in wire loss resulting from inaccurate cutting through the use of standardized dies and uniform work standards. The financial savings achieved amounted to approximately (450) dinars per unit produced, which contributes to lowering production costs and increasing resource efficiency.

The Check Phase

Results were compared before and after implementing the improvements. A clear decrease in operating time, material consumption, production defects, and energy consumption was observed, in addition to reduced handling and movement time within the production line. This positively impacted production process efficiency and cost reduction. In the Act Phase, the new procedures were adopted as a permanent operating standard within the factory.

Table 10. Total Green Kaizen Savings per Unit

Activity	Surplus (dinar)
5S Workplace Organization	**1,200**
Reduced Production Time	**180**
Reduced Foam Waste	**1,100**
Reduced Paint Loss	**383**
Energy Conservation	**1,500**
Reduced Defects	**2,500**
Reduced Movement	**700**
Reduced Wiring Loss	**450**

Total Kaizen savings per unit = 8,013 dinars
If annual production = 300 units

Total annual savings from Kaizen:
2,403,900 = 300 × 8,013

Total savings after applying the two techniques
- Green value chain savings
22,396,473 =dinars
- Green Kaizen savings
2,403,900 =dinars
Total savings
24,800,373 = 2,403,900 + 22,396,473dinars annually
- New cost per unit after reduction
Original cost per unit = 209,466 dinars
Save per unit from Kaizen = 8,013
Save from the value chain per unit:
74,655 = 300 / 22,396,473 ÷
Total savings Per unit:
82,668 = 8,013 + 74,655dinars
New cost:
209,466 - 82,668 = 126,798 dinars per unit

Conclusions

The research results showed that the application of the green value chain contributes to cost reduction by minimizing waste in resources, energy, and raw materials, and improving the efficiency of production activities.. It has been shown that integrating environmental considerations into various production stages helps improve the environmental performance of the economic unit and reduce industrial waste. The application of green Kaizen has proven effective in achieving continuous improvement in production processes by reducing wasted time, production defects, and improving work organization

Recommendations

Industrial economic units must adopt the concept of the green value chain and integrate it into their production and management strategies to achieve economic and environmental efficiency. The Green Kaizen philosophy should be continuously applied within production lines to reduce waste, improve quality, and enhance operational performance. Green research and development programs should be prioritized, focusing on creating environmentally friendly products that consume less energy and resources.

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