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Productivity Effect of Adopting Environmental Management Measures Integrated with Labor Investments After the COVID-19 Pandemic in Indonesian Enterprises

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Abstract

Recent statistics have shown that carbon dioxide emissions in Indonesia are increasing due to its booming economy. However, the adoption of environmental management measures consumes labor for their execution, which may reduce manufacturing outputs due to the extracted workforce. Previous literature reported mixed results of environmental investments in different production contexts. This paper examines how the adoption of environmental management measures influences labor productivity in Indonesian enterprises. The regression analysis results of a World Bank Enterprise Survey for Indonesia in 2023 show that increasing labor investments such as wages, training, and bonuses, significantly increase the positive impact of the adoption of environmental management on labor productivity. The finding indicates that with more significant labor inputs, the adverse impact of environmental management on labor productivity diminishes. The study results suggest that firms should integrate their investments in environmental management with labor inputs to leverage productivity.

Keywords: *Emissions, Environmental Management, Labor, Productivity, Indonesia.*

Introduction

Humans now live in the Anthropocene Epoch, when they are primary agents that negatively impact Earth systems, causing environmental degradation (Bülgözdi, 2024; Hamilton et al., 2015). For human security, people must limit their activities, including manufacturing, within planetary boundaries (Biggeri & Tapia, 2023). For environmental justicve, manufacturing activities should be performed within the safe operating space for humanity to prevent damage to the planet (Afolabi, 2024). Manufacturers must adopt corporate social responsibility (CSR) practices that involve social, environmental, and economic dimensions. On the one hand, manufacturers must also adhere to environmental, social, and governance (ESG) standards (Baroni, 2023). On the other hand, environmental performance creates firm value through growth and profitability (Dwianto et al., 2024).

Today, manufacturing enterprises must prioritize environmental management in their production areas as a must-do, not only because they must comply with environmental standards but also because the impact of not doing so can be severe. Investment projects in working environments align with the United Nations' Sustainable Developments, including Goal 12 (Responsible Consumption and Production: Ensuring sustainable consumption and production patterns), Goal 3 (Good Health and Well-being: Ensuring healthy lives and promoting well-being for all ages), Goal 8 (Decent Work and Economic Growth), and Goal 17 (Partnerships for the Goals)[2]. Noncompliance violations cause heavy penalties for law enforcement agencies, emphasizing the importance of responsible and sustainable production. Furthermore, if they realize corporate social responsibility initiatives, manufacturing companies can create economic value in a supply chain in the current business context from the "Creating Shared Value" perspective (Porter & Kramer, 2006).

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[2] For detailed information on 17 United Nations' Sustainable Development Goals (SDGs), visit https://sdgs.un.org/goals

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This paper examines the curious case of Indonesia, a Southeast Asian country with reduced poverty but increasing carbon emissions over the past decades (Figure 1). There is a debate on the trade-off between economic growth and air pollution. Not on par with impressive economic growth and poverty reduction, Indonesia has faced a concern on environmental quality (Dwianto et al., 2024). During the COVID-19 pandemic, environmental performance in manufacturing companies was mixed. On the one hand, production restrictions and disruptions in supply chains might slow down manfuacturing activities, hencing mitigate negative environmental impacts. On the other hand, a soaring demand for healthcare products increased plastic waste and energy consumption in manufacturing companies (Dwianto et al., 2024).

In this study, we provide evidence that increasing production does not necessarily entail higher carbon emissions. We expect that production companies can adopt environmental management measures, such as controlling pollution, waste, and heat, and at the same time increase productivity.

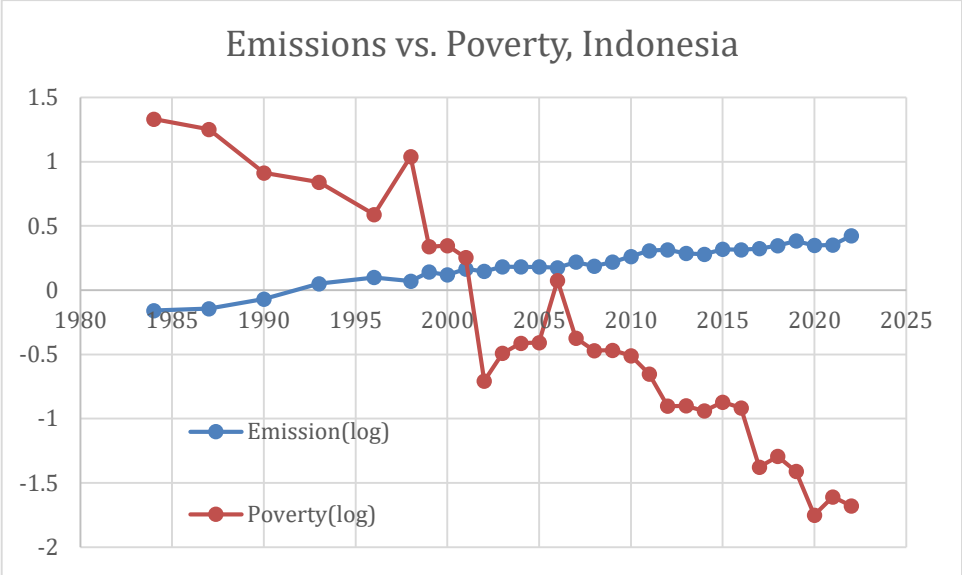

Figure 1. Trade-Off Between Carbon Emissions and Poverty Reduction in Indonesia

Source: International Energy Agency, World Bank Poverty and Inequality Platform (2024)

Based on the need for the positive impact of environmental control, this study aims to address the following questions.

RQ1: What is the historical correlation between economic growth and carbon emissions in Indonesia?

RQ2: What is the role of labor in leveraging the impact of environmental management measures on firm-level labor productivity?

This paper continues with theories and previous studies related to the relationship between environmental improvement and firm performance in Literature Review. In Methodology, we develop a conceptual model for estimating regression. Result Section presents the regression results and a profound discussion. In Conclusion Section, we summarize our findings, and provide implications.

Literature Review

In the theoretical view of stakeholder shared value, corporate investments in adopting environmental measures benefit many stakeholders, including workers, environmentalists, government agencies, nongovernmental organizations (NGOs), and local residents (Porter and Kramer, 2006). If workers know that their exposure to a poorly managed manufacturing environment may cause health problems, they demand that employers closely control environmental factors such as air, water, noise, and soil in their

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production areas. External stakeholders, such as environmentalists, government agencies, and residents living adjacent to factories, may use their influence to force employers to control pollution and other hazardous substances discharged from production processes. These stakeholder pressures are believed to push manufacturers to improve the manufacturing environment for labor health. If a company fails to provide safe and healthy work conditions, it will be deprived of a "social license" (Graafland & Smid, 2017). It will lose credibility in fulfilling its commitment to environmental protection and demonstrating its social irresponsibility. In contrast, companies that achieve social licenses demonstrate that they sympathize with the concerns of stakeholders and work to mitigate the negative impacts of their manufacturing activities.

In addition, an improved physical environment positively affects human health. Workers who work according to more environmentally friendly systems are healthier, improving the quality of their work life. However, workers do not have the power to determine environmental policies within their companies, although their health may be affected by these policies. Power-interest stakeholder analysis positions managers as key stakeholders because they have power in decision-making processes. On the one hand, prosocial researchers indicate social injustice when those with power, i.e., bosses, ignore their social responsibilities to stakeholders without power, i.e., subordinates (Sodhi, 2015). On the other hand, the shareholder value view holds that managerial decisions should prioritize profit maximization for shareholders (Smith, 2003). However, all stakeholders must agree on some key shared values: (1) the importance of long-term benefits of CSR activities, not short-term profit, and (2) a company should provide at least some corporate liabilities, directly during their production processes or indirectly through corporate taxes, which are used for environmental improvement for communities (Sodhi, 2015).

Different theories set different guidelines for businesses to decide how they implement CSR activities. The shareholder perspective views a CSR project as a financial investor, whereas the stakeholder perspective examines other ancillary benefits of a CSR initiative, such as innovation and happiness. For example, introducing a zero-emission product requires a corporation to spend more R&D resources, leading to stronger knowledge and innovation capabilities. Furthermore, this new environmentally friendly product satisfies other stakeholders (such as environmental agencies and green users). However, CSR initiatives are facing challenges. One of the major challenges is that a framework to guide companies to prioritize proposed CSR initiatives and integrate social benefits with economic benefits is lacking. According to the creating shared value theory, corporations need to distinguish CSR initiatives into three categories: generic impact, value chain impact, and the social dimension of the competitive environment (Porter and Kramer, 2006).

In manufacturing firms, the physical environmental factors affecting work performance should include light, temperature, humidity, air, water, noise, soil, and waste. For example, the U.S. Occupational Safety and Health Administration established temperature and noise standards. The standardized temperature in a manufacturing environment is approximately 20°C to 25°C (68°F to 77°F). Exposure to noise levels above 85 decibels for 8 hours or more damages human ears and requires ear protection. These standards are designed to ensure worker comfort and prevent related illnesses. Working outside this comfort zone decreases productivity (Somanathan et al., 2021).

The Impact of the Physical Environment on Labor Productivity

At the national level, the impacts of climate change on labor productivity and economic and social costs have been studied. The globe is facing more frequent, more severe, and difficult-to-detect environmental hazards, such as air pollution due to wildfires. According to a 2022 Stanford University study, wildfire smoke causes a loss of US$125 billion due to lost labor productivity in the United States (Stanford Institute for Economic Policy Research, 2022). Air pollution exacerbates respiratory diseases, leading to hospitalization and death. Another severe environmental risk is heatwaves, which cause chronic illnesses such as cardiovascular disease, diabetes and respiratory problems. A 2022 Stanford study revealed that above 100°F, productivity decreases by 70% ("The Mounting Costs of Extreme Heat," 2023). Severe heatwaves cause a loss of labor productivity of approximately $100 billion per year in the US (*Extreme Heat: The Economic and Social Consequences for the United States*, 2021).

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At the firm level, environmental management in production areas also benefits workers' health and quality of life. They are unhappy if they know that their work environment may damage their health and expose them to hazardous materials (Majumder & Chowdhury, 2023). Other stakeholders, such as their families, environmentalists, and customers, are also unhappy about corporate ignorance of CSR. Conversely, stakeholders are happy if companies properly implement CSR activities that benefit them. Specifically, a healthy physical environment improves the quality of work life for workers. Local residents benefit from treated water discharged from plants or factories. Families of workers will benefit because healthy workers keep working, and their income will help support their families. The local government benefits from its commitment to the UN's sustainable development goals (i.e., goals related to decent work, health, and wealth generation). Customers buy more services or products that increase their happiness. This means that happiness is a shared value of stakeholders in society. Their quality of life will improve if this shared value, i.e., happiness, is achieved.

However, environmental improvements require one-time and recurrent expenditures. Related costs cover the procurement, installation, and operation of environmental monitoring systems, leading to more financial pressure on capital-hungry enterprises. In a company, the role of managers is undoubtedly critical in planning and monitoring the implementation of environmental standards, such as ISO 14000. These systems are related to controlling the negative impacts of waste, polluted air, and heat (Delmas & Pekovic, 2013; Lannelongue et al., 2017). Managers decide to install environmental control systems to increase the quality of the physical environment, leading to increased safety and occupational health for their workers.

Workers also play an important role in implementing environmental control activities. Without proper training, they may not operate environmental monitoring equipment effectively. Without financial incentives for environmental initiatives, their companies find it difficult to make significant progress toward environmental performance targets.

Hypothesis 1: Labor investments (wages, training, insurance, bonuses) have a positive effect on labor productivity.

Hypothesis 2: The adoption of environmental measures (to reduce emissions, waste, and air pollution) has a positive effect on labor productivity.

The Moderating Role of Labor in the Relationship Between Environmental Management and Labor Productivity

Although literature reviews have examined the impact of labor investments (training, wages, financial incentives) on labor productivity, little is known about the interaction between labor investments and environmental management (i.e., air, water, and waste control measures) and how this connection affects labor productivity. The results of past studies on the influence of environmental initiatives and per-worker productivity are mixed. While most classical economics and business studies have confirmed the positive role of environmental sustainability in increasing firm performance, a few studies have revealed that the installation of new processes and technology to conform to internationally recognized quality standards is likely to interrupt routine work. Companies adopting new processes demand new skills to run the new equipment and monitor the novel processes effectively, leading to retraining their workforce. Nevertheless, most previous studies on this topic have focused on larger firms. Given their strong financial resources, larger firms can invest in these CSR activities (Nejati & Amran, 2012). In contrast, small and medium-sized enterprises (SMEs) struggle to invest in environmental management systems, especially in poorer developing countries, due to their limited financial capabilities (Baumann-Pauly et al., 2013). A study on 182 manufacturing companies in Indonesia using panel data from 2019 to 2022 and during the COVID-19 pandemic found that environmental performance creates firm value (Dwianto et al., 2024). Nevertheless, the moderating role of labor in the relationship of environmental management and labor productivity has not been studied after the Covid-19 pandemic. Therefore, we hypothesize that labor investments, for example, for training and salaries, increase the impact of environmental systems on labor productivity.

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Hypothesis 3: Labor-related investments (wages, training, insurance, bonuses) moderate the impact of the adoption of environmental measures on labor productivity.

A conceptual map of the three hypotheses proposed above is presented in Figure 2.

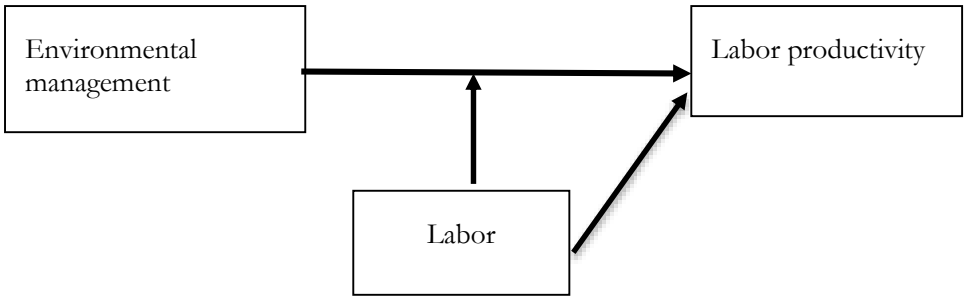

Figure 2. Conceptual Model Adapted from Lannelongue Et Al.)

Methodology

Data

We employ country-level World Bank time series data (1992 – 2022) to investigate the correlation between carbon emissions and poverty rate. For regression, we use firm-level World Bank's Enterprise Survey (ES) in 2023. This dataset is the most recent after several waves of data collection. The study population is the population of nonagricultural enterprises in Indonesia. The sample was selected following stratified random sampling. A stratified random sample is obtained by separating the population elements into strata and selecting a simple random sample from each stratum.

Model

Based on the conceptual model in Figure 2, we hypothesize that at the firm level, environmental improvement measures, moderated by labor, have a significant effect on labor productivity, as in the following equation.

$$LaborProductivity = \beta_0 + \beta_1(CapitalIntensity) + \beta_2(EnvironmentControl) + \beta_3(EnvironmentControl * Labor) + \beta_4(Labor) + \varepsilon$$

where the dependent variable $LaborProductivity$ is measured by the ratio of sales to the total number of full-time permanent employees (Delmas & Pekovic, 2013; Salis et al., 2010). In this paper, the measure of labor productivity is transformed into logarithmic form, which is consistent with prior research (Ichniowski et al., 1997; Lannelongue et al., 2017).

$CapitalIntensity$ is the firm intensity of capital, measured by the ratio of fixed assets to the total number of full-time permanent employees (Crepon et al., 1998).

$EnvironmentControl$ is measured by the adoption of environmental control measures to reduce heat, waste, and pollution (McCoy & Evans, 2005). In this paper, the variable of environmental control is used as a moderating variable that influences the relationship between high-performance operating systems and firm performance (Huselid, 1995; Koch & McGrath, 1996).

$Labor$ is measured by labor costs, including wages, training costs, bonuses, and insurance per worker. We select the variable labor because it represents human capital investments. Finally, ε is the error term.

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Analysis

First, we run the correlation between emissions (average annual carbon dioxide emissions per capita) and poverty rate (less than US$1 per day) for Indonesia using the country-level data from the World Bank. Second, to analyze the impact of environmental management on labor productivity at the firm level, we use the World Bank's Enterprise Survey. To explore how much the independent variables influence the dependent variable, we employ the ordinary least squares (OLS) estimation approach. Before regression, we standardized the variable standardization following the suggestion in the OLS models with a moderator by Dawson (2014). This means that all model continuous variables will be mean-centered, and their new means will be zero. The benefits of this variable standardization include the satisfaction of normally and independently distributed residuals (Dawson, 2014). We find no serious collinearity problem because the variance inflation factors (VIFs) are under three (VIF = 1.19).

Results

The Case of Indonesia

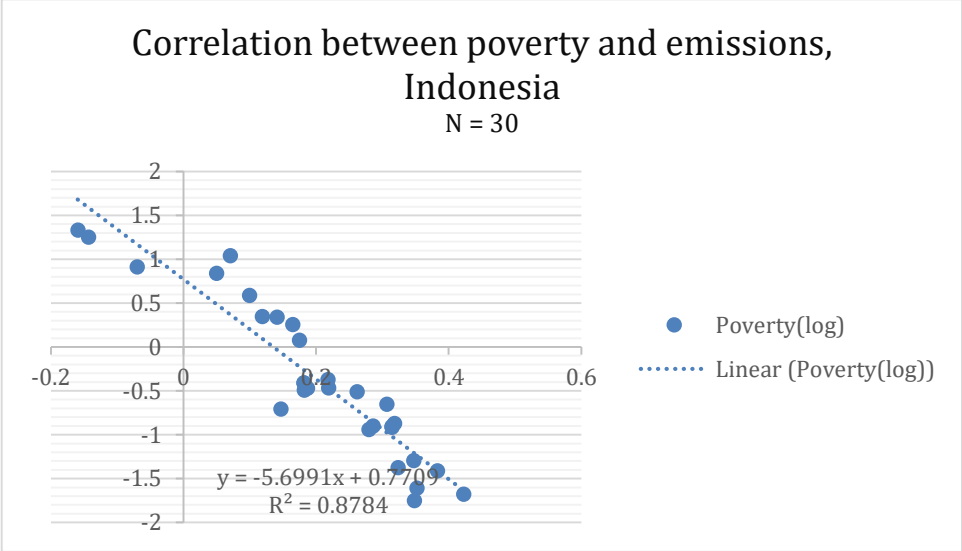

Figure 3. Correlations Between Poverty and Carbon Emissions

Source: World Bank; International Energy Agency

Figure 3 shows a strong positive correlation between the poverty rate (less than $1 per day) and emissions in Indonesia (unit of Mt CO_2). The model has a high degree of fit (R_squared value of 0.878). Although the number of observations in years is only 30, which is not enough to suggest any prediction, it generates a concern that Indonesia has not achieved the double objective for socioeconomic development: economic growth in hand with poverty reduction. This shows that the poverty rate is low when emissions are high. The socioeconomic target is that poverty is low at the same time that emissions are low.

Descriptive Statistics

Table 1. Descriptive Statistics

Variable	Measurement	Obs	Mean	Std. Dev.	Min	Max
Labor productivity	Sales per full-time workers (log)	2192	17.825	1.692	11.513	28.101

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Capital intensity	Fixed assets per full-time worker (log)	290	15.655	2.084	8.517	24.54
Labor	Total costs for workers (log)	2088	19.157	2.088	6.908	27.747
Environmental Control	Dummy (1 for adopting environmental management measures; 0 for none)	1378	.096	.294	0	1

The descriptive statistics table presents a comprehensive overview of four key variables: labor productivity, capity intensity, labor and environmental control. Labor productivity has a standard deviation of 1.69, suggesting moderate variability among observations. In contrast, capital intensity and labor show standard deviations of 2.08 and 2.09 respectively, reflecting notable differences in investments in fixed assets and labor among enterprises. The dummy variable, environmental control, has a mean of 0.096, suggesting that only about 9.6% of cases reported the adoption of environmental management measures (reducing air pollution, waste and heat).

The pairwise correlation analysis reveals several noteworthy relationships among the variables. A positive correlation of 0.373 between labor productivity and capital intensity suggests that increased capital investment is associated with higher labor productivity, though this relationship is moderate and significant at the 0.1 level. A stronger positive correlation of 0.580 between labor productivity and labor indicates that greater labor utilization is linked to enhanced sales performance, also significant at the 0.1 level. The correlation between labor and the adoption of environmental management is 0.395, while the correlation between labor productivity and environmental control is 0.263, indicating that the adoption of environmental measures may contribute to increased labor productivity.

Table. Pairwise Correlations

Variables	(1)	(2)	(3)	(4)
(1) Labor productivity	1.000			
(2) Capital intensity	0.373*	1.000		
(3) Labor	0.580*	0.135	1.000	
(4) Environmental Control	0.263*	0.156	0.395*	1.000

*** p<0.01, ** p<0.05, * p<0.1

Regression Results

Table 3: Regression Results

Dependent variable: labor productivity (sales per worker)

	(1)	(2)
VARIABLES	Model 1	Model 2
Capital intensity	0.288***	0.285***
	(0.0673)	(0.0663)
Labor	0.518***	0.484***
	(0.0654)	(0.0661)
Environmental Control	0.126	-0.129
	(0.251)	(0.272)
Environmental Control * Labor		0.611**
		(0.274)
Constant	-0.0552	-0.0607
	(0.0620)	(0.0611)

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Observations	130	130
R-squared	0.447	0.468

Standard errors in parentheses. Variables are standardized.

*** p<0.01, ** p<0.05, * p<0.1

Table 3 shows the regressions results of Model 1 (without moderator) and Model 2 (with labor as moderator). In Model 1, without moderating analysis, the positive impact of environmental management on labor productivity is insignificant. In Model 2, the regression results indicate that both capital intensity and labor have significant positive impacts on labor productivity. We find that while the direct effect of the environmental control is not statistically significant, the significant interaction term (EnvironmentalControl*Labor) suggests that increasing labor inputs can significantly increase the positive impact of environmental measures on labor productivity. Specifically, the interaction term indicates that for a percentage point increased in labor, labor productivity in firms adopting environmental management measures increase their labor productivity by 0.61 percentage point.

Conclusions

Research has revealed that investments in eco-friendly workplace enhancements improve labor performance. Allocating funds to ameliorate environmental elements, including air, waste, and heat, increases sales revenue per worker. Enterprises that invest more in human resources through salary, training, and insurance policies are more likely to capitalize on environmental management systems, as their workers have suitable skills and motivation, resulting in higher productivity. However, the descriptive statistics of the data used indicates that only 9.6% of surveyed enterprises reported the adoption of environmental management measures to reduce air pollution, waste and heat.

Environmental, Economic and Social Implications

Environmentally, numerous manufacturing activities in polluting sectors may worsen environmental degradation and slow the achievement of the United Nations Sustainable Development Goals, indicating that a nation must balance economic growth, environmental protection, and social development objectives. Our research results provide empirical evidence that companies in Indonesia can simultaneously increase these three sustainable objectives in practice. Firm-level environmental investments also accelerate economic returns, i.e., labor productivity, through a healthy and dedicated workforce that benefits from a clean physical environment at the workplace.

Economically, this research has led to a high demand for environmental tools and technologies, such as ambient air quality monitoring equipment, source emission measurement technologies, waste collection and handling technologies, recycling equipment, environmental monitoring and analytical equipment, chemical disinfection, sanitary landfill design, and soil contamination testing and monitoring equipment.

Socially, firms should be aware that social licenses are granted to firms that adopt environmental management practices. Stakeholder pressures are believed to push manufacturers to improve the manufacturing environment for labor health. Nevertheless, firms seek ways to reduce environmental management costs due to limited financial resources and capabilities. This evasion risks labor health, especially in manufacturing environments where workers are exposed to health-related elements such as air, water, waste, soil, and noise. Our study results show that investments in environments positively impact labor productivity, enhancing living standards. Regarding social impacts, a cleaner work environment benefits workers by improving their health, safety, and quality of work life and reducing social costs related to resource allocation to treat sick workers.

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Recommendations

Governments should provide technical and financial support for companies to realize such environmental investments in their production areas. Despite the above urgent human health hazards due to the deteriorating environment, limited investments have been made in preventive solutions. For example, in 2022, only approximately 3% of global health spending was directed toward the prevention of climate-related health issues (Buchner et al., 2023). To address this financial gap, all stakeholders, including businesses and manufacturers, should implement environmental control measures, for example, through corporate policies to reduce the negative impacts of their production processes. Corporate-level budgets must be allocated for these efforts because current investments in environmental management at the macro level are limited.

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