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SAFE-GREEN (Safety and Efficiency for Green Economic Resilience): Integration of OSH in Sustainable Development in Asia–Africa

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Abstract

The development of a green economy in Asia and Africa is an urgent necessity amid the challenges of climate change, social inequality, and economic structural transformation. These efforts emphasize not only technological innovation, but also human-centered development as the main driver of sustainable growth. Although both regions have adopted the Sustainable Development Goals, global studies linking SDG 3 (Good Health and Well-being) and SDG 8 (Decent Work and Economic Growth) with occupational risk management are still limited. Furthermore, the integration of SDGs into occupational safety and health (OSH) systems and their impact on long-term economic resilience and growth have not been widely discussed. This study introduces the SAFE-GREEN (Safety and Efficiency for Green Economic Resilience) conceptual framework, which integrates occupational safety, resource efficiency, and sustainable development. The research method uses a qualitative approach through a review of international institutions' literature and a comparative analysis of policies in ASEAN and the African Union. The results of the study show that effective Occupational Safety and Health implementation can reduce economic losses, increase productivity, attract green industry investment, and strengthen long-term economic resilience, with workers as the main foundation of an inclusive green economy.

Keywords

Asia–Africa, Economic Resilience, Green Economy, Occupational Safety and Health, Sustainable Development.

1. Introduction

The transition to a green economy is now a global challenge that requires a balance between economic growth, environmental preservation, and human well-being. Asia and Africa are the two most dynamic regions in facing this change, with high economic growth rates but significant social inequality and occupational risks. Along with efforts to achieve the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being) and SDG 8 (Decent Work and Economic Growth), there is an urgent need to integrate occupational safety and health dimensions into sustainable green development strategies (Figure 1).

Figure 1. Sustainable Development Goals (SDGs)

According to the International Labor Organization (ILO, 2023), every year there are more than 2.9 million deaths due to occupational accidents and diseases worldwide, with global economic losses reaching around 4% of the world's gross domestic product (GDP). This figure shows that OSH is not only a technical or moral issue, but also has significant economic consequences. At the regional level, Asia accounts for nearly 65% of the global workforce in high-risk sectors such as manufacturing, agriculture, and construction, while in Africa, weak oversight systems and limited institutional capacity leave workers vulnerable to work-related injuries and illnesses (ILO, 2023). These conditions indicate that economic growth without a strong foundation of occupational safety will result in productivity losses and long-term social burdens.

Based on the ASEAN Cost Benefit Analysis on Occupational Safety and Health (2022) report, it is clear that every dollar invested in OSH systems can generate an average economic return of 2.2 to 4.0 dollars in the form of increased productivity, reduced compensation costs, and operational efficiency. These findings reinforce the argument that investment is an efficient economic strategy, not just a regulatory obligation. This approach is particularly important given that both regions are accelerating green economy policy changes involving labor-intensive sectors and new technologies, such as renewable energy, waste treatment, and environmentally friendly manufacturing, which also bring new types of occupational risks, including heat stress, exposure to green chemicals, and work fatigue due to the digitization of production processes (UNEP, 2022).

However, there is still a significant research gap. Most green economy studies focus on energy efficiency, carbon emissions, and technological innovation, while the dimensions of worker safety and health are rarely discussed systematically as factors supporting economic resilience. In Africa, research on OSH is still limited to the mining and construction sectors, while in Asia, more attention is given to regulatory

compliance than to the strategic integration of OSH with green economic policies (Adu-Gyamfi, 2020; Ramos et al., 2020). This gap points to the need for a new approach that places OSH at the core of resource efficiency and long-term economic resilience.

The diagram explains how prior studies, research gaps, and the current study relate to the integration of Occupational Health and Safety (OHS/K3) with green economy initiatives. Previous research emphasizes integrating K3 into sustainable construction to improve worker protection and resource efficiency, examines green job readiness with limited K3–sustainability integration, and links K3 to the Sustainable Development Goals, particularly SDG 3 on health, well-being, and decent work (Bourahla et al., 2024). However, studies on K3 within the green economy remain scarce, especially in developing countries. This research addresses the gap by applying the SAFE-Green model to enhance K3, resource efficiency, economic resilience, and policy implementation in the Asia–Africa region.

To address these challenges, this study proposes the SAFE-GREEN (Safety and Efficiency for Green Economic Resilience) conceptual framework. This concept stems from the idea that occupational safety and resource efficiency are two mutually reinforcing pillars in creating sustainable productivity. Through the integration of OSH principles into green industry policies and practices, economic systems can become more resilient to social, environmental, and economic risks. This study aims to analyze the implementation of effective OSH systems that can increase production efficiency, attract foreign investment, and strengthen the economic resilience of Asia and Africa amid the transition to global green development.

2. Literature Review

2.1. Safety and Green Economy

The green economy has emerged as a key development paradigm that seeks to harmonize economic growth, environmental protection, and social well-being. This approach is closely linked to the Sustainable Development Goals (SDGs), particularly SDG 8 on decent work and economic growth and SDG 3 on good health and well-being. Existing literature emphasizes that the success of green economic transformation depends not only on technological innovation and environmental performance but also on the quality and safety of employment generated through this transition (UNEP, 2022). In this context, Occupational Safety and Health (OSH) plays a crucial role in ensuring that green jobs are not only environmentally sustainable but also socially inclusive and safe.

The importance of OSH is reinforced by global evidence from the International Labour Organization (ILO, 2023), which reports that work-related accidents and occupational diseases cause approximately 2.9 million deaths annually, resulting in economic losses equivalent to nearly 4% of global GDP. These figures highlight that inadequate OSH systems impose substantial economic and social costs. Studies increasingly recognize that effective OSH implementation enhances labor productivity, reduces absenteeism, and supports long-term economic sustainability. Moreover, the expansion of green sectors such as renewable energy, waste management, and eco-friendly manufacturing introduces new occupational risks, including exposure to hazardous materials, heat stress, and work intensification driven by digitalization. Consequently, integrating OSH into green economy strategies is essential to achieving sustainable productivity and protecting workers' well-being.

2.2. OSH Challenges

In Asia and Africa, the integration of OSH into green economic development remains uneven and fragmented. Asia, which accounts for a large share of the global workforce in high-risk sectors, has made progress in establishing OSH regulations;

however, the literature indicates that implementation often focuses on compliance rather than strategic alignment with green industrial policies (Ramos et al., 2020). As a result, OSH is frequently treated as a standalone regulatory requirement rather than as a driver of innovation, efficiency, and economic resilience.

In Africa, research on OSH is still limited and largely sector-specific, particularly in mining and construction. Scholars highlight persistent challenges such as weak enforcement mechanisms, limited institutional capacity, and insufficient investment in safety infrastructure (Adu-Gyamfi, 2020). These constraints increase workers' vulnerability to occupational injuries and illnesses, especially as countries pursue green development pathways that involve labor-intensive activities. Although economic studies, such as the ASEAN Cost-Benefit Analysis on OSH (2022), demonstrate that investment in OSH yields significant economic returns, similar evidence is rarely incorporated into green economy policy discussions in Africa and Asia. Recent studies have begun linking OSH with sustainable development and green job creation, yet comprehensive frameworks integrating OSH, resource efficiency, and economic resilience remain scarce (Bourahla et al., 2024). This gap underscores the need for approaches such as the SAFE-GREEN framework, which positions OSH as a central pillar of green economic resilience in developing regions.

3. Methods

This study uses a descriptive qualitative approach with a literature review method to analyze the relationship between Occupational Safety and Health (OSH), resource efficiency, and economic resilience in the context of sustainable development in Asia and Africa. This approach was chosen because it is suitable for examining complex socio-economic phenomena and public policy through narrative and conceptual interpretation (Fadli, 2021).

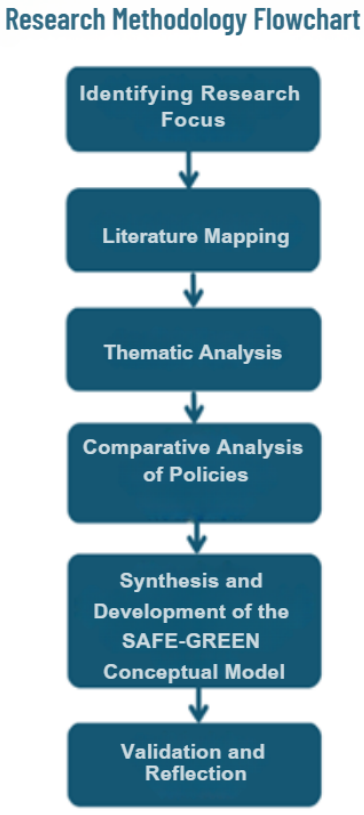

Figure 2. Research Methodology Flow (SAGE-GREEN Model)

The descriptive qualitative method provides space to understand the relationships between concepts without manipulating variables, but rather by describing patterns and interrelationships based on credible literature analysis. With this approach, the research is directed at developing the SAFE-GREEN (Safety and Efficiency for Green Economic Resilience) conceptual model, which is an integrative framework in Figure 2 that links occupational safety, resource efficiency, and human-centered green economic resilience (Al Hakim et al., 2021).

Data was collected through documentary study and literature mapping. This process was carried out by searching scientific databases such as Google Scholar, ScienceDirect, SpringerLink, and the ILO Library Database, using a combination of keywords: Occupational Safety and Health, Green Economy, Resource Efficiency, Economic Resilience, Asia, and Africa. The sources found were then selected based on three main criteria, namely: published between 2018 and 2025 to ensure topicality, discussing the relationship between OSH, green economy, or SDGs (3, 8, 12, 13), and containing empirical or policy analysis in the Asia or Africa regions. After selection, the literature was grouped thematically to identify patterns of interconnection between occupational safety, resource efficiency, and economic resilience.

Data analysis was conducted using a combination of thematic analysis and comparative policy analysis. Through thematic analysis, each piece of literature is examined to find the main themes that emerge (Braun & Clarke, 2024), such as the contribution of OSH to resource efficiency and productivity, the economic impact of workplace accidents, regional policies that support the green economy, and the role of OSH in achieving sustainable development targets. This approach helps the study identify patterns of relationships and strategic principles relevant to strengthening the integration of OSH into sustainable development policies.

Meanwhile, policy analysis is used to assess differences in the approach to implementing OSH policies between Asia and Africa. This analysis covers institutional aspects, investment, and the effectiveness of implementing occupational safety and health standards. The results of these two analysis methods are then synthesized to formulate the SAFE-GREEN conceptual model, which describes the interrelationship between occupational safety, resource efficiency, and regional economic resilience. In this way, the analysis not only presents empirical conditions but also identifies policy gaps and the potential for strengthening OSH systems in regional green development strategies.

The validity of the research was maintained through triangulation of sources and content validity by comparing data from various international institutions such as the ILO, UNEP, APO, and ASEAN. This approach ensured the accuracy and consistency of the information used. The validity of the analysis is also strengthened by grouping data based on themes, so that the resulting interpretations are systematic and accountable. The limitations of this study lie in its reliance on secondary data, which may vary in context and quality. Nevertheless, the conceptual approach still makes a significant contribution through the development of the SAFE-GREEN framework, which can serve as a basis for formulating policies to improve occupational safety and productivity in the sustainable economy sector, particularly in Asia and Africa.

4. Results

This analysis presents a representation of occupational accident conditions in Asia and Africa through representative countries with varying levels of industrialization and economic structures. Countries such as Indonesia, Saudi Arabia, China, India, and Kazakhstan were selected for the Asian region, while Egypt, South Africa South Africa, Nigeria, Kenya, and the Democratic Republic of

Congo for the African region was made to reflect the main economic characteristics of each region. These countries were selected because they represent a combination of dominant sectors such as manufacturing, energy, and mining, which have high occupational risk levels while also illustrating variations in the implementation of Occupational Safety and Health (OSH) policies. Thus, the graphs presented not only illustrate national occupational accident figures, but also reflect a comparative regional portrait of how economic dynamics, industrial policy, and OSH system readiness interact in the context of the transition to a green economy.

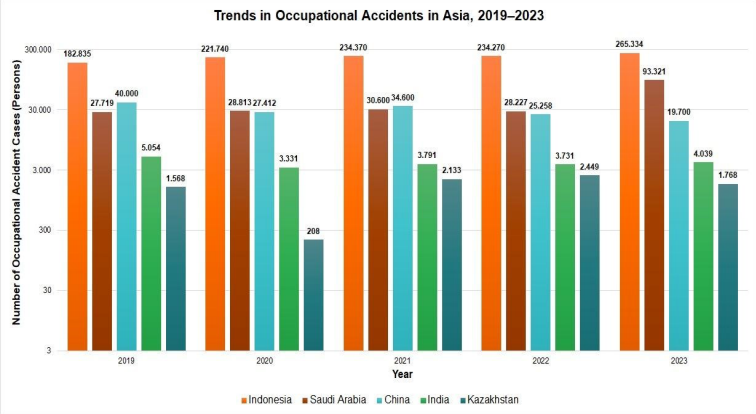

Figure 3. Work Accident Trends in Asia (2019–2023)

Countries in Asia show a gradual downward trend in the number of workplace accidents during the period 2019–2023 (Figure 3). Although there was a slight increase in 2023, particularly in Indonesia and Saudi Arabia, the overall pattern shows an increase in the effectiveness of OSH policies and strengthened investment in industrial risk management systems. According to the APO (2023), the implementation of green productivity in Asia is beginning to emphasize energy efficiency and worker protection as key elements of industrial sustainability. The implementation of integrated safety management systems, such as ISO 45001, has been proven to reduce accident rates by more than 30% in the manufacturing sector (Ramos et al., 2020). However, the surge in cases in 2023 also indicates a post-pandemic rebound effect, where increased economic activity has not been fully matched by preparedness in oversight, adaptation of safety technology, and a mature work culture.

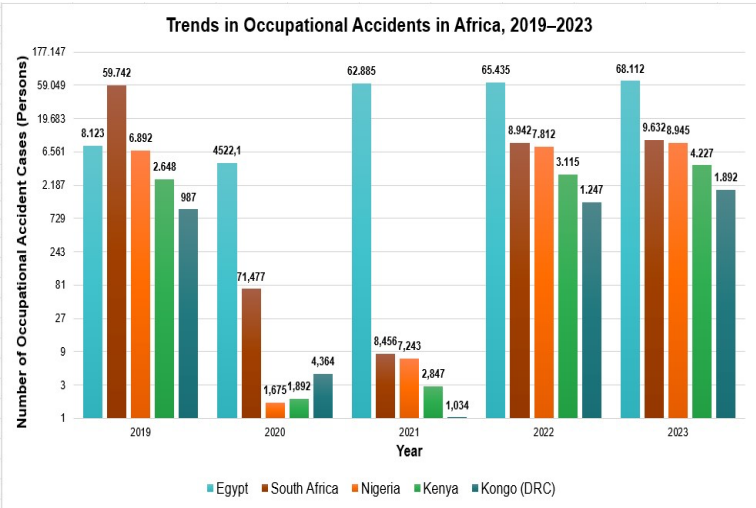

Figure 4. Work Accident Trends in Africa (2019–2023)

In contrast, Figure 4 shows countries in Africa is a more acute situation with an increasing trend in the number of workplace accidents until 2023, especially in Egypt and South Africa, which have high economic activity in the mining and energy sectors. This condition reveals structural gaps and institutional weaknesses in the implementation of OSH policies. According to the ILO (2023), more than 70% of the workforce in Africa still works in the informal sector without formal occupational safety protection. UNEP (2022) also notes that only about 20% of African countries have integrated occupational safety and health (OSH) policies into their national green economy strategies. Similarly, Dhoorgapersadh and Awuor (2024) emphasize that weak enforcement mechanisms and limited training resources in African mining industries contribute significantly to recurring workplace incidents and hinder sustainable industrial recovery. This shows that economic growth in the region has not always been accompanied by improvements in the quality of occupational safety governance, making the industrialization process fragile and non-inclusive.

A comparison between the two regions confirms that economic stability is directly proportional to the effectiveness of OSH systems. Asian countries, with stronger institutional capacity, tend to be able to reduce workplace accidents while maintaining productivity and attracting green investment. In contrast, Africa faces structural obstacles in the form of dependence on high-risk sectors, weak safety infrastructure, and minimal cross-sector policy integration. These findings reinforce the principle in the SAFE-GREEN (Safety and Efficiency for Green Economic Resilience) Model that economic sustainability cannot be achieved without human safety as its foundation. The integration of OSH with resource efficiency strategies has been proven to not only reduce accident risks but also strengthen economic resilience, increase investor confidence, and create robust and sustainable industrial development in Asia and Africa. OECD (2024) further supports this argument, stating that countries with coherent OSH–green economy frameworks experience higher labor productivity and greater resilience to global economic shocks.

Analysis of economic growth data between 2019 and 2023 shows a strong correlation between regional economic performance and the implementation of occupational safety and health (OSH) systems that support green productivity.

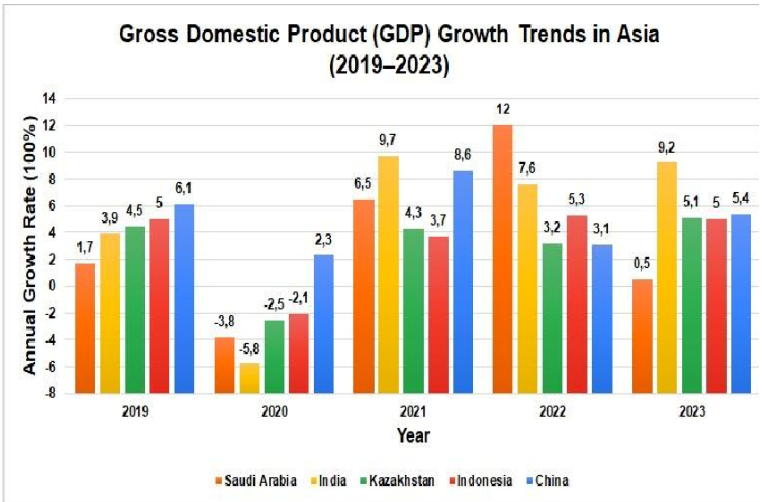

Figure 5. Gross Domestic Product (GDP) Growth Trends in Asia (2019-2023)

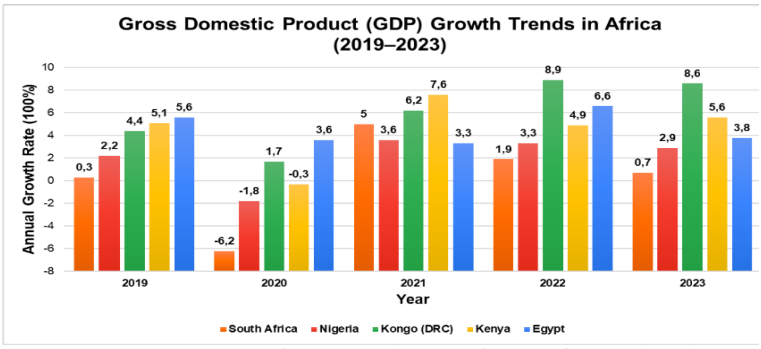

Figure 6. Gross Domestic Product (GDP) Growth Trends in Africa (2019-2023)

As shown in Figure 5 (GDP Growth Trends in Asia) and Figure 6 (GDP Growth Trends in Africa), Asian countries such as China, India, and Indonesia showed a faster economic recovery after the pandemic with an average growth rate of above 5%, while most African countries such as Egypt and Kenya also began to show stable growth, albeit with higher fluctuations. Quantitatively, this stability is related to the ability of these countries to manage resource efficiency and implement better OSH systems. Asia has integrated the concept of green productivity introduced by the APO (2023), in which energy efficiency, industrial waste management, and worker welfare are integrated into a single policy. In contrast, African countries still face institutional limitations and OSH investment constraints that cause disparities between economic growth and worker protection (UNEP, 2022; ILO, 2023).

Conceptually, the integration of green productivity, occupational safety and health (OSH) systems, and the Sustainable Development Goals (SDGs) is key to creating sustainable green economic resilience. According to APEC (2024), the integration of green jobs and OSH frameworks within national development agendas directly contributes to SDG 8 by enhancing both productivity and worker protection in emerging economies. SDG 8 on decent work and economic growth requires a balance between increasing productivity and protecting people in the workplace, while SDGs 12 and 13 promote resource efficiency and climate change mitigation through sustainable industrial practices. Toha et al. (2022) further emphasize that achieving these goals requires systemic adaptation of OSH policies to the evolving risks of the green economy, particularly in renewable energy and waste management sectors where new occupational hazards are emerging. Empirical data from the graph shows that regions with strong OSH policies and integrated green productivity programs, such as in Asia, are able to maintain a balance between economic growth and workplace safety. Meanwhile, Africa is still in the transition phase towards a more comprehensive OSH system. Thus, these two graphs show that the success of green productivity does not only depend on technological innovation, but also on the integration of an OSH system that is aligned with the SDGs, placing people at the center of productivity and long-term economic resilience.

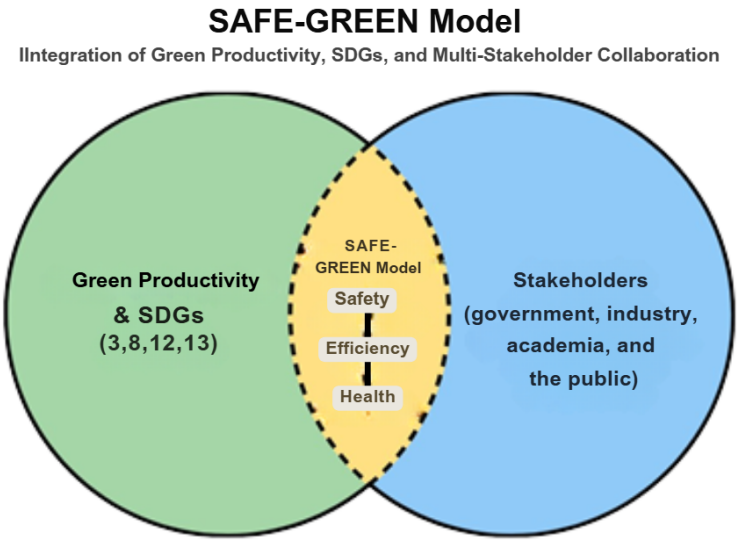

Figure 7. SAFE-GREEN Model: Integration of Green Productivity, Sustainable Development Goals (SDGs), and Multi-Stakeholder Collaboration

The SAFE-GREEN (Safety and Efficiency for Green Economic Resilience) model is a conceptual framework that places people at the center of green economic resilience (Figure 7). This model is based on the understanding that occupational safety, resource efficiency, and environmental sustainability are not three separate things, but rather a single entity that reinforces each other. According to Marhavilas et al. (2022), the implementation of integrated safety management systems such as ISO 45001 has been shown to reduce workplace accidents by more than 30% in manufacturing industries, while simultaneously improving productivity and organizational resilience. In practice, the implementation of an effective OSH system not only protects workers from the risk of accidents, but also reduces economic losses and increases industrial productivity.

Resource efficiency through a green productivity approach helps reduce operational costs, strengthen competitiveness, and open up opportunities for environmentally friendly technological innovation. Butchers (2020) argue that combining resource efficiency strategies with OSH-based risk prevention can create sustainable industrial ecosystems, particularly in developing countries transitioning toward low-carbon economies. At a broader level, collaboration between government, industry, academia, and society is key to creating a resilient green economic cycle in which policies that prioritize human safety result in a healthy, productive workforce that is adaptable to change. Thus, SAFE-GREEN is not only a theoretical model, but also a practical vision for Asia and Africa to build an economy that not only grows, but is also able to survive, adapt, and transform sustainably amid global dynamics.

The integration of occupational safety and health, resource efficiency, and the green economy still faces various structural and institutional challenges, especially in Asia and Africa. According to Tuffour et al. (2024), one of the main barriers to effective OSH integration within green development frameworks in developing regions is the lack of cross-sectoral governance and inadequate funding for institutional capacity building. The main challenge arises from the low integration of OSH policies into the green development agenda and SDGs, where environmental and labor policies are still implemented sectorally. In many developing countries, including Indonesia, Kenya, and Egypt, more than 60–70% of the workforce is still in the informal sector, which is not covered by formal OSH system protections. This situation is exacerbated by the limited availability of standardized occupational accident data, minimal investment in safety monitoring and training systems, and

economic dependence on high-risk sectors such as mining, energy, and construction. In addition, coordination between government agencies is often suboptimal, resulting in OSH and environmental policies that do not reinforce each other but rather run parallel without synergy.

Policy direction needs to be geared toward strengthening cross-sectoral governance and increasing institutional capacity to integrate OSH into sustainable development strategies. The government needs to establish OSH as a preventive and productive policy instrument, not merely an administrative obligation. Strategic steps include the development of a "green safety policy," a policy that combines occupational safety standards with energy efficiency, waste management, and environmentally friendly technological innovation. As noted by Houssam et al. (2023), such an integrated approach would align labor protection with low-carbon transition goals, ensuring that productivity gains from green innovation do not compromise worker safety or social equity.

5. Discussion

The results of this study confirm that the integration of occupational safety and health (OSH) systems, the green economy, and economic resilience has a strong correlation in supporting long-term economic sustainability in Asia and Africa. OSH plays a fundamental role in creating an economic system that not only grows but is also able to withstand various forms of external shocks. With increasing investment in the green sector, developing countries face the challenge of ensuring that new technological changes and industrial practices do not create uncontrolled occupational risks. According to Schulte et al. (2023), changes in the structure of work in the green economy require OSH policy adaptations to protect workers from new hazards such as chemical exposure, extreme heat, and psychosocial stress.

In addition, the development of green skills is an important pillar in strengthening OSH and economic resilience. APEC (2024) states that skills training for the green sector improves workers' ability to adapt to new technologies while reducing the risk of accidents. This is in line with the findings of the OECD (2024), which emphasizes that countries with high investment in OSH training and workforce skills tend to have higher productivity and more stable socioeconomic systems. Therefore, improving human capacity is a strategic step in ensuring a safe and inclusive green transition.

From a socioeconomic perspective, effective OSH implementation can also reduce inequality and strengthen inclusive development. In regions dominated by the informal sector, such as Africa and Southeast Asia, workers without social protection are often the most vulnerable to economic and environmental risks. By expanding the reach of OSH to the informal sector, governments can increase community resilience to economic shocks while strengthening the national productivity base (Aditya & Amri, 2023).

Conceptually, OSH in a green economy should be viewed as a productive instrument, not merely an administrative obligation. This approach requires cross-sectoral synergy between government, industry, and educational institutions. Integrating OSH policies with sustainable development goals (SDGs 8, 12, and 13) will strengthen the country's economic position in facing global challenges. Thus, OSH not only protects workers but also becomes an important foundation in building a resilient, productive, and inclusive green economy in Asia and Africa (OECD, 2024; ILO, 2023).

6. Conclusion

This study examines the relationship between the implementation of occupational safety and health (OSH) and green economic resilience in Asia and Africa. The

results of the analysis show that the implementation of a good OSH management system contributes to increased productivity, resource efficiency, and a reduction in workplace accidents. These conditions have a positive impact on economic growth stability, especially in countries that have integrated OSH principles into their sustainable development policies. The SAFE-GREEN (Safety and Efficiency for Green Economic Resilience) framework shows that OSH has a strategic role in strengthening the green economy. Workplace safety is not merely an aspect of worker protection, but also a long-term investment to increase industrial competitiveness and national economic resilience. With proper integration between energy efficiency, human safety, and environmental preservation, economic development can be more balanced and sustainable. This finding also reinforces the Human Capital Theory, which asserts that worker welfare and safety are important assets in creating high national productivity. Protecting workers not only reduces the risk of economic losses due to accidents but also improves the quality of human resources as the main driver of development. Therefore, the application of the SAFE-GREEN principle is an important foundation for achieving a balance between industrial progress, social welfare, and environmental sustainability.

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