TWIN TRANSITION AS AN ADAPTIVE STRATEGY FOR ECONOMIC RECOVERY AND RESILIENCE POST CRISIS

Muhammad Amin Azis[1]
Laila Kalsum Hasibuan[2]
Rini Syahfriani Batabura[3]

[1,2,3] Universitas Muhammadiyah Tapanuli Selatan
amin.azis@um-tapsel.ac.id

Abstract: *The twin transition, which combines digital transformation and the green transition, is increasingly important as an adaptive strategy for post-crisis economic recovery and resilience. The global economic crisis demonstrates the need for an approach that focuses not only on economic recovery but also on economic sustainability. However, research on the twin transition has not been widely conducted, especially in developing countries. The purpose of this study is to bridge this gap by reviewing empirical studies on the contribution of the twin transition as a mechanism for post-crisis economic recovery and resilience, as well as future economic shocks. This study uses a library research approach with content analysis methods and systematic analysis of the twin transition adaptive strategy as a mechanism for post-crisis economic recovery and resilience. The results of this study indicate that the twin transition can be used as a highly potential adaptive strategy to support long-term economic recovery. The twin transition, when implemented, can create an economic structure that is more resilient to shocks, flexible, competitive, and sustainable. However, the implementation of the twin transition is not immediately successful, as its success is determined by institutional capacity, technological readiness, human resources, and regulations implemented by policymakers.*

Keywords: *Twin Transition, Economic Resilience, Digital Economy, Green Economy, Economic Crisis*

Introduction

In the global economy, crises occur systematically and unexpectedly. Crises ranging from global disruption, supply chain shortages, climate change, and pandemics have shaken countries' economic stability, industrial productivity, and employment structures. These conditions demonstrate that traditional economic development models, which rely on resource intensity (conventional energy), are vulnerable to external shocks. Relying solely on short-term fiscal stimulus to restore the economy to normalcy is inadequate for building a truly stable and sustainable economic foundation.

Given the challenges that have arisen, and the inability of conventional development models to maintain economic growth and normalcy, the need for a recovery strategy that focuses not only on economic growth but also on building long-term economic resilience is increasingly pressing. This demonstrates that the concept of economic development has shifted from a recovery paradigm to a resilience paradigm. From these conditions and awareness, a transformative idea emerged as a global agenda known as the Twin Transition (TT), which is expected to become a crucial foundation for post-crisis economic recovery and resilience. Within this concept, the Twin Transition serves as a strategic pillar for European Union countries and other developed nations, as it is seen as a structural imperative for creating economic growth that is not only productive but also uses resources more efficiently, is carbon-free, and is inclusive.

The Twin Transition concept can be interpreted as the integration of digital transformation and green transition (sustainability). Digital transformation and green transition are not two separate concepts, but can be interconnected, resulting in efficiency, innovation, and sustainable competitiveness both technologically and economically. Judijanto et al. (2025) defines twin transition as the synergy between technological transformation (digital) and green economic transition (sustainability). In practice, this twin transition concept illustrates how digitalization can be used as a sustainability initiative, such as product optimization and efficiency through machine learning, digital-based resource management, and the implementation of smart technology-based renewable energy.

The twin transition concept is increasingly recognized as a strategy for economic recovery and resilience that can be implemented by countries and institutions. However, the implementation of twin transition as an economic resilience concept remains very limited. This implementation weakness is exacerbated by the limited literature that utilizes the twin transition concept, which focuses on a single aspect, such as the digital economy or green economic transformation. This raises the question of to what extent twin transitions influence and contribute as an effective recovery mechanism while simultaneously strengthening long-term economic resilience.

Based on these weaknesses, this study aims to bridge the existing gap by reviewing empirical studies on the contribution of twin transitions as a mechanism for economic recovery and resilience after crises and future economic shocks. More specifically, the study aims to identify how the digital economy and green economic transformation can support and integrate each other, evaluate key internal and external factors that influence the effectiveness of twin transitions, and offer an analytical framework that combines the dimensions of technology, economic sustainability, and economic resilience.

Previous research has found that a twin transition, combining digital tools and sustainability, can maintain organizational resilience and operational efficiency (Schallmo & Jehle, 2025). Another study by Diodato et al., (2023) found the need for investment in diverse technologies and sustainable innovation policies for regions with companies lagging behind in digitalization.

Previous findings have demonstrated that the twin transition concept is an effective strategy for economic recovery and resilience in regional and national contexts. However, research gaps remain, such as the twin transition being studied in a stable economic context, but missing the crucial phase of post-crisis economic recovery and resilience. Furthermore, studies focused on technical access and neglected non-technical aspects that influence twin transition outcomes. A key gap in previous studies is the lack of consensus on the twin transition framework and terminology, which complicates its implementation and operationalization.

Future studies will examine the holistic concept of twin transitions, integrating technical, social, and sustainability perspectives to improve efficiency. Thus, this article is expected to not only enrich the academic literature on twin transition, but also provides an empirical and conceptual basis for a more holistic and sustainable recovery strategy that is able to respond to the challenges of the crisis while building a resilient and adaptive economic foundation to dynamic global conditions.

Literature Review

The term "twin transition" is defined as a concept of a digital transition and a green economic transition simultaneously (mutually supporting each other) (Shajari & David, 2025). In another sense, "twin transition" is not merely a term referring to contemporary economic transformation trends (digital economy and green economy), but rather a term that combines two

transitions that can accelerate crisis-resistant economic transformation and bring society to the necessary level of transformation (Salvi et al., 2022).

Thus, the twin transition is a concept that integrates digital transformation and the green transition, used as a mechanism for economic recovery and post-crisis resilience, aiming to create an adaptive, low-carbon, and highly competitive economic structure. The urgency to implement the twin transition is driven by the fragile economic structure, driven by economic uncertainty and competitive pressures that threaten economic sustainability.

1. The Impact of the Digital Economy on Economic Resilience

Several previous studies have shown that digital transformation in the economy can increase economic resilience. This is evident in research (Lestari & Choirunnisa, 2025), which found that digital transformation is a factor in the resilience of SMEs in the face of crises. This transformation helps SMEs adapt, utilize digital media to survive, and remain operational. Based on this study, it can be seen that the digital economy is not only about operational efficiency, but also an economic instrument that is more resilient to economic shocks.

An economic structure with a digital economy concept can also contribute to a sustainable economy, because digital economic transformation strengthens the green economy in the sectors of ecological literacy, improving public services and energy efficiency (Febrianti et al., 2024).

2. Evidence of Green Transformation

The concept of green transition in the economy aims to encourage structural changes through the use of renewable energy, natural resource efficiency, circular economy and carbon emission reduction to increase the competitiveness of the economy and become a mechanism for economic resilience.

The concept of a green economy is not merely an ecologically focused mechanism, but also one that creates long-term economic resilience by creating highly competitive green jobs. However, the implementation of the green economy transition still faces various challenges, such as fragile policies, the adoption of low-carbon technologies, and the depletion of natural resources (Ardiansyah et al., 2024).

These two economic mechanisms offer significant potential as post-crisis economic recovery concepts and as efficient, effective, and adaptive mechanisms for economic resilience. A study by Benedetti et al. (2023) found that regions that embraced digital transformation alongside the green transition successfully reduced emissions without sacrificing industrial productivity. This finding aligns with a study by Fouquet & Hippe (2022), which states that the integration of these two mechanisms represents a continuation of global economic evolution, where clean energy and the surge in digital technology will form the foundation of the future economy.

Method

This study uses a library research approach designed to generate in-depth conceptual and theoretical understanding of the dynamics and contribution of twin transitions to post-crisis economic recovery and economic resilience to future shocks. Library research is used in this study because it allows for critical analysis through systematic searches, source evaluation, and synthesis across publications from various sources, resulting in comprehensive results.

The research was conducted using journals, books, and other publications that discuss the digital economy, green economic transformation, post-crisis economic recovery mechanisms, and economic resilience mechanisms in the face of future shocks in the modern economic system (Ben Youssef, 2025). This research sample used a document-based purposive sampling approach to ensure structured, comprehensive, analytically rigorous, and relevant analysis (Çakmak, 2024).

This study uses secondary data obtained from studies, research, books, and reports discussing the twin transition as an adaptive strategy and mechanism for post-crisis economic recovery and resilience. Data collection was conducted by gathering and classifying relevant data to ensure only those with significant contributions were included.

The analytical methods used in this study were content analysis and systematic analysis. Content analysis was used to identify conceptual patterns and argumentative structures from the reviewed literature. Systematic analysis was used to integrate these findings into a coherent and constructive theoretical narrative, providing a robust analysis of the study's contribution to explaining the twin transitions as an adaptive strategy for post-crisis economic recovery and resilience.

Result and Discussion

Based on the literature analyzed, the research reveals that the twin transition is not simply a combination of two concepts, but rather an adaptive mechanism for the economy in responding to economic crises, post-crisis recovery, and economic resilience. This concept, unlike traditional economic structures that perpetuate the status quo, represents a leap forward that is more efficient, productive, and sustainable.

1. Twin Transition Dimension

In modern economic structures, the Twin Transition is a mechanism used for contemporary economic policy and innovation. This concept originated in the European Union and has been studied in academic discourse and as a foundation for industrial strategy. Tabares et al. (2025) defines the twin transition as a parallel and mutually reinforcing digital and green transition, aiming to establish a robust mechanism and sustainable competitiveness for companies. The integration of digital transformation and green transition can then form a mechanism where digital transformation can drive process optimization, waste reduction, and energy efficiency. The green transition can encourage renewable energy, low-carbon business practices, and a circular economy (Ben Youssef, 2025).

The twin transition, as an economic mechanism, displays an evolutionary pattern in which digital technology intensity and energy intensity interact during the industrialization period, then diverge as the economy shifts to high-tech and ICT-intensive sectors (Fouquet & Hippe, 2022). This demonstrates that the twin transition is not merely a contemporary phenomenon or a recent concept, but has been part of the long evolution of economic structures. From this long evolution of economic structures, the twin transition emerges as a concept and mechanism that can be used to explore economic recovery and resilience after an economic crisis, which can then be directed toward restructuring the structures of production, distribution, consumption, and innovation with the goal of sustainable and long-term growth.

2. The Relevance of Twin Transition in the Context of the Economic Crisis

The 2008 economic crisis, the Covid-19 pandemic, and economic volatility have demonstrated the fragility and weakness of traditional economic concepts. A study by Ben Youssef (2025) found that the twin transition plays a crucial role as an adaptive mechanism in economic recovery and resilience. This further demonstrates that the twin transition is not merely a concept that prioritizes environmental sustainability but can also be used as a business strategy that can strengthen competitiveness, flexibility, and resilience to external shocks.

Digital transformation through Artificial Intelligence (AI), big data, cloud computing, and the Internet of Things can contribute as a mechanism for post-crisis economic recovery. For example, manufacturing companies that simultaneously utilize digital economy concepts and environmentally friendly innovations significantly contribute to business sales performance. A

study by Choi & Kim (2025) found that South Korean manufacturing firms implementing the twin transition concept recorded an 84% increase in sales in 2021, with an average after-effects of 47% to 57%.

The green transition session can be used as an economic mechanism amidst crises, climate change, and fluctuating energy prices. Research (Ahmad & Syam, 2025) found that the green economic transition is a global economic concept that supports environmental sustainability, social equity, and poverty reduction. The green transition can also serve as a foundation for economic diversification, the development of new sectors, and mitigating the effects of global economic vulnerabilities.

Previous studies clearly demonstrate that digital transformation and green transition, implemented separately, can significantly contribute to economic recovery and resilience. However, both mechanisms are more effective when combined (twin transition) than when implemented separately. The integration of these two concepts is more effective because it allows for cumulative benefits, such as digital aid to support green innovation, improved production transparency, and operational efficiency (Ben Youssef, 2025). An example of the cumulative contribution of this conceptual integration is described in research (Pan et al., 2023), where the twin transition can simultaneously meet Environmental, Social, and Governance (ESG) standards, increase transparency, support human rights, and sustainability, rather than simply expanding economic benefits.

3. Twin Transition as a Post-Crisis Adaptive Strategy

Based on the literature synthesis that has been carried out, it was found that twin transition is an adaptive strategy that can be used for post-crisis economic recovery by paying attention to several mechanisms.

First, increasing adaptive capacity and innovation. In the twin transition, digital transformation contributes to operational flexibility and fosters innovation. The green transition contributes to encouraging product innovation within a sustainable economic framework. In an integral concept, the twin transition contributes to improving the economic system's ability to react to external shocks and changing market preferences.

Second, diversifying economic structures and resources. The green transition can open up new, superior industrial sectors, emphasizing clean energy, greater resilience, resource efficiency, and a circular economy, effectively reducing dependence on traditional economic sectors vulnerable to economic uncertainty. In parallel, digital economic transformation can act as an accelerator, leveraging digital technology to increase productivity and operational efficiency in both new and existing sectors, while diversifying economic resources from raw materials to non-physical assets. This integration provides a more flexible and resilient economy to future economic shocks.

Third, strengthening long-term resilience. Fundamentally, the twin transition can be a mechanism for future economic resilience against multidimensional economic shocks, encompassing market, environmental, and production and consumption structures, transforming for the better and sustainably. The green transition strategy, as an adaptive strategy for economic resilience, is implemented through the decentralization of renewable energy and a circular economy, creating redundancies and mitigating supply risks. A digital transformation strategy that combines real-time data and automation provides operational flexibility that can be used to respond to market fluctuations and sustain economic activity even when physical mobility is disrupted.

Fourth, increasing national and regional competitiveness. In the global economic landscape, the twin transition, as an adaptive strategy for post-crisis economic recovery and resilience, is a crucial catalyst for increasing national and regional competitiveness, prioritizing

economic sustainability and digitalization. Countries that utilize the twin transition concept will increase their competitiveness by attracting foreign direct investment, particularly companies that prioritize clean energy policies and circular solutions. This capital influx not only provides funding but also triggers the formation of innovation clusters—knowledge-intensive ecosystems that integrate research centers, green technology startups, and manufacturing industries. These clusters naturally drive increased human resource capacity through the demand for skilled labor in renewable energy engineering, data science, and biotechnology. By combining the operational efficiency of digitalization with the added value of sustainability, these regions are able to offer superior, resource-efficient products and services that meet global market standards, thereby collectively significantly strengthening their competitiveness in the international market.

However, as an adaptive strategy, the twin transition also faces various challenges in its implementation, particularly in developing countries. These challenges stem from gaps in institutional capacity, technological and regional disparities, regulatory fragmentation, and the risk of digitalization increasing energy consumption without a corresponding increase in clean energy use (Ben Youssef, 2025).

4. Implications for Post-Crisis Economic Recovery and Resilience

Twin transition as an adaptive strategy for post-crisis economic recovery and resilience, including monetary crises, pandemics, and environmental crises, can also increase long-term economic resilience.

a. Theoretical Implications

Twin transition has new theoretical implications, explaining that twin transition is not merely a corporate policy strategy, but rather a structural policy strategy that contributes to the economy in the long term. This suggests that companies, national, and regional institutions should incorporate twin transition into their policies and strategies. A multi-scale approach, including from the company, national, and regional levels, is also necessary to understand the dynamics of twin transition implementation and its impact.

b. Practical Implications for Policy Makers, Industry, and Stakeholders

- The government needs to design a regulatory and incentive framework to support the simultaneous implementation of twin transitions.
- Companies need to implement twin transition, because this concept has been proven to bring benefits to the business (sales growth, increased capacity, and resource efficiency).
- For developing countries, the twin transition can be used as a strategy to escape the traditional economic trap. This must also be accompanied by efforts to narrow the capacity gap.

5. Limitations and Risks of the Library Research Approach and Twin Transition Implementation

Research using a library research approach, with findings in available academic publications predominantly originating from developed countries, creates gaps in generalizations, particularly for developing countries with different circumstances. Another risk is that the normative and aspirational discourse on twin transitions, which ignores the complexities of implementation at the local level, can impact transition costs, social resistance, and human resource quality.

6. Research Contribution

This research contributes theoretically and practically, especially to the concept of a global economy that is increasingly complex and vulnerable to shocks of future economic uncertainty.

a. Developing a conceptual framework that combines digitalization and sustainability literature as post-crisis adaptive strategies.
b. Synthesizes empirical evidence from recent studies on the impact of twin transitions on business performance, economic resilience, and innovation structures.
c. Provides a roadmap for practical policy implementation and strategies for policy makers and industry players in developing countries.
d. Identify research gap areas (e.g. implementation in developing countries, regional disparities, social distribution impacts), which could be the focus of future research.

Conclusion

Based on the analysis, the twin transition model has been found to be a highly potential adaptive strategy for supporting long-term economic recovery. When implemented, the twin transition model can create an economic structure that is more resilient to shocks, flexible, competitive, and sustainable. However, twin transition implementation is not immediately successful; its success is determined by institutional capacity, technological readiness, human resources, and regulations implemented by policymakers. Therefore, twin transition implementation for developing countries is carried out as a long-term economic strategy by preparing infrastructure, structural transformation, investment, and long-term policies.

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