Enterprise Resilience as a Pathway to Sustainability Under Environmental Turbulence: Evidence from Indonesian Agribusiness

Iman Hardiantara[1]*, Umi Kartini Rashid[2], Zurina Samsudin[3], Arifha Mohamad[4]

[1]Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Johor, Malaysia

[2,3]Johor Business School, Universiti Tun Hussein Onn Malaysia, Johor, Malaysia

[4]Faculty of Business, Economics and Social Development, University Malaysia Terengganu, Terengganu, Malaysia

***Corresponding Author**

DOI: https://doi.org/10.47772/IJRISS.2026.100900233

Received: 14 September 2026; Accepted: 19 September 2026; Published: 07 October 2026

ABSTRACT

Indonesian agribusiness enterprises operate under substantial climatic, biological, market, and regulatory turbulence that can disrupt production continuity and threaten long-term sustainability. This study examines the relationships among business environment (BE), conceptualized as environmental turbulence, enterprise resilience (ER), and enterprise sustainability performance (ESP), with particular attention to the mediating role of resilience in crop and livestock enterprises. A quantitative cross-sectional survey was conducted with 576 Indonesian agribusiness enterprises distributed across six geographical regions, comprising 289 crop and 287 livestock enterprises. Respondents were owners, managers, or other personnel with enterprise-level decision-making authority. Data were analyzed using partial least squares structural equation modeling (PLS-SEM), with the structural relationships estimated separately for the two subsectors. The results show that environmental turbulence was positively associated with enterprise resilience and sustainability performance in both groups. For crop enterprises, BE significantly affected ER ($\beta = 0.787$) and ESP ($\beta = 0.260$), while ER significantly affected ESP ($\beta = 0.493$); the indirect effect of BE on ESP through ER was also significant ($\beta = 0.388$). For livestock enterprises, the corresponding effects were $\beta = 0.601$, $\beta = 0.181$, $\beta = 0.710$, and $\beta = 0.427$, respectively, with all relationships significant at $p < .001$. The findings indicate complementary partial mediation in both subsectors, suggesting that environmental turbulence does not inherently improve sustainability but may activate organizational responses that strengthen resilience and help enterprises maintain economic, environmental, and social performance. The study advances a challenge–response perspective by positioning enterprise resilience as an organizational pathway through which external pressures are translated into more adaptive and sustainable agribusiness outcomes.

Keywords: agribusiness, business environment, enterprise resilience, enterprise sustainability performance, environmental turbulence

INTRODUCTION

As the world's food systems contend with rising population numbers, climatic disruptions, geopolitical volatility, and agricultural and distributional disruptions, food security has become an ever more critical challenge. Recognition of adequate food as an essential human right is well established, but persistent gaps remain: roughly 29.6% of the global population lacks dependable food access, and close to 900 million people are confronted with critical food shortages (Barrett, 2020; FAO, 2023). At the same time, agriculture's contribution to global gross domestic product declined from 7.1% in 1981 to 4.1% in 2023, despite continuously rising demand for food and agricultural products (World Bank, 2024). These conditions

emphasize the strategic importance of agribusiness, understood in this study as the umbrella system encompassing the economic value chain of agricultural inputs, primary production, processing, and distribution. Within this structure, crops and livestock constitute two major primary-production subsectors of agribusiness, rather than livestock being treated as a sector separate from agribusiness. This conceptual distinction is important because the sustainability of crop and livestock enterprises ultimately influences the stability of the broader agribusiness system and its capacity to support food security and economic development. Accordingly, the sustainability of enterprises operating in the crop and livestock subsectors is not only a firm-level concern but also has implications for the resilience of the broader agribusiness system and the continuity of domestic food supply.

Indonesia provides a particularly relevant setting for investigating these challenges because of its large population, substantial agricultural resource base, and continued dependence on agribusiness for food provision, employment, and rural livelihoods (Osabohien et al., 2019; Tambunan, 2022). While the real value of Indonesia's agriculture, forestry, and fisheries output increased substantially between 2010 and 2023, its relative contribution to the national economy declined from 13.93% to 11.67%, indicating that the sector has grown more slowly than other parts of the economy (BPS, 2024). More importantly, the number of enterprises engaged in agricultural production activities declined by approximately 18.68%, from about 31.2 million units in 2003 to 25.4 million units in 2023, revealing persistent structural pressures on enterprise survival (BPS, 2024). This decline is particularly consequential because food-oriented crop and livestock enterprises directly support household consumption, rural employment, and the continuity of domestic food supply. Evidence from Indonesia shows that these enterprises operate under recurring structural pressures, including productivity constraints in major food crops and sustained margin pressures in livestock production, making enterprise continuity relevant not only to business survival but also to food affordability and availability (BPS, 2025; FAO, 2023; The World Bank Group, 2023). Consequently, the long-term viability of Indonesian agribusiness depends not merely on increasing production, but increasingly on the ability of enterprises operating in the crop and livestock subsectors to sustain their economic, environmental, and social performance under turbulent conditions. Although crop and livestock enterprises operate within the same agribusiness system, their exposure to environmental turbulence may differ because of differences in production cycles, biological risks, input dependence, and market conditions.

A central source of this turbulence is the business environment (BE) surrounding agribusiness enterprises. Unlike firms in many other industries, crop and livestock enterprises are highly exposed to environmental, biological, market, and institutional uncertainties because their production processes depend directly on natural conditions and living biological resources. Climate variability and extreme weather can reduce yields and increase the frequency of production failures, while pests and animal diseases can cause substantial biological and financial losses (Agus et al., 2023; Febriandika & Rahayu, 2021; Sattler et al., 2021; Sekaranom et al., 2021). These pressures are compounded by commodity-price volatility, fluctuations in production and feed costs, exchange-rate movements, dependence on imported inputs, and uncertainty surrounding government policies and regulations (Zielińska-Chmielewska et al., 2021). Importantly, such turbulence does not manifest uniformly across agribusiness activities: food-crop enterprises may face chronic productivity and supply constraints, livestock enterprises may experience animal-health risks, volatile feed costs, and supply-demand imbalances, while horticultural crops, as part of the crop subsector, remain highly exposed to price volatility and perishability. Recent evidence illustrates this heterogeneity, with food-crop production continuing to face productivity challenges, poultry markets experiencing periods in which live-bird prices fell below production costs, and horticultural commodities exhibiting substantial short-term price fluctuations (BPS, 2025; FAO, 2023; The World Bank Group, 2023). Accordingly, this study conceptualizes BE through four interconnected dimensions—climate and weather conditions, agricultural health, commodity prices, and government policies and regulations—that jointly capture the environmental, biological, market, and institutional uncertainty confronting crop and livestock enterprises.

In this study, BE represents the degree of environmental turbulence experienced by agribusiness enterprises, not the favorability or attractiveness of the external environment. Turbulence encompasses uncertainty and change in climate and weather, agricultural health, commodity prices, and policies and regulations. These conditions can disrupt production, increase uncertainty, and limit managerial predictability. Viewed through a

challenge–response lens, however, they may also prompt enterprises to improve coordination, information gathering, monitoring, preparedness, and adaptation. Thus, a positive association between BE and ER should not be interpreted as evidence that turbulence is inherently beneficial. It may instead indicate that greater exposure to external challenges is associated with efforts to develop or activate resilience capabilities.

Such uncertainty has important implications for enterprise sustainability performance (ESP). Contemporary perspectives on sustainability increasingly reject the view that enterprise success can be evaluated solely through profitability; instead, sustainable performance requires firms to simultaneously maintain economic viability, minimize environmental harm, and generate positive social value (Ketprapakorn & Kantabutra, 2019; Nikolaou et al., 2019; Trianni et al., 2019; Yang & Yang, 2022). This multidimensional perspective is particularly relevant to agribusiness because economic outcomes are intrinsically linked to ecological resources, resource efficiency, community livelihoods, food availability, and responsible production practices. Crop and livestock enterprises therefore face the dual challenge of maintaining operational and financial performance while responding to increasing demands for environmental stewardship and social responsibility (L. Li et al., 2023; Manzaneque-Lizano et al., 2019; Swaffield et al., 2019). A deteriorating or unpredictable business environment may directly undermine ESP by increasing production costs, reducing productivity, disrupting supply chains, and limiting enterprises' capacity to invest in sustainability practices. Because these enterprises form part of the domestic food-production base, deterioration in their sustainability may also have wider consequences for the stability, accessibility, and affordability of food. Nevertheless, exposure to external turbulence does not necessarily produce identical sustainability outcomes across enterprises, suggesting that the relationship between BE and ESP cannot be understood solely as a direct effect. Thus, ER is a means by which enterprises translate external pressures into actions that support sustainability. Resilience may help enterprises maintain operations, reallocate resources, and sustain economic, environmental, and social performance.

One mechanism that may explain these heterogeneous outcomes is enterprise resilience (ER), broadly defined as an enterprise's capacity to withstand disruption, adapt its operations, recover from adverse conditions, and continue functioning while responding to emerging opportunities (Orengo Serra & Sanchez-Jauregui, 2022; Patel, 2023; Rose, 2007; Saad et al., 2021; Sabahi & Parast, 2020). In this study, ER is reflected through collaboration, information technology capability, and awareness. Collaboration enables enterprises to mobilize resources and information through relationships with suppliers, customers, communities, institutions, and other stakeholders; IT capability facilitates information exchange, digital coordination, market access, and timely decision-making; while awareness strengthens preparedness by enabling enterprises to recognize potential threats and respond before disruptions escalate (Rađenović et al., 2020; Siagian et al., 2021). These capacities are especially important for agribusiness SMEs, which often operate with limited buffers and are strongly dependent on external networks and information flows. The food-security perspective further reinforces the importance of resilience because enterprises that can absorb shocks and preserve continuity may contribute to stabilizing domestic food supply when production, price, health, or regulatory disruptions occur. Importantly, environmental turbulence is not assumed to be inherently beneficial to enterprises; rather, it represents an external stressor that may trigger a challenge–response process by increasing the need for coordination, information acquisition, preparedness, and adaptation. Through this mechanism, exposure to environmental turbulence may stimulate the development or activation of resilient practices, while greater resilience enables firms to preserve continuity, reorganize resources, diversify activities, and sustain performance under adverse conditions (Abeysekara et al., 2019; Skouloudis et al., 2020).

Despite increasing scholarly attention to sustainability and resilience, important theoretical, empirical, methodological, and contextual gaps remain. Previous studies have largely investigated environmental uncertainty, enterprise resilience, or sustainable performance separately, while comparatively limited evidence explains how enterprise resilience functions as an intervening mechanism through which the business environment influences sustainability performance, particularly within agribusiness SMEs in emerging economies (Abeysekara et al., 2019; Putritamara et al., 2023; Skouloudis et al., 2020). Resilience has frequently been treated as a stand-alone organizational capability rather than as the mechanism through which multiple external pressures are translated into economic, environmental, and social sustainability outcomes. Methodologically, prior studies have often relied on regression, AHP, or qualitative approaches, while PLS-

SEM remains less frequently applied to simultaneously estimate multidimensional environmental pressures, resilience, and sustainability outcomes (Abbas et al., 2019; Al-Hakimi et al., 2022; Aray et al., 2021; Cui et al., 2023). Contextually, agribusiness research in Indonesia has often emphasized export-oriented commodities or generalized SME vulnerability, leaving comparatively limited understanding of how climatic, biological, market, and regulatory turbulence jointly affects crop and livestock enterprises that directly support domestic food systems. Moreover, although crop and livestock enterprises constitute primary-production subsectors within the same agribusiness system, limited empirical evidence has established whether the relationships among environmental turbulence, enterprise resilience, and sustainability performance are structurally comparable across these two subsectors. This raises an important empirical concern regarding whether crop and livestock enterprises can be appropriately pooled within a common structural model or whether subsector-specific differences characterize their responses to environmental turbulence. This fragmentation restricts understanding of why enterprises facing comparable environmental pressures may exhibit different sustainability outcomes and why some remain viable while others decline. Examining ER as a mediator therefore provides a more process-oriented explanation by proposing that the consequences of BE partly depend on an enterprise's capacity to transform external pressures into resilient organizational responses.

Against this background, this study develops and empirically examines an integrated framework linking business environment (BE), conceptualized as environmental turbulence, enterprise resilience (ER), and enterprise sustainability performance (ESP) among Indonesian agribusiness enterprises operating in the crop and livestock subsectors. Specifically, the study addresses four questions: (1) What is the effect of BE on ESP? (2) What is the effect of BE on ER? (3) Does ER mediate the relationship between BE and ESP? and (4) Do the structural relationships among BE, ER, and ESP differ between crop and livestock enterprises? By addressing these questions, the study makes four principal contributions. First, it clarifies the sustainability consequences of environmental turbulence by conceptualizing BE as a multidimensional external stressor encompassing climatic, biological, market, and regulatory uncertainty and adopting a challenge–response perspective to explain how exposure to such pressures may activate organizational adaptation rather than assuming that turbulence is inherently beneficial. Second, it advances resilience research by positioning ER not merely as an outcome of disruption but as a strategic mechanism through which enterprises translate external pressures into sustainability outcomes. Third, it contributes empirical evidence from Indonesia, an important yet comparatively underrepresented emerging-economy agribusiness context, while adopting a technically consistent hierarchy in which agribusiness represents the overarching value-chain system and crops and livestock represent its primary-production subsectors. Fourth, it addresses potential subsector heterogeneity by assessing measurement invariance and comparing structural relationships between crop and livestock enterprises, thereby examining whether the proposed relationships operate consistently across the two primary-production subsectors. Beyond the Indonesian context, the study offers insights relevant to other developing economies where small-scale agribusiness enterprises play a central role in domestic food supply chains, thereby contributing to broader debates on food security, enterprise resilience, and inclusive agribusiness policy.

LITERATURE REVIEW

Enterprise Sustainability Performance

Enterprise sustainability performance (ESP) reflects an enterprise's capacity to generate long-term economic value while simultaneously maintaining environmental responsibility and contributing positively to society. Sustainability has increasingly shifted from a peripheral corporate concern to a strategic requirement as enterprises face growing expectations from stakeholders, regulators, and markets to address economic, environmental, and social challenges simultaneously (Alsayegh et al., 2020; Kuznetsov, 2023; T. Li et al., 2021). From this perspective, sustainable performance extends beyond conventional financial outcomes by emphasizing an enterprise's ability to meet current organizational and stakeholder needs without compromising the resources and opportunities available to future generations (Markard et al., 2020). Integrating sustainability into enterprise strategies and operations can strengthen operational efficiency, stakeholder relationships, reputation, and long-term competitiveness (Gupta & Gupta, 2020; Lu et al., 2022; Muhmad & Muhamad,

2021). This perspective is especially important for agribusiness enterprises because their economic activities are closely connected with natural resources, food systems, rural communities, and ecological conditions.

The literature generally conceptualizes sustainability performance through the triple bottom line, comprising economic, environmental, and social performance (Alsayegh et al., 2020; Hutchins et al., 2019). Economic sustainability concerns an enterprise's ability to maintain profitability, control costs, increase productivity, respond to market developments, and generate stable business growth (Iranmanesh et al., 2019; G. Zhou et al., 2022). Environmental sustainability focuses on minimizing the ecological consequences of business activities through efficient resource use, waste management, reduced emissions and energy consumption, and compliance with environmental standards (Kamble et al., 2020; Siagian et al., 2021). Social sustainability, meanwhile, concerns the enterprise's contribution to employees and broader communities through occupational welfare, fair labor practices, stakeholder engagement, social responsibility, and community involvement (do Amaral et al., 2023; Nikolaou et al., 2019; Wang et al., 2022). Together, these dimensions provide a multidimensional assessment of whether an enterprise can create value without undermining the environmental and social systems on which its long-term operations depend.

Accordingly, this study measures enterprise sustainability performance through three dimensions: economic, environmental, and social performance. The economic dimension captures enterprises' capacity to sustain business growth, efficiency, profitability, and market performance; the environmental dimension reflects their ability to conserve resources, manage waste, reduce adverse environmental impacts, and conduct production responsibly; and the social dimension represents their contribution to employees, stakeholders, and surrounding communities. These dimensions are particularly relevant to agribusiness enterprises operating in the crop and livestock subsectors, whose sustainability is strongly affected by resource availability, ecological conditions, production risks, and relationships with local communities. Prior studies suggest that enterprises capable of balancing these three dimensions are better positioned to achieve long-term viability and respond to environmental and market disruptions (Feng & Huaccho Huatuco, 2022; Irangani, 2021; Ketprapakorn & Kantabutra, 2019; Nikolaou et al., 2019; Pramono et al., 2021; Trianni et al., 2019). Thus, ESP in this study represents an integrated outcome reflecting the enterprise's capacity to remain economically viable while simultaneously preserving environmental resources and generating social value.

Business Environment

The business environment (BE) represents external conditions surrounding an enterprise that influence its operations, strategic decisions, and performance. Environmental uncertainty emerges when decision-makers cannot obtain complete, accurate, or consistent information regarding future developments, making it difficult to predict changes and formulate appropriate strategic responses (Darvishmotevali et al., 2020). Such uncertainty may originate from economic, political, technological, regulatory, market, or ecological changes and can substantially alter the availability and cost of resources, market opportunities, production processes, and enterprise competitiveness (García-Pérez & Yanes-Estévez, 2022; Halushka, 2023). Agribusiness enterprises are particularly exposed to these conditions because their operations depend not only on market mechanisms but also on climatic and biological systems that cannot be completely controlled by enterprise managers. Consequently, changes in the external environment may rapidly translate into variations in production, costs, revenues, and operational continuity.

The effects of environmental uncertainty are particularly evident in crop and livestock production. Extreme temperatures, unpredictable rainfall, droughts, floods, and other climatic changes may affect production planning and productivity while simultaneously increasing exposure to pests and diseases (Findlater et al., 2019; Michalk et al., 2019; Wreford & Topp, 2020; Zerssa et al., 2021). Agribusiness enterprises also face considerable market uncertainty arising from fluctuations in input and output prices. Variations in feed prices, agricultural inputs, and commodity prices can alter production costs and reduce the predictability of enterprise revenues (Boyd & Bellemare, 2020; Inoubli et al., 2022). At the same time, changes in government regulations, agricultural policies, environmental standards, trade arrangements, and institutional requirements may impose new compliance obligations and alter investment decisions (Zrobok & Hluschenko, 2020). These

interconnected uncertainties make the business environment an important external determinant of enterprise behavior and performance.

Based on these conditions, the present study conceptualizes BE through four dimensions: climate and weather conditions, cultivated agricultural health, commodity prices, and policy and regulations. Climate and weather conditions capture uncertainty associated with rainfall, temperature, extreme weather, and other natural conditions affecting production. Cultivated agricultural health reflects uncertainty associated with crop health, pests, animal health, and disease outbreaks that may disrupt production. Commodity prices represent fluctuations in input and output prices that influence production costs, margins, and financial planning. Finally, policy and regulations concern uncertainty resulting from changes in governmental policies, agricultural regulations, trade rules, and compliance requirements. These four dimensions represent particularly salient external pressures for agribusiness enterprises because they jointly influence production stability, resource allocation, operational risk, and strategic decision-making (Darvishmotevali et al., 2020; García-Pérez & Yanes-Estévez, 2022). Therefore, BE is viewed in this study as a multidimensional external condition capable of shaping both enterprise resilience and sustainability performance.

Enterprise Resilience

Enterprise resilience (ER) refers to an enterprise's capacity to withstand disruption, adapt to changing circumstances, recover from adverse events, and maintain essential functions under conditions of uncertainty. Rather than simply returning to a pre-disruption state, resilience involves an organization's ability to manage risks, adjust strategies and operations, preserve continuity, and respond productively to emerging challenges and opportunities (Conz & Magnani, 2020; Salam & Bajaba, 2023; Sanchis et al., 2020). Resilient enterprises are therefore better positioned to reduce the negative effects of natural disasters, supply disruptions, economic instability, market volatility, and regulatory changes. Resilience can also contribute to performance by enabling firms to maintain stakeholder confidence, preserve competitiveness, and pursue long-term growth despite disruptions (Sanchis et al., 2020; Zerssa et al., 2021). For agribusiness enterprises, this capability is particularly important because disruptions can rapidly affect biological production processes, supply chains, product availability, and enterprise income.

Enterprise resilience is a multidimensional capability, and previous studies have associated it with collaboration, agility, redundancy, flexibility, visibility, IT capability, robustness, awareness, and risk-management culture (Aghaei et al., 2017; Jain et al., 2017; Singh et al., 2019). Collaboration facilitates coordination and joint responses among supply-chain partners, thereby improving access to information and resources during disruptions (Azadeh et al., 2014; Lotfi & Larmour, 2022). IT capability supports accurate and timely information exchange, enhances supply-chain visibility, and enables firms to recognize and respond to disruptions more quickly (Colicchia et al., 2019; Setak et al., 2018; Shishebori & Babadi, 2018). Awareness complements these capacities by enabling enterprises to identify early warning signals, recognize vulnerabilities, interpret potential risks, and formulate mitigation strategies before adverse conditions escalate (Jain et al., 2017; Mandal, 2014; Singh et al., 2019). These capabilities collectively strengthen an enterprise's ability to anticipate, respond to, and recover from external shocks.

Although resilience can be represented through numerous indicators, this study specifically measures ER through collaboration (Azadeh et al., 2014; Lotfi & Larmour, 2022), IT capability (Colicchia et al., 2019; Setak et al., 2018; Shishebori & Babadi, 2018), and awareness (Jain et al., 2017; Mandal, 2014; Singh et al., 2019) because these dimensions are highly relevant to the operational characteristics of Indonesian agribusiness enterprises. Collaboration represents the ability to coordinate with suppliers, customers, business partners, institutions, and other stakeholders when responding to uncertainty. IT capability reflects the enterprise's capacity to employ information and communication technologies to obtain, process, exchange, and utilize timely information for decision-making. Awareness represents an enterprise's ability to recognize threats, anticipate disruptions, and prepare appropriate responses. In agribusiness, where production networks are frequently fragmented and enterprises are exposed to rapidly changing climatic, biological, market, and regulatory conditions, these three dimensions provide a focused representation of resilience. Consequently, ER is conceptualized as an internal organizational capability that enables enterprises to transform exposure to

environmental uncertainty into coordinated, informed, and anticipatory responses that protect their continuity and long-term sustainability.

Business Environment and Enterprise Sustainability Performance

The business environment can substantially influence an enterprise's ability to achieve sustainable economic, environmental, and social outcomes. Environmental uncertainty associated with climate variability, commodity-price fluctuations, regulatory changes, and biological risks can increase operating costs, disrupt production schedules, constrain resource availability, and reduce the predictability of enterprise revenues (Findlater et al., 2019; García-Pérez & Yanes-Estévez, 2022; Pilvere et al., 2021). Economic uncertainties, particularly fluctuations in input and raw-material prices, may compress profit margins and weaken economic sustainability (Lanfranchi et al., 2019; Pilvere et al., 2021). Regulatory changes may similarly create new compliance costs and affect investment decisions, whereas extreme weather and resource degradation may reduce production and increase the environmental costs of maintaining business operations (Hutchins et al., 2019; Rehman & Jajja, 2023). Thus, the conditions surrounding an enterprise are closely connected to its capacity to maintain stable and sustainable performance.

The implications of BE extend across all three dimensions of ESP. Climate and agricultural-health uncertainties affect productivity and environmental resource management; price volatility shapes profitability and economic continuity; and regulatory changes influence environmental practices, employee responsibilities, and relationships with stakeholders (Alsayegh et al., 2020; Kamble et al., 2019; Trianni et al., 2019; G. Zhou et al., 2022). However, uncertain environments may also encourage enterprises to reconsider production processes, improve resource utilization, and adopt more sustainable practices to protect their long-term position (Alsayegh et al., 2020; Mariam et al., 2023; Siagian et al., 2021). Existing evidence therefore establishes a meaningful association between external environmental conditions and sustainability outcomes, although the magnitude and consequences of such conditions may differ across enterprises depending on their capacity to respond. Accordingly, this study proposes that the business environment significantly influences enterprise sustainability performance.

H1: Business environment (BE) has a significant effect on enterprise sustainability performance (ESP).

Business Environment and Enterprise Resilience

Environmental uncertainty creates conditions under which enterprises must strengthen their capacity to anticipate, withstand, and respond to disruption. This relationship is particularly relevant to agribusiness because crop and livestock enterprises operate under continuous exposure to weather variability, agricultural-health risks, commodity-price fluctuations, and changes in government policies. Extreme temperatures, irregular rainfall, and natural hazards can disrupt agricultural schedules and reduce production efficiency, while changing ecological conditions may increase plant pests and animal-disease risks (Findlater et al., 2019; Wreford & Topp, 2020). Commodity-price fluctuations and changes in input costs can similarly undermine financial stability and planning, whereas regulatory changes may require enterprises to modify operational practices within relatively short periods (Imbiri et al., 2024; Permana et al., 2022). These environmental pressures create a need for enterprises to develop mechanisms that allow them to preserve functionality under changing conditions.

In response to such uncertainty, enterprises may strengthen collaborative relationships, improve their capacity to obtain and process information, and enhance awareness of emerging risks. Collaborative networks allow enterprises to share information and resources with supply-chain partners, while IT capability improves the speed and accuracy with which environmental changes can be identified and addressed. Awareness enables enterprises to anticipate threats and prepare mitigation strategies rather than relying solely on reactive measures after disruptions occur. Previous studies indicate that enterprises employing responsive planning, diversified resources, risk monitoring, and collaborative mechanisms are more capable of maintaining operations and recovering from external shocks (Lanfranchi et al., 2019; Lotfi & Larmour, 2022; Skouloudis et

al., 2020). Thus, the external business environment can function as an important stimulus for developing and activating resilience capabilities. Based on this reasoning, the following hypothesis is proposed:

H2: Business environment (BE) has a significant effect on enterprise resilience (ER).

Mediating Role of Enterprise Resilience in the Relationship Between Business Environment and Enterprise Sustainability Performance

The direct influence of the business environment on sustainability performance does not fully explain why enterprises exposed to similar environmental conditions may achieve different outcomes. Unpredictable weather, agricultural-health problems, commodity-price volatility, and regulatory shifts can threaten economic viability, environmental performance, and social responsibilities when enterprises lack mechanisms for anticipating and managing disruptions (Boyd & Bellemare, 2020; Rehman & Jajja, 2023). Enterprise resilience provides such a mechanism by enabling firms to withstand adverse conditions, adapt their operations, and recover while preserving essential business functions (Salam & Bajaba, 2023; Settembre-Blundo et al., 2021). From this perspective, BE creates external pressures, whereas ER represents the internal organizational response through which those pressures are managed. Consequently, the sustainability implications of environmental uncertainty may depend partly on the extent to which enterprises possess resilience capabilities.

The three dimensions of ER considered in this study provide specific channels through which this mediation can occur. Collaboration enables firms to coordinate resources and information with business partners, thereby reducing supply-related uncertainty and supporting operational and economic continuity (Aghaei et al., 2017; Azadeh et al., 2014). IT capability supports real-time information sharing, supply-chain monitoring, and data-driven decision-making, allowing enterprises to identify disruptions and respond more effectively (Colicchia et al., 2019; Setak et al., 2018).

Awareness helps enterprises recognize vulnerabilities and early warning signals, allowing proactive mitigation of climatic, biological, market, or regulatory risks (Jain et al., 2017). These resilience mechanisms can help firms protect financial performance, use resources more effectively, maintain relationships with stakeholders, and reduce the adverse environmental and social consequences of disruption. Empirical literature consequently suggests that resilience can translate environmental pressures into adaptive responses that support sustainable performance (Putritamara et al., 2023; Skouloudis et al., 2020; Wreford & Topp, 2020). Therefore, this study proposes the following mediation hypothesis:

H3: Enterprise resilience (ER) mediates the relationship between business environment (BE) and enterprise sustainability performance (ESP).

METHODOLOGY

Research Design

This study employed a quantitative, cross-sectional survey design to examine the relationships among business environment (BE), conceptualized as perceived environmental turbulence, enterprise resilience (ER), and enterprise sustainability performance (ESP) in Indonesian agribusiness enterprises operating in the crop and livestock subsectors. The quantitative approach was appropriate because the study sought to test theoretically derived hypotheses, estimate relationships among latent constructs, and examine whether the structural relationships differed between crop and livestock enterprises (Creswell, 2018). The study followed a positivist and deductive approach, in which the hypothesized relationships were empirically assessed using data obtained from structured questionnaires.

Because observations were collected at a single point in time, the cross-sectional design captured respondents' perceptions of environmental turbulence, organizational resilience practices, and sustainability performance under prevailing business conditions without manipulating the research environment. The enterprise constituted the unit of analysis, with one eligible owner, manager, or other individual possessing enterprise-level decision-making authority serving as the key informant for each participating enterprise. Such

respondents were expected to possess sufficient knowledge of the enterprise's external operating conditions, organizational capabilities, and sustainability performance.

Population, Sampling, and Data Collection

The study population comprised Indonesian agribusiness enterprises operating in the crop and livestock primary-production subsectors. Based on official statistical data, the population frame consisted of 15,772,098 crop enterprises and 12,190,152 livestock enterprises (BPS, 2024). An a priori sample-size assessment using G*Power was conducted to determine an adequate sample for the statistical analysis.

The resulting target samples were 289 crop enterprises and 287 livestock enterprises, yielding a combined sample of 576 enterprises. Respondents were proportionally distributed across six geographical regions of Indonesia: Java, Sumatra, Bali and Nusa Tenggara, Sulawesi, Kalimantan, and Maluku and Papua. Crop and livestock enterprises were treated as distinct sampling strata and were retained as separate grouping categories for subsequent measurement-invariance and multi-group analyses.

A proportionate stratified sampling approach was combined with purposive respondent recruitment. The allocation of respondents across regions was determined proportionally according to the population of enterprises within each stratum. Within these strata, eligible respondents were approached through contacts facilitated by relevant agricultural institutions and industry associations.

Participation was limited to owners, managers, or other personnel with enterprise-level decision-making authority and sufficient knowledge of the enterprise's operations, external business conditions, organizational capabilities, and performance. This approach was intended to maintain geographical representation while ensuring that the information was provided by respondents capable of reporting enterprise-level conditions.

Data collection was conducted in 2025 with the assistance of trained enumerators. Participation was voluntary, and respondents completed the questionnaire according to their availability. Some respondents provided their responses immediately when approached, whereas others completed the questionnaire at a later time when they were available or after receiving follow-up reminders from the enumerators. Follow-up contact was used to facilitate completion by respondents who had already been approached rather than to alter the established sampling allocation.

Before participation, respondents were informed about the purpose of the study and were provided with informed-consent information. Confidentiality and anonymity were emphasized to encourage candid responses. Completed questionnaires were subsequently screened for missing information, incomplete responses, outliers, logical inconsistencies, and data-entry errors before inclusion in the final dataset. Because information on enterprises that ultimately did not participate was not systematically retained for analytical purposes, a formal comparison between respondents and non-respondents could not be conducted..

Construct Measurement

Data were collected using a structured questionnaire containing measures adapted from established studies. All substantive construct items were evaluated using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) (Sekaran & Bougie, 2016). The dependent construct, enterprise sustainability performance (ESP), was operationalized through three dimensions: economic performance, environmental performance, and social performance. Economic performance captured changes in production, productivity, sales, customers, profit, capital, and business assets; environmental performance covered resource consumption, waste utilization, waste-to-value practices, and carbon-related initiatives; while social performance reflected employment, employee rights and safety, inclusiveness, community involvement, and support for local producers (Feng & Huaccho Huatuco, 2022; Irangani, 2021; Ketprapakorn & Kantabutra, 2019; Nikolaou et al., 2019; Pramono et al., 2021; Trianni et al., 2019).

The mediating construct, enterprise resilience (ER), was measured through three dimensions: collaboration, IT capability, and awareness. Collaboration captured enterprises' coordination with suppliers, other enterprises,

distributors, and retailers in managing supply, markets, demand, bargaining power, and product distribution. IT capability assessed the use of information technologies for accessing supply and price information, identifying market opportunities, improving operational efficiency, and supporting technology-enabled agricultural operations. Awareness measured enterprises' understanding and monitoring of markets, consumers, competitors, business processes, environmental impacts, government policies, and contingency planning (Abeysekara et al., 2019; Aghaei et al., 2017; Azadeh et al., 2014; Cui et al., 2023; Hsieh, 2019; Jain et al., 2017; Kamalahmadi & Parast, 2016; Liu et al., 2018; Pettit et al., 2010; Salam & Bajaba, 2023; Setak et al., 2018; Shishebori & Babadi, 2018; Singagerda et al., 2022).

The independent construct, business environment (BE), was operationalized through four dimensions: climate and weather conditions, cultivated agricultural health, commodity prices, and policies and regulations. Climate and weather conditions captured the perceived unpredictability of weather and its consequences for productivity, production quality, and disease or infestation risks. Cultivated agricultural health assessed uncertainties associated with disease occurrence, prevention, detection, treatment, and maintenance of crops and livestock.

Commodity prices reflected uncertainty in raw-material prices, input availability, and product selling prices. Policies and regulations represented enterprises' exposure to changes in food-safety requirements, waste-management regulations, subsidies, price controls, international trade policies, social stability, exchange rates, and inflation (Boyd & Bellemare, 2020; Findlater et al., 2019; Hussain & Malik, 2022; Inoubli et al., 2022; Lanfranchi et al., 2019; Purbiyati & Rachmawati, 2023; Toia, 2019; Wreford & Topp, 2020).

Data Analysis

The research model was analyzed using partial least squares structural equation modeling (PLS-SEM) with SmartPLS. PLS-SEM was selected because it enables the simultaneous estimation of relationships among multiple latent constructs and is suitable for assessing direct and mediating relationships (Hair et al., 2019). The measurement model was evaluated using indicator loadings, Cronbach's alpha, composite reliability, average variance extracted (AVE), and the heterotrait–monotrait ratio (HTMT) to assess indicator reliability, internal consistency, convergent validity, and discriminant validity. Potential common method bias was additionally assessed using full collinearity variance inflation factors (VIFs).

Following satisfactory measurement-model assessment, the structural model was evaluated using path coefficients, coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), and the standardized root mean square residual (SRMR). Statistical significance of the direct and indirect effects was assessed through bootstrapping, which generated standard errors, t-statistics, confidence intervals, and p-values.

The structural analysis examined the direct effect of BE on ESP, the effect of BE on ER, the effect of ER on ESP, and the indirect effect of BE on ESP through ER. Because the study also examined whether the proposed relationships differed between crop and livestock enterprises, measurement invariance was assessed prior to group comparison using the Measurement Invariance of Composite Models (MICOM) procedure.

After establishing an adequate level of measurement invariance, PLS multi-group analysis (PLS-MGA) was employed to compare the structural path coefficients between crop and livestock enterprises. Differences between groups were interpreted based on the statistical significance of the between-group differences rather than solely on differences in the magnitude of the group-specific coefficients. Goodness-of-Fit (GoF) was not retained as a model-fit criterion in the revised analysis, with SRMR used instead as the principal model-fit index.

RESULTS AND DISCUSSION

PLS-SEM Results

PLS-SEM produced separate models for crop and livestock enterprises to examine the effect of the business environment on enterprise sustainability performance, both directly and through enterprise resilience. Figures 1–3 present the estimated models.

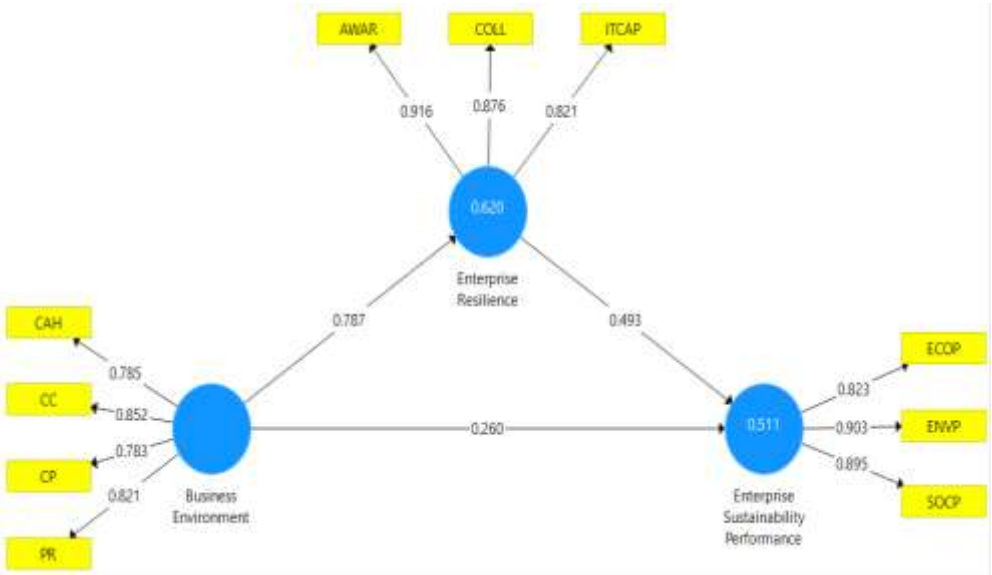

Figure 1. PLS-SEM model of the effect of business environment on enterprise sustainability performance mediated by enterprise resilience in crop enterprises

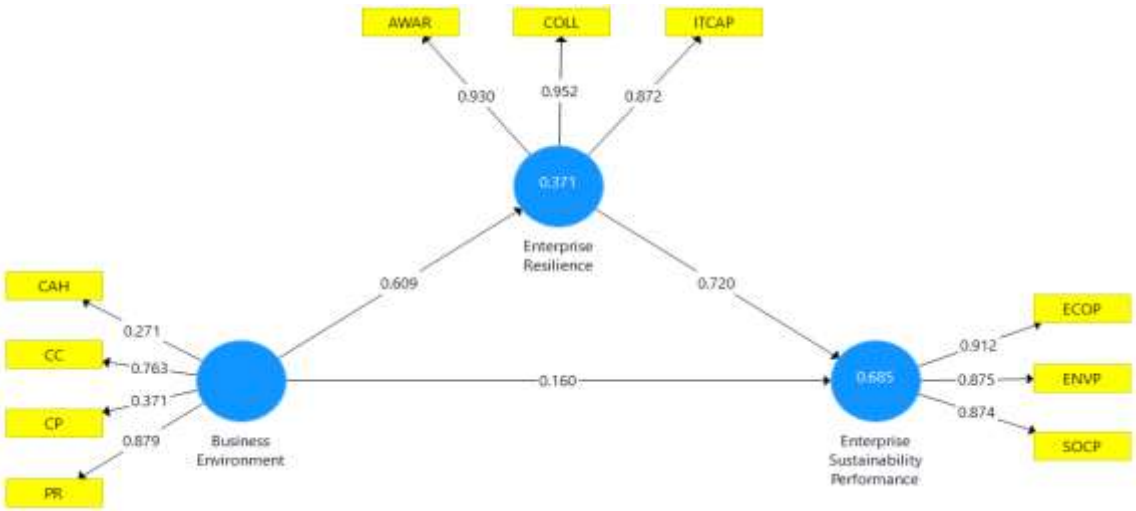

Figure 2. Initial PLS-SEM model of the effect of business environment on enterprise sustainability performance mediated by enterprise resilience in livestock enterprises After the model of the effect of business environment on enterprise sustainability performance mediated by enterprise resilience in crop and livestock enterprises was obtained, the outer model was subsequently assessed, covering convergent validity (loading factor), average variance extracted (AVE), composite reliability, and Cronbach's alpha. From the results of the calculation in the crop group, it was found that all loading factor values showing the relationship between observed (manifest) variables and the construct were above 0.7. It can therefore be concluded that each construct in the study has good validity. However, in the livestock group, it was found that there were loading factor values showing the relationship between observed (manifest) variables and the construct that were below 0.7, namely for the manifests Cultivated Agricultural Health and Commodity Prices. It can therefore be concluded that these constructs have poor validity and must be removed from the model. The results after these manifests were removed are as follows.

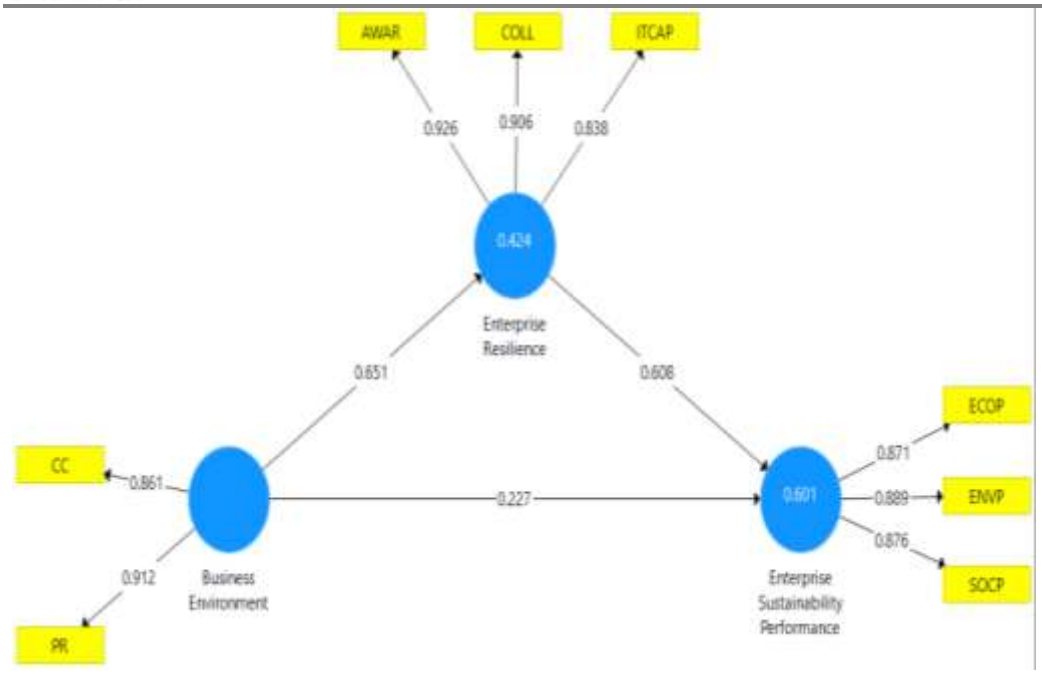

Figure 3. The effect of business environment on enterprise sustainability performance mediated by enterprise resilience in livestock enterprises (final PLS-SEM model) Average Variance Extracted (AVE) testing was subsequently conducted to reinforce the convergent validity results, adhering to the criterion that an AVE value greater than 0.50 establishes construct validity (Hair et al., 2019). Cronbach's alpha and composite reliability were evaluated to determine the internal consistency and reliability of the constructs. Each construct is considered reliable if both Cronbach's alpha and composite reliability values exceed 0.70 (Hair et al., 2014). The AVE and reliability test results for the models are presented below.

Table 1. AVE, Cronbach's Alpha and Composite Reliability Group Crop and Livestock

Group	Latent Variables	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Crop	Business Environment	0,829	0,884	0,657
	Enterprise Resilience	0,841	0,905	0,761
	Enterprise Sustainability Performance	0,849	0,907	0,765
Livestock	Business Environment	0,758	0,817	0,691
	Enterprise Resilience	0,907	0,942	0,843
	Enterprise Sustainability Performance	0,865	0,917	0,787

Based on Table 1, each construct demonstrated adequate reliability, as all Cronbach's alpha and composite reliability values exceeded 0.70. Heterotrait–Monotrait ratio (HTMT) analysis was additionally performed. Technically, the HTMT approach provides an estimate of the true correlation between two latent constructs if they were measured perfectly (i.e., if they were perfectly reliable), also referred to as the disattenuated correlation. A disattenuated correlation approaching 1.0 indicates a lack of discriminant validity.

Table 2. Heterotrait-Monotrait Ratio (HTMT) Group Crop and Livestock

Group		Business Environment	Enterprise Resilience
Crop	Enterprise Resilience	**0,831**	
	Enterprise Sustainability Performance	0,705	**0,800**
Livestock	Enterprise Resilience	**0,820**	
	Enterprise Sustainability Performance	0,862	**0,812**

Based on the HTMT results for both the crop and livestock models, all HTMT values remained below 0.90, establishing good discriminant validity. Following this, the AVE values presented in Table 1 confirm that all latent variables exceeded the 0.50 threshold, indicating that the indicators forming the latent constructs possessed sound convergent validity. Based on cross-loading evaluation (presented in Table 3), each indicator exhibited a higher correlation with its assigned construct than with any other construct, demonstrating robust discriminant validity at the indicator level. Additionally, Cronbach's alpha and composite reliability values for all latent constructs exceeded 0.70, confirming that the measurement model possessed satisfactory internal consistency reliability.

Table 3. Cross Loading Group Crop and Livestock

Group		Business Environment	Enterprise Resilience	Enterprise Sustainability Performance
Crop	CAH	**0,785**	0,557	0,371
	CC	**0,852**	0,664	0,501
	CP	**0,783**	0,603	0,441
	PR	**0,821**	0,702	0,714
	AWAR	0,683	**0,916**	0,666
	COLL	0,629	**0,876**	0,625
	ITCAP	0,746	**0,821**	0,530
	ECOP	0,345	0,449	**0,823**
	ENVP	0,719	0,667	**0,903**
	SOCP	0,556	0,664	**0,895**
Livestock	CC	**0,786**	0,412	0,462
	PR	**0,875**	0,574	0,543
	AWAR	0,645	**0,930**	0,836
	COLL	0,516	**0,952**	0,773
	ITCAP	0,476	**0,871**	0,620
	ECOP	0,466	0,727	**0,912**
	ENVP	0,686	0,731	**0,876**
	SOCP	0,452	0,720	**0,873**

Collinearity testing was subsequently conducted using the Variance Inflation Factor (VIF) criteria proposed by Hair et al. (2014) and Garson (2016). A VIF value exceeding 5.00 indicates potential collinearity issues, whereas a VIF value below 5.00 indicates the absence of collinearity problems (Hair et al., 2014).

Table 4. Variance Inflation Factor (VIF) Values

Group		VIF
Crop	CAH	2,862
	CC	2,650
	CP	2,474
	PR	2,214
	AWAR	2,880
	COLL	2,476
	ITCAP	1,637
	ECOP	1,943
	ENVP	2,110
	SOCP	2,184
Livestock	CC	1,176
	PR	1,176
	AWAR	3,476
	COLL	4,689

	ITCAP	2,519
	ECOP	2,765
	ENVP	2,062
	SOCP	2,217

As shown in Table 4, all VIF values across both the crop and livestock models were well below 5.00, confirming that multicollinearity was not present in either model. Following the measurement model evaluation, the structural model (inner model) was evaluated using the coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), and model fit. The R^2 values obtained are presented below.

Table 5. R-square

Group	Variable	R Square
Crop	Enterprise Resilience	0,620
	Enterprise Sustainability Performance	0,511
Livestock	Enterprise Resilience	0,362
	Enterprise Sustainability Performance	0,691

Based on Table 5, the R^2 value for Enterprise Resilience in the crop group was 0.620, indicating that the Business Environment explained 62.0% of the variance in Enterprise Resilience. The R^2 value for Enterprise Sustainability Performance was 0.511, demonstrating that the Business Environment operating through Enterprise Resilience explained 51.1% of the variance in Enterprise Sustainability Performance. For the livestock group, the R^2 value for Enterprise Resilience was 0.362, showing that the Business Environment explained 36.2% of the variance in Enterprise Resilience. The R^2 value for Enterprise Sustainability Performance in the livestock group was 0.691, indicating that the Business Environment operating through Enterprise Resilience accounted for 69.1% of the variance in Enterprise Sustainability Performance.

In the crop group, the f^2 effect size of the Business Environment on Enterprise Resilience was 1.629, representing a large effect. The f^2 effect sizes of the Business Environment and Enterprise Resilience on Enterprise Sustainability Performance were 0.052 (small effect) and 0.189 (medium effect), respectively. In the livestock group, the f^2 effect size of the Business Environment on Enterprise Resilience was 0.567, representing a large effect. The f^2 effect sizes of the Business Environment and Enterprise Resilience on Enterprise Sustainability Performance were 0.067 (small effect) and 1.040 (large effect), respectively. The Q^2 predictive relevance results are presented below.

Table 6. Q-square

Group		SSO	SSE	Q^2 (=1-SSE/SSO)
Crop	Business Environment	1260,000	1260,000	
	Enterprise Resilience	945,000	660,181	0,301
	Enterprise Sustainability Performance	945,000	444,075	**0,530**
Livestock	Business Environment	630,000	630,000	
	Enterprise Resilience	945,000	669,068	0,292
	Enterprise Sustainability Performance	945,000	439,080	**0,535**

Based on the calculations, the Q^2 values for both the crop and livestock groups were substantially greater than 0, demonstrating that the observed values were successfully reconstructed and that the structural models possessed predictive relevance. Standardized Root Mean Square Residual (SRMR) values of 0.530 for the crop group model and 0.535 for the livestock group model indicated good overall structural model fit across both subsectors. Hypotheses were subsequently evaluated by comparing the calculated t-statistics against the critical t-value of 1.96 and assessing p-values against significance levels of $\alpha = 0.01$, 0.05, and 0.10. The structural hypothesis testing results are summarized in Tables 7 and 8.

Table 7. Hypothesis Testing Results for the Crop Group

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Keputusan
Business Environment -> Enterprise Resilience	0,787***	0,790	0,030	26,406	0,000	H_0 ditolak
Business Environment -> Enterprise Sustainability Performance	0,260***	0,255	0,057	4,562	0,000	H_0 ditolak
Enterprise Resilience -> Enterprise Sustainability Performance	0,493***	0,495	0,050	9,830	0,000	H_0 ditolak
Business Environment -> Enterprise Resilience -> Enterprise Sustainability Performance	0,388***	0,391	0,040	9,718	0,000	H_0 ditolak
Notes: ***signifikan pada 1% **signifikan pada 5% *signifikan pada 10%						

Based on the hypothesis testing results for the crop group, all proposed hypotheses were supported. The Business Environment exerted a positive and statistically significant effect on Enterprise Resilience ($\beta = 0.787$, $p < .001$). The Business Environment also had a positive and statistically significant direct effect on Enterprise Sustainability Performance ($\beta = 0.260$, $p < .001$). Enterprise Resilience demonstrated a positive and statistically significant direct effect on Enterprise Sustainability Performance ($\beta = 0.493$, $p < .001$). Finally, the Business Environment exerted a positive and statistically significant indirect effect on Enterprise Sustainability Performance through Enterprise Resilience ($\beta = 0.388$, $p < .001$), confirming that Enterprise Resilience served as a significant mediating mechanism.

Table 8. Hypothesis Testing Results for the Livestock Group

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Keputusan
Business Environment -> Enterprise Resilience	0,601***	0,605	0,026	23,315	0,000	H_0 ditolak
Business Environment -> Enterprise Sustainability Performance	0,181***	0,181	0,045	3,982	0,000	H_0 ditolak
Enterprise Resilience -> Enterprise Sustainability Performance	0,710***	0,710	0,037	19,107	0,000	H_0 ditolak
Business Environment -> Enterprise Resilience -> Enterprise Sustainability Performance	0,427***	0,429	0,031	13,916	0,000	H_0 ditolak
Nnotes: ***signifikan pada 1% **signifikan pada 5% *signifikan pada 10%						

Based on the hypothesis testing results for the livestock group, all proposed hypotheses were likewise supported. The Business Environment exerted a positive and statistically significant effect on Enterprise Resilience ($\beta = 0.601$, $p < .001$). The Business Environment demonstrated a positive and statistically significant direct effect on Enterprise Sustainability Performance ($\beta = 0.181$, $p < .001$). Enterprise Resilience exerted a positive and statistically significant direct effect on Enterprise Sustainability Performance ($\beta = 0.710$, $p < .001$). Lastly, the Business Environment exerted a positive and statistically significant indirect effect on Enterprise Sustainability Performance through Enterprise Resilience ($\beta = 0.427$, $p < .001$), establishing that Enterprise Resilience functioned as a significant mediating mechanism in the livestock subsector as well.

DISCUSSION

The research findings revealed a consistent pattern of structural relationships among the Business Environment (BE), Enterprise Resilience (ER), and Enterprise Sustainability Performance (ESP) across agribusiness enterprises in both the crop and livestock subsectors. In both subsectors, BE positively and significantly affected ESP and ER, ER positively and significantly affected ESP, and ER significantly mediated the relationship between BE and ESP. These findings are particularly meaningful because BE in this study does not represent a favorable or stable external operating environment, but rather the degree of environmental turbulence reflected through uncertainty in climate and weather, agricultural health, commodity prices, and policies and regulations. Consequently, positive path coefficients must not be interpreted as implying that environmental turbulence is inherently beneficial. Instead, the results support a challenge–response mechanism, wherein external pressures create an urgent imperative for strategic and operational adjustments, while an enterprise's capability to deploy resilient responses determines the extent to which sustainable performance can be preserved. This perspective is consistent with literature demonstrating that environmental uncertainty can serve simultaneously as a source of operational disruption and as a stimulus for adaptation, resource efficiency, and sustainability-oriented responses (Alsayegh et al., 2020; Lu et al., 2022; Mariam et al., 2023; Siagian et al., 2021).

The empirical support for Hypothesis 1 demonstrated that greater exposure to environmental turbulence was positively associated with higher ESP across both subsectors. This result indicates that agribusiness enterprises operating under unpredictable external conditions are frequently compelled to refine how they sustain business continuity. Input and output price uncertainty, for instance, can drive cost control and the search for stable revenue streams; regulatory changes demand operational adjustments and compliance standards; and climatic and biological uncertainties elevate the need for resource efficiency and production risk management. This finding does not negate the severe adverse impacts of turbulence. Rather, as documented in prior literature, climatic, price, and regulatory uncertainties can severely disrupt production, inflate costs, and erode performance predictability (Boyd & Bellemare, 2020; Findlater et al., 2019; García-Pérez & Yanes-Estévez, 2022; Pilvere et al., 2021; Wreford & Topp, 2020). The positive relationship identified in this study is therefore best understood as an indication that external stressors evoke organizational adaptations that help enterprises defend and maintain their sustainability performance.

Within the crop subsector, Climate and Weather Conditions exhibited the highest factor loading on BE, whereas Commodity Prices displayed a relatively lower loading. This pattern shows that perceptions of environmental turbulence among crop enterprises were strongly anchored in weather and climate uncertainties. The biological characteristics of crop production render erratic rainfall, temperature shifts, seasonal volatility, droughts, floods, and pest or disease outbreaks immediate threats to planting schedules, yields, product quality, and production continuity. This aligns with prior evidence establishing that weather variability and changing ecological conditions induce direct agricultural disruptions and heighten adaptation requirements (Findlater et al., 2019; Wreford & Topp, 2020). Conversely, the lower relative loading for Commodity Prices does not imply that price volatility is unimportant; rather, it indicates that variation in perceived environmental turbulence within the crop subsector was more strongly reflected by climatic factors than by price fluctuations. Ecological factors thus represent a primary characteristic through which crop enterprises experience external environmental stress.

In contrast, for the livestock subsector, Policies and Regulations emerged as the BE dimension with the highest factor loading among the retained indicators, whereas Climate Conditions exhibited a lower relative loading. This finding indicates that environmental turbulence in livestock enterprises was strongly driven by institutional and regulatory dynamics. Shifts in food safety standards, waste management rules, subsidies, price controls, trade regulations, and macroeconomic conditions directly alter operational costs, production standards, market access, and investment decisions. Literature confirms that regulatory adjustments often force enterprises to modify operations within short timeframes, elevating the need for organizational flexibility and rapid response capabilities (Imbiri et al., 2024; Permana et al., 2022). The lower relative loading for Climate Conditions does not mean weather is irrelevant to livestock, but indicates that, within the retained measurement model, institutional pressures provided a stronger reflection of environmental turbulence.

Empirical support for Hypothesis 2 confirmed that environmental turbulence was positively related to Enterprise Resilience across both subsectors. This finding reinforces the view that resilience is not a static organizational attribute, but a dynamic capability that becomes increasingly vital when firms confront heightened uncertainty. Exposure to erratic weather, biological threats, market volatility, and regulatory shifts creates an urgent imperative to detect threats, gather information, coordinate resources, and formulate contingency plans. Environmental turbulence thus functions as an external stimulus that activates adaptive mechanisms. This aligns with resilience theory, which emphasizes an enterprise's capacity to anticipate disruptions, adjust strategies, maintain core functions, and recover from shocks (Conz & Magnani, 2020; Salam & Bajaba, 2023; Sanchis et al., 2020). Thus, the positive BE–ER link represents the activation and strengthening of response capabilities under environmental stress rather than a direct benefit of turbulence itself.

For crop enterprises, Awareness recorded the highest factor loading on ER, whereas IT Capability exhibited the lowest relative loading. The dominance of Awareness highlights the critical importance of recognizing shifts in markets, consumer demands, competitor behaviors, financial conditions, ecological impacts, policies, and emerging risks before disruptions escalate. In crop production, where operations depend on natural systems, early threat detection provides the essential foundation for preventive measures and contingency planning. This finding supports Jain et al. (2017), Mandal (2014), and Singh et al. (2019), who identified awareness as a vital element for identifying vulnerabilities and executing mitigation strategies. Meanwhile, the lower relative loading for IT Capability suggests that digital technology was not the primary reflection of resilience among crop enterprises in this sample, although IT retains strategic value by accelerating information access, supply chain visibility, and data-driven decision-making (Colicchia et al., 2019; Setak et al., 2018; Shishebori & Babadi, 2018).

A distinct pattern emerged in the livestock subsector, where Collaboration achieved the highest factor loading on ER, while IT Capability again displayed the lowest relative loading. The high loading for Collaboration demonstrates that livestock enterprise resilience relies heavily on coordination with suppliers, peer producers, distributors, retailers, and value-chain partners. Collaborative relationships enable livestock firms to share vital information, secure scarce inputs, maintain market access, and enhance bargaining power during disruptions. Literature confirms that collaborative networks mitigate information asymmetry and distribute risk across supply chains, thereby fortifying organizational survival under uncertainty (Aghaei et al., 2017; Azadeh et al., 2014; Lotfi & Larmour, 2022; Singh et al., 2019). The lower relative loading for IT Capability across both subsectors indicates that digital tools were not the dominant reflection of agribusiness resilience in this context, highlighting that interpersonal relationships, business networks, and risk awareness remain central to resilience building among Indonesian agribusinesses.

Beyond the direct relationships hypothesized in H1 and H2, structural model estimation confirmed that ER exerted a strong positive effect on ESP in both subsectors. This establishes that enterprise sustainability depends not merely on enduring pressure, but on maintaining economic, environmental, and social functions during disruptions. Collaboration helps preserve supply and distribution continuity; IT capability enhances information speed and decision efficiency; and awareness enables proactive risk recognition. Together, these capacities help firms sustain productivity, conserve environmental resources, safeguard worker welfare, and maintain community relationships. This supports the perspective that resilient enterprises are better equipped to preserve stakeholder trust, competitive advantage, and business continuity during crises (Sanchis et al., 2020; Zerssa et al., 2021). ER thus functions as a crucial organizational capability bridging short-term survival needs with long-term sustainability outcomes.

The relative contribution of the three ESP dimensions varied notably between subsectors. Among crop enterprises, Environmental Performance registered the highest factor loading, whereas Economic Performance had the lowest relative loading. This reveals that sustainability in crop enterprises was most strongly reflected by resource efficiency, waste management, environmental impact reduction, and responsible production practices. This is logical given that crop production relies directly on soil quality, water availability, climate, and ecosystem health. Conversely, in the livestock subsector, Economic Performance achieved the highest factor loading, whereas Social Performance had the lowest relative loading. Production continuity,

productivity, sales stability, profitability, and asset growth thus served as the primary reflections of livestock enterprise sustainability. Nevertheless, lower-loading dimensions remain essential, as true sustainability requires balancing economic, environmental, and social performance (Alsayegh et al., 2020; Hutchins et al., 2019; Nikolaou et al., 2019; Wang et al., 2022).

Support for Hypothesis 3 established that ER significantly mediated the relationship between BE and ESP across both crop and livestock enterprises. Because both the direct effect of BE on ESP and the indirect effect through ER were statistically significant and pointed in the same positive direction, the pattern demonstrates complementary partial mediation. Theoretically, this clarifies that environmental turbulence influences sustainability not only through direct operational adjustments, but also through the activation of organizational resilience capabilities. Unpredictable external conditions do not automatically yield sustainable outcomes; external pressures must first be translated into internal organizational actions such as stakeholder coordination, information gathering, threat monitoring, and contingency planning. Resilience thus serves as the essential explanatory pathway connecting external turbulence to sustainable performance. This supports literature positioning resilience as an organizational process that converts external stress into adaptive capacity and sustainable outcomes (Abeysekara et al., 2019; Salam & Bajaba, 2023; Settembre-Blundo et al., 2021).

This mediating mechanism can be further understood through the substantive linkages between BE and ER dimensions. Climate uncertainty heightens the need for environmental monitoring and contingency planning; input and price volatility increases the necessity of coordinating with suppliers and peers; and regulatory changes require rapid information processing and compliance. In this process, Collaboration provides access to external resources and knowledge, IT Capability accelerates information flows, and Awareness enables early threat recognition. ER thus provides the internal structure through which external signals are translated into organized responses. Scholarly work confirms that collaboration, information technology, and risk awareness enhance an organization's capacity to anticipate, respond to, and recover from shocks (Azadeh et al., 2014; Colicchia et al., 2019; Jain et al., 2017; Lotfi & Larmour, 2022; Setak et al., 2018). This reinforces ER not merely as an outcome of disruption, but as an organizational pathway explaining how turbulence relates to sustainability.

The structural coefficients also indicated distinct response patterns between subsectors. The effect of BE on ER appeared stronger in crop enterprises ($\beta = 0.787$ vs. 0.601), whereas the effect of ER on ESP appeared stronger in livestock enterprises ($\beta = 0.710$ vs. 0.493). This corresponds with their dimensional structures: crop enterprises were characterized more strongly by climate uncertainty, awareness, and environmental performance, whereas livestock enterprises were driven more by regulatory dynamics, collaboration, and economic performance. However, path coefficient differences must not be interpreted as definitive proof of structural moderation without formal invariance testing. Final conclusions regarding structural heterogeneity rely on MICOM and PLS-MGA procedures. Group-specific coefficients at this stage describe empirical patterns within each subsector and provide the theoretical grounding for formal multi-group comparisons.

Overall, the research findings strengthen the challenge–response perspective by demonstrating that agribusiness sustainability depends not on the absence of turbulence, but on an enterprise's capability to organize resilient responses to that turbulence. The primary contribution of this study lies in establishing ER as the central organizational mechanism linking external pressures to multidimensional sustainability performance. The loading patterns further show that this mechanism is subsector-sensitive: crop enterprises rely heavily on climate monitoring, risk awareness, and environmental stewardship, whereas livestock enterprises depend more on regulatory compliance, collaborative networks, and economic viability. Practically, resilience strategies must align with subsector realities: enhancing environmental monitoring and early warning systems is vital for crop producers, whereas fortifying collaborative networks and regulatory adaptability is essential for livestock operators. Across both groups, expanding digital IT capabilities represents a strategic opportunity to improve information speed, coordination, risk visibility, and decision quality. Agribusiness sustainability under environmental turbulence is thus best understood as an ongoing capability to anticipate disruptions, coordinate resources, adapt operations, and simultaneously maintain economic, environmental, and social functions (Cui et al., 2023; Siagian et al., 2021; Skouloudis et al., 2020; Wreford & Topp, 2020).

CONCLUSION

This study demonstrated that the Business Environment, conceptualized as environmental turbulence, exhibits a positive and statistically significant relationship with both Enterprise Resilience (ER) and Enterprise Sustainability Performance (ESP) across Indonesian agribusiness enterprises in the crop and livestock subsectors. Furthermore, ER positively affects ESP and significantly mediates the relationship between environmental turbulence and sustainability performance. These findings confirm that external pressures stemming from climatic variability, biological threats, commodity price volatility, and regulatory shifts do not directly produce superior performance; rather, they initiate a challenge–response process that activates an enterprise's organizational capabilities. In the crop subsector, environmental turbulence is most strongly reflected by climate conditions, resilience by awareness, and sustainability by environmental performance. In the livestock subsector, turbulence is reflected most strongly by policies and regulations, resilience by collaboration, and sustainability by economic performance. Ultimately, agribusiness sustainability under environmental uncertainty is determined less by external conditions alone and more by an enterprise's internal capacity to detect environmental changes, coordinate stakeholder resources, adapt operations, and balance economic, environmental, and social functions.

This study possesses several limitations that offer valuable avenues for future research. First, the cross-sectional survey design limits the ability to observe how environmental turbulence, resilience, and sustainability performance evolve over time; future studies should employ longitudinal or panel designs to capture these dynamic relationships. Second, data were gathered through self-reported perceptions of a single key informant per enterprise, introducing potential common method and social desirability biases; future research could incorporate multiple informants, objective financial/environmental metrics, or administrative records. Third, while sampling spanned six major Indonesian regions across two subsectors, non-response bias could not be formally evaluated because non-participating firms were not systematically tracked. Fourth, measurement model refinements in the livestock group required dropping two initial BE dimensions, indicating a need to refine and validate subsector-specific environmental turbulence constructs. Finally, future research could expand this framework by integrating moderating or antecedent variables—such as enterprise size, digital capability, access to finance, supply chain structure, or institutional support—and testing the model across other developing economy contexts to evaluate its broader generalizability.

ACKNOWLEDGMENT

The author gratefully acknowledges the owners, managers, and other decision makers from crop and livestock enterprises across Indonesia who participated in the survey. The author also acknowledges the institutions and enumerators who supported respondent access and data collection.

Ethical Considerations

This study followed ethical principles for research involving human participants. Before participation, respondents received information about the study and provided informed consent. Participation was voluntary. The study protected respondent confidentiality and anonymity, and the data were analyzed in aggregate form for academic purposes.

Conflict Of Interest

The author declares no financial, personal, or professional conflicts of interest that could have influenced the conduct, results, or reporting of this research.

Data Availability Statement

The survey data generated and analyzed during this study are available from the corresponding author upon reasonable academic request, subject to participant confidentiality and applicable data-protection requirements.

REFERENCES

1. Abbas, J., Raza, S., Nurunnabi, M., Minai, M. S., & Bano, S. (2019). The impact of entrepreneurial business networks on firms' performance through a mediating role of dynamic capabilities. Sustainability, 11(11), 3006. https://doi.org/10.3390/su11113006
2. Abeysekara, N., Wang, H., & Kuruppuarachchi, D. (2019). Effect of supply-chain resilience on firm performance and competitive advantage: A study of the Sri Lankan apparel industry. Business Process Management Journal, 25(7), 1673–1695. https://doi.org/10.1108/BPMJ-09-2018-0241
3. Aghaei, M., Zeinal Hamadani, A., & Abouei Ardakan, M. (2017). Redundancy allocation problem for k-out-of-n systems with a choice of redundancy strategies. Journal of Industrial Engineering International, 13, 81–92. https://doi.org/10.1007/s40092-016-0169-3
4. Agus, F., Surmaini, E., & Lina, H. (2023). Strategies for Indonesia's Agricultural Climate Change Adaptation and Mitigation. Jurnal Sumberdaya Lahan. https://doi.org/10.21082/jsdl.v16n2.2022.67-81
5. Al-Hakimi, M. A., Borade, D. B., Saleh, M. H., & Nasr, M. A. A. (2022). The moderating role of supplier relationship on the effect of postponement on supply chain resilience under different levels of environmental uncertainty. Production & Manufacturing Research, 10(1), 383–409. https://doi.org/10.1080/21693277.2022.2089264
6. Alsayegh, M. F., Abdul Rahman, R., & Homayoun, S. (2020). Corporate Economic, Environmental, and Social Sustainability Performance Transformation through ESG Disclosure. Sustainability, 12(9), 3910. https://doi.org/10.3390/su12093910
7. Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. Psychological Bulletin, 103(3), 411–423. https://doi.org/10.1037/0033-2909.103.3.411
8. Aray, Y., Veselova, A., Knatko, D., & Levchenko, A. (2021). Drivers for adoption of sustainability initiatives in supply chains of large Russian firms under environmental uncertainty. Corporate Governance: The International Journal of Business in Society, 21(2), 322–338. https://doi.org/10.1108/CG-02-2020-0048
9. Azadeh, A., Atrchin, N., Salehi, V., & Shojaei, H. (2014). Modelling and improvement of supply chain with imprecise transportation delays and resilience factors. International Journal of Logistics Research and Applications, 17(4), 269–282. https://doi.org/10.1080/13675567.2013.846308
10. Barrett, C. (2020). Overcoming Global Food Security Challenges through Science and Solidarity. American Journal of Agricultural Economics. https://doi.org/10.1111/ajae.12160
11. Boyd, C. M., & Bellemare, M. F. (2020). The Microeconomics of Agricultural Price Risk. Annual Review of Resource Economics, 12(1), 149–169. https://doi.org/10.1146/annurev-resource-100518-093807
12. BPS. (2024). Agricultural Census 2023. https://sensus.bps.go.id/main/index/st2023
13. BPS. (2025). Statistik Perusahaan Hortikultura dan Usaha Hortikultura Lainnya. https://www.bps.go.id/en/publication/2025/10/17/7f17adf769e2783748de5ab4/statistik-perusahaan-hortikultura-dan-usaha-hortikultura-lainnya-2025.html
14. Colicchia, C., Creazza, A., Noè, C., & Strozzi, F. (2019). Information sharing in supply chains: a review of risks and opportunities using the systematic literature network analysis (SLNA). Supply Chain Management: An International Journal, 24(1), 5–21. https://doi.org/10.1108/SCM-01-2018-0003
15. Conz, E., & Magnani, G. (2020). A dynamic perspective on the resilience of firms: A systematic literature review and a framework for future research. European Management Journal, 38(3), 400–412. https://doi.org/10.1016/j.emj.2019.12.004
16. Creswell, J. W. (2018). Research Design. SAGE.
17. Cui, L., Jin, Z., Li, Y., & Wang, Y. (2023). Effects of control mechanisms on supply chain resilience and sustainability performance. Australian Journal of Management, 48(2), 323–340. https://doi.org/10.1177/03128962211066532
18. Darvishmotevali, M., Altinay, L., & Köseoglu, M. A. (2020). The link between environmental uncertainty, organizational agility, and organizational creativity in the hotel industry. International Journal of Hospitality Management, 87, 102499. https://doi.org/10.1016/j.ijhm.2020.102499

19. do Amaral, M. R., Willerding, I. A. V., & Lapolli, É. M. (2023). SUSTENTABILIDADE ORGANIZACIONAL: a sinergia entre ESG e Organizações Saudáveis. Anais Do Congresso Internacional de Conhecimento e Inovação–Ciki. http://proceedingegc.sites.ufsc.br/index.php/ciki/article/view/1428
20. FAO. (2023). The State of Food Security and Nutrition in The World.
21. Febriandika, N. R., & Rahayu, C. (2021). The Impact of Climate Change on Economic Conditions: Evidence in Indonesia. JEJAK. https://doi.org/10.15294/JEJAK.V14I2.29920
22. Feng, K., & Huaccho Huatuco, L. (2022). Sustainable Purchasing Practices: A Study of Fresh Food SMEs in Yorkshire. In Sustainable Design and Manufacturing: Proceedings of the 8th International Conference on Sustainable Design and Manufacturing (KES-SDM 2021) (pp. 149–158). Springer. https://doi.org/10.1007/978-981-16-6128-0_15
23. Findlater, K. M., Satterfield, T., & Kandlikar, M. (2019). Farmers' Risk-Based Decision Making Under Pervasive Uncertainty: Cognitive Thresholds and Hazy Hedging. Risk Analysis, 39(8), 1755–1770. https://doi.org/10.1111/risa.13290
24. García-Pérez, A. M., & Yanes-Estévez, V. (2022). Longitudinal study of perceived environmental uncertainty. An application of Rasch methodology to SMEs. Journal of Advances in Management Research, 19(5), 760–780. https://doi.org/10.1108/JAMR-02-2022-0033
25. Garson, G. D. (2016). Partial least squares: Regression & structural equation models. Asheboro, NC: Statistical Associates Publishing
26. Gupta, A. K., & Gupta, N. (2020). Effect of corporate environmental sustainability on dimensions of firm performance – Towards sustainable development: Evidence from India. Journal of Cleaner Production, 253, 119948. https://doi.org/10.1016/j.jclepro.2019.119948
27. Hair, J. F., Jr., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). A primer on partial least squares structural equation modeling (PLS-SEM). Thousand Oaks, CA: SAGE Publications DOI:10.54055/ejtr.v6i2.134
28. Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. European Business Review, 31(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203
29. Halushka, Z. (2023). Uncertainty as an Economic Category and as a Business Functioning Environment. Economics: Time Realities, 1(65), 26–32. https://doi.org/10.15276/ETR.01.2023.3
30. Hsieh, F.-S. (2019). Dynamic configuration and collaborative scheduling in supply chains based on scalable multi-agent architecture. Journal of Industrial Engineering International, 15(2), 249–269. https://doi.org/10.1007/s40092-018-0291-5
31. Hussain, M., & Malik, M. (2022). How do dynamic capabilities enable hotels to be agile and resilient? A mediation and moderation analysis. International Journal of Hospitality Management, 106, 103266. https://doi.org/10.1016/j.ijhm.2022.103266
32. Hutchins, M. J., Richter, J. S., Henry, M. L., & Sutherland, J. W. (2019). Development of indicators for the social dimension of sustainability in a U.S. business context. Journal of Cleaner Production, 212, 687–697. https://doi.org/10.1016/j.jclepro.2018.11.199
33. Imbiri, S., Rameezdeen, R., Chileshe, N., & Statsenko, L. (2024). Risk propagation and resilience in the agribusiness supply chain: a systematic literature review. Journal of Agribusiness in Developing and Emerging Economies, 14(4), 712–732. https://doi.org/10.1108/JADEE-08-2022-0180
34. Inoubli, A., Onkware Sarangé, C., & Adebola, M. (2022). The Agribusiness Ecosystem in East and Southern Africa: Exploring the Role and Synergies of Key Stakeholders in the Space. https://hdl.handle.net/10568/125136
35. Irangani, S. (2021). Impact of Global Value Chain on the Performance of SME. In Enhancing SME Participation in Global Value Chains (Vol. 299). https://doi.org/10.2139/ssrn.3938637
36. Iranmanesh, M., Zailani, S., Hyun, S. S., Ali, M. H., & Kim, K. (2019). Impact of Lean Manufacturing Practices on Firms' Sustainable Performance: Lean Culture as a Moderator. In Sustainability (Vol. 11, Issue 4). https://doi.org/10.3390/su11041112
37. Jain, V., Kumar, S., Soni, U., & Chandra, C. (2017). Supply chain resilience: model development and empirical analysis. International Journal of Production Research, 55(22), 6779–6800. https://doi.org/10.1080/00207543.2017.1349947
38. Kamalahmadi, M., & Parast, M. M. (2016). A review of the literature on the principles of enterprise and supply chain resilience: Major findings and directions for future research. International Journal of Production Economics, 171, 116–133. https://doi.org/10.1016/j.ijpe.2015.10.023

39. Kamble, S., Gunasekaran, A., & Arha, H. (2019). Understanding the Blockchain technology adoption in supply chains-Indian context. International Journal of Production Research, 57(7), 2009–2033. https://doi.org/10.1080/00207543.2018.1518610
40. Kamble, S., Gunasekaran, A., & Dhone, N. C. (2020). Industry 4.0 and lean manufacturing practices for sustainable organisational performance in Indian manufacturing companies. International Journal of Production Research, 58(5), 1319–1337. https://doi.org/10.1080/00207543.2019.1630772
41. Ketprapakorn, N., & Kantabutra, S. (2019). Sustainable Social Enterprise Model: Relationships and Consequences. Sustainability, 11(14), 3772. https://doi.org/10.3390/su11143772
42. Kuznetsov, M. (2023). ESG transformation as a new management paradigm. Financial Analytics: Science and Experience. https://doi.org/10.24891/fa.16.4.404
43. Lanfranchi, M., Giannetto, C., Rotondo, F., Ivanova, M., & Dimitrova, V. (2019). Economic and social impacts of price volatility in the markets of agricultural products. Bulgarian Journal of Agricultural Science, 25(6). https://www.agrojournal.org/25/06-01.html
44. Li, L., Gao, Y., & Wang, X. (2023). Impact of Economic Policy Uncertainty on Agribusiness Technology Innovation: Evidence from 231 Listed Firms in China. In Sustainability (Vol. 15, Issue 13). https://doi.org/10.3390/su151310037
45. Li, T., Wang, K., Sueyoshi, T., & Wang, D. (2021). ESG: Research Progress and Future Prospects. Sustainability. https://doi.org/10.3390/su132111663
46. Liu, C.-L., Shang, K.-C., Lirn, T.-C., Lai, K.-H., & Lun, Y. H. V. (2018). Supply chain resilience, firm performance, and management policies in the liner shipping industry. Transportation Research Part A: Policy and Practice, 110, 202–219. https://doi.org/10.1016/j.tra.2017.02.004
47. Lotfi, M., & Larmour, A. (2022). Supply chain resilience in the face of uncertainty: how horizontal and vertical collaboration can help? Continuity & Resilience Review, 4(1), 37–53. https://doi.org/10.1108/CRR-04-2021-0016
48. Lu, J., Rodenburg, K., Foti, L., & Pegoraro, A. (2022). Are firms with better sustainability performance more resilient during crises? Business Strategy and the Environment, 31(7), 3354–3370. https://doi.org/10.1002/bse.3088
49. Mandal, S. (2014). Supply chain resilience: a state-of-the-art review and research directions. International Journal of Disaster Resilience in the Built Environment, 5(4), 427–453. https://doi.org/10.1108/IJDRBE-03-2013-0003
50. Manzaneque-Lizano, M., Alfaro-Cortés, E., & Priego de la Cruz, A. M. (2019). Stakeholders and Long-Term Sustainability of SMEs. Who Really Matters in Crisis Contexts, and When. Sustainability, 11(23), 6551. https://doi.org/10.3390/su11236551
51. Mariam, S., Khawaja, K. F., & Khan, H. G. A. (2023). Dynamic Capabilities, Innovation, and Sustainable Competitive Advantage under Environmental Uncertainty in Textile Industry. NUML International Journal of Business & Management, 18(1), 1–15. https://doi.org/10.52015/nijbm.v18i1.160
52. Markard, J., Geels, F. W., & Raven, R. (2020). Challenges in the acceleration of sustainability transitions. Environmental Research Letters, 15(8), 081001. https://doi.org/10.1088/1748-9326/ab9468
53. Michalk, D. L., Kemp, D. R., Badgery, W. B., Wu, J., Zhang, Y., & Thomassin, P. J. (2019). Sustainability and future food security—A global perspective for livestock production. Land Degradation & Development, 30(5), 561–573. https://doi.org/10.1002/ldr.3217
54. Muhmad, S. N., & Muhamad, R. (2021). Sustainable business practices and financial performance during pre- and post-SDG adoption periods: a systematic review. Journal of Sustainable Finance & Investment, 11(4), 291–309. https://doi.org/10.1080/20430795.2020.1727724
55. Nikolaou, I. E., Tsalis, T. A., & Evangelinos, K. I. (2019). A framework to measure corporate sustainability performance: A strong sustainability-based view of firm. Sustainable Production and Consumption, 18(xxxx), 1–18. https://doi.org/10.1016/j.spc.2018.10.004
56. Orengo Serra, K. L., & Sanchez-Jauregui, M. (2022). Food supply chain resilience model for critical infrastructure collapses due to natural disasters. British Food Journal, 124(13), 14–34. https://doi.org/10.1108/BFJ-11-2020-1066
57. Osabohien, R., Akinpelumi, D., Matthew, O., Okafor, V., Iku, E., Olawande, T., & Okorie, U. (2019). Agricultural Exports and Economic Growth in Nigeria: An Econometric Analysis. IOP Conference Series: Earth and Environmental Science, 331(1), 012002. https://doi.org/10.1088/1755-1315/331/1/012002

58. Patel, K. R. (2023). Enhancing Global Supply Chain Resilience: Effective Strategies for Mitigating Disruptions in an Interconnected World. BULLET: Jurnal Multidisiplin Ilmu, 2(1), 257–264. https://www.neliti.com/publications/592257/enhancing-global-supply-chain-resilience-effective-strategies-for-mitigating-dis#cite
59. Permana, B. L. D. I., Suharno, S., & Rifin, A. (2022). The Exchange Rate Volatility Impact on Agricultural Trade: An Evidence From Indonesian Pepper Export. Jurnal Manajemen Dan Agribisnis, 19. https://doi.org/10.17358/jma.19.1.12
60. Pettit, T. J., Fiksel, J., & Croxton, K. L. (2010). ENSURING SUPPLY CHAIN RESILIENCE: DEVELOPMENT OF A CONCEPTUAL FRAMEWORK. Journal of Business Logistics, 31(1), 1–21. https://doi.org/10.1002/j.2158-1592.2010.tb00125.x
61. Pilvere, I., Upite, I., Muska, A., Zdanovskis, K., Nipers, A., & Janmere, L. (2021). Resilience of milk supply chains during and after the COVID-19 crisis in Latvia. Rural Sustainability Research, 45(340), 53–64. https://doi.org/10.2478/plua-2021-0007
62. Pramono, R., Sondakh, L. W., Bernarto, I., Juliana, J., & Purwanto, A. (2021). Determinants of the small and medium enterprises progress: A case study of SME entrepreneurs in Manado, Indonesia. The Journal of Asian Finance, Economics and Business, 8(1), 881–889. https://ssrn.com/abstract=3881568
63. Purbiyati, Y. S., & Rachmawati, D. (2023). The Effect of Dynamic Capabilities on Organization Resilience With Mediation of Digital Transformation. International Journal of Economics and Management Studies, 10(1), 19–27. https://doi.org/10.14445/23939125/ijems-v10i1p103
64. Putritamara, J. A., Hartono, B., Toiba, H., Utami, H. N., Rahman, M. S., & Masyithoh, D. (2023). Do Dynamic Capabilities and Digital Transformation Improve Business Resilience during the COVID-19 Pandemic? Insights from Beekeeping MSMEs in Indonesia. Sustainability (Switzerland), 15(3). https://doi.org/10.3390/su15031760
65. Rađenović, Ž., Krstić, B., & Marković, M. (2020). Smart farming in agricultural industry: Mobile technology perspective. Ekonomika Poljoprivrede, 67(3), 925–938. https://doi.org/10.5937/ekoPolj2003925R
66. Rehman, A. ur, & Jajja, M. S. S. (2023). The interplay of integration, flexibility and coordination: a dynamic capability view to responding environmental uncertainty. International Journal of Operations & Production Management, 43(6), 916–946. https://doi.org/10.1108/IJOPM-11-2021-0708
67. Rose, A. (2007). Economic resilience to natural and man-made disasters: Multidisciplinary origins and contextual dimensions. Environmental Hazards, 7(4), 383–398. https://doi.org/10.1016/j.envhaz.2007.10.001
68. Saad, M. H., Hagelaar, G., van der Velde, G., & Omta, S. W. F. (2021). Conceptualization of SMEs' business resilience: A systematic literature review. Cogent Business & Management, 8(1), 1938347. https://doi.org/10.1080/23311975.2021.1938347
69. Sabahi, S., & Parast, M. M. (2020). Firm innovation and supply chain resilience: a dynamic capability perspective. International Journal of Logistics Research and Applications, 23(3), 254–269. https://doi.org/10.1080/13675567.2019.1683522
70. Salam, M. A., & Bajaba, S. (2023). The role of supply chain resilience and absorptive capacity in the relationship between marketing–supply chain management alignment and firm performance: a moderated-mediation analysis. Journal of Business & Industrial Marketing, 38(7), 1545–1561. https://doi.org/10.1108/JBIM-02-2022-0105
71. Sanchis, R., Canetta, L., & Poler, R. (2020). A Conceptual Reference Framework for Enterprise Resilience Enhancement. Sustainability, 12(4), 1464. https://doi.org/10.3390/su12041464
72. Sattler, C., Schrader, J., Flor, R. J., Keo, M., Chhun, S., Choun, S., Hadi, B. A. R., & Settele, J. (2021). Reducing pesticides and increasing crop diversification offer ecological and economic benefits for farmers — A case study in Cambodian rice fields. Insects, 12(3). https://doi.org/10.3390/insects12030267
73. Sekaran, U., & Bougie, R. (2016). Research Methods for Business: A Skill-Building Approach (7th ed.). Wiley & Sons, Inc.
74. Sekaranom, A. B., Nurjani, E., & Nucifera, F. (2021). Agricultural Climate Change Adaptation in Kebumen, Central Java, Indonesia. Sustainability. https://doi.org/10.3390/su13137069
75. Setak, M., Kafshian Ahar, H., & Alaei, S. (2018). Incentive mechanism based on cooperative advertising for cost information sharing in a supply chain with competing retailers. Journal of Industrial Engineering International, 14(2), 265–280. https://doi.org/10.1007/s40092-017-0225-7

76. Settembre-Blundo, D., González-Sánchez, R., Medina-Salgado, S., & García-Muiña, F. E. (2021). Flexibility and Resilience in Corporate Decision Making: A New Sustainability-Based Risk Management System in Uncertain Times. Global Journal of Flexible Systems Management, 22(S2), 107–132. https://doi.org/10.1007/s40171-021-00277-7
77. Shishebori, D., & Babadi, A. Y. (2018). Designing a capacitated multi-configuration logistics network under disturbances and parameter uncertainty: a real-world case of a drug supply chain. Journal of Industrial Engineering International, 14, 65–85. https://doi.org/10.1007/s40092-017-0206-x
78. Siagian, H., Tarigan, Z. J. H., & Jie, F. (2021). Supply Chain Integration Enables Resilience, Flexibility, and Innovation to Improve Business Performance in COVID-19 Era. Sustainability, 13(9), 4669. https://doi.org/10.3390/su13094669
79. Singagerda, F. S., Fauzan, A. T., & Desfiandi, A. (2022). The role of supply chain visibility, supply chain flexibility, supplier development on business performance of logistics companies. Uncertain Supply Chain Management, 10(2), 463–470. https://doi.org/10.5267/j.uscm.2021.12.005
80. Singh, C. S., Soni, G., & Badhotiya, G. K. (2019). Performance indicators for supply chain resilience: review and conceptual framework. Journal of Industrial Engineering International, 15(s1), 105–117. https://doi.org/10.1007/s40092-019-00322-2
81. Skouloudis, A., Tsalis, T., Nikolaou, I., Evangelinos, K., & Leal Filho, W. (2020). Small & Medium-Sized Enterprises, Organizational Resilience Capacity and Flash Floods: Insights from a Literature Review. Sustainability, 12(18), 7437. https://doi.org/10.3390/su12187437
82. Swaffield, S. R., Corry, R. C., Opdam, P., McWilliam, W., & Primdahl, J. (2019). Connecting business with the agricultural landscape: business strategies for sustainable rural development. Business Strategy and the Environment, 28(7), 1357–1369. https://doi.org/10.1002/bse.2320
83. Tambunan, T. T. H. (2022). Recent Development of Micro, Small and Medium Enterprises in Indonesia. International Journal of Social Sciences and Management Review, 06(01), 193–214. https://doi.org/10.37602/ijssmr.2022.6112
84. The World Bank Group. (2023). Indonesia Laporan Iklim dan Pembangunan Negara. The World Bank Group A to Z 2016, 189a – 190. https://doi.org/10.1596/978-1-4648-0484-7_world_bank_group
85. Toia, A. (2019). Toward agriculture 4.0: opportunities and threats of the agribusiness sector: an analysis of the risk management strategies developed by Brazilian SMEs to cope with commodity price risk. Unpublished Master Thesis, Fundação Getúlio Vargas, Brazil. https://pesquisa-eaesp.fgv.br/teses-dissertacoes/toward-agriculture-40-opportunities-and-threats-agribusiness-sector-analysis-risk
86. Trianni, A., Cagno, E., Neri, A., & Howard, M. (2019). Measuring industrial sustainability performance: Empirical evidence from Italian and German manufacturing small and medium enterprises. Journal of Cleaner Production, 229, 1355–1376. https://doi.org/10.1016/j.jclepro.2019.05.076
87. Wang, J., Chen, R., & Zhang, S. (2022). The Mediating and Moderating Effect of Organizational Resilience on Competitive Advantage: Evidence from Chinese Companies. Sustainability. https://doi.org/10.3390/su142113797
88. World Bank. (2024). Agriculture, forestry, and fishing, value added (% of GDP). https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS
89. Wreford, A., & Topp, C. F. E. (2020). Impacts of climate change on livestock and possible adaptations: A case study of the United Kingdom. Agricultural Systems, 178, 102737. https://doi.org/10.1016/j.agsy.2019.102737
90. Yang, B. M., & Yang, O. S. (2022). Assessing the Effect of Dynamic Capabilities on the ESG Reporting and Corporate Performance Relationship With Topic Modeling: Evidence From Global Companies. Frontiers in Psychology, 13, 898935. https://doi.org/10.3389/fpsyg.2022.898935
91. Zerssa, G., Feyssa, D., Kim, D.-G., & Eichler-Löbermann, B. (2021). Challenges of Smallholder Farming in Ethiopia and Opportunities by Adopting Climate-Smart Agriculture. In Agriculture (Vol. 11, Issue 3). https://doi.org/10.3390/agriculture11030192
92. Zhou, G., Liu, L., & Luo, S. (2022). Sustainable development, ESG performance and company market value: Mediating effect of financial performance. Business Strategy and the Environment, 31(7), 3371–3387. https://doi.org/10.1002/bse.3089
93. Zhou, J., Hu, L., Yu, Y., Zhang, Z. J., & Zheng, L. (2022). Impacts of IT capability and supply chain collaboration on supply chain resilience: empirical evidence from China in COVID-19 pandemic. J. Enterp. Inf. Manag., 37, 777–803. https://doi.org/10.1108/jeim-03-2022-0091

94. Zielińska-Chmielewska, A., Mruk-Tomczak, D., & Wielicka-Regulska, A. (2021). Qualitative Research on Solving Difficulties in Maintaining Continuity of Food Supply Chain on the Meat Market during the COVID-19 Pandemic. Energies, 14(18), 5634. https://doi.org/10.3390/en14185634
95. Zrobok, O., & Hluschenko, Y. (2020). The Essence Of The International Competitiveness Mechanism Of Enterprises Under Uncertainty. Black Sea Economic Studies. https://api.semanticscholar.org/CorpusID:226091347