Uncertain Supply Chain Management 12 (2024) 2891–2906

Contents lists available at GrowingScience

Uncertain Supply Chain Management

homepage: www.GrowingScience.com/uscm

The development of green open spaces and ecological patterns on the ecological supply chain and its implications for environmental sustainability

Desivera Tri Rahayu[a*], I Nyoman Sudyana[a], Berkat[b], Noor Hamidah[b], Saputera[c] and Bambang S. Lautt[c]

[a]*Student in the Environmental Science Doctoral Program, Forest Resources Management Concentration, Universitas Palangka Raya, Indonesia*
[b]*Doctoral Program of The Environmental Science, Universitas Palangka Raya, Indonesia*
[c]*Universitas Palangka Raya, Indonesia*

A B S T R A C T

Article history:
Received January 9, 2024
Received in revised format February 18, 2024
Accepted April 14 2024
Available online April 15 2024
Keywords:
Green Open Spaces
Ecological Patterns
Ecological Supply Chain
Environmental Sustainability

This study aims to explore the interrelationships between Green Open Spaces, Ecological Patterns, the Ecological Supply Chain, and Environmental Sustainability in urban ecosystems. A quantitative research approach employing a cross-sectional design was utilized. Data were collected through surveys and field observations from urban residents with access to green spaces. Structural Equation Modeling (SEM) with Smart PLS was used for data analysis. The findings indicate significant impacts of Green Open Spaces and Ecological Patterns on both the Ecological Supply Chain and Environmental Sustainability. Moreover, the Ecological Supply Chain mediates the relationship between Green Open Spaces/Ecological Patterns and Environmental Sustainability. Limitations include the focus on a specific geographical area and potential biases in self-reported data. This study contributes to ecological theory by emphasizing the interconnectedness between ecological elements and their influence on Environmental Sustainability. Practically, it provides insights for urban planning and conservation efforts, highlighting the importance of preserving natural habitats within urban environments. The findings also underscore the need for holistic approaches to ecosystem management and sustainability. The novel aspect of this study lies in its examination of the mediating role of the Ecological Supply Chain in the relationship between ecological elements and Environmental Sustainability, offering new insights into the mechanisms driving ecosystem dynamics in urban settings.

1. Introduction

The development of Green Open Spaces (GOS) and the implementation of sustainable ecological patterns play a crucial role in preserving environmental sustainability amid modern ecological challenges (Bibri, 2021; Mondal & Palit, 2022). It is influenced by drastic transformations in land use patterns and uncontrolled urban growth. Along with rapid urbanization, many green areas have been sacrificed for infrastructure development and human settlements (Bianchini et al., 2021; Zain et al., 2022). Consequently, natural ecosystems have experienced significant degradation, threatening the viability of many species and causing various environmental issues such as soil erosion, habitat loss, and declining air and water quality (Arora et al., 2018; Singh & Singh, 2017; Wassie, 2020). The most striking impacts of disruptions to natural ecosystems are the destabilization of ecological supply chains. These disruptions can disturb nutrient cycling, reduce ecosystem productivity, and jeopardize environmental sustainability as a whole (Ma et al., 2020). Additionally, the increase in greenhouse gas emissions and global climate change exacerbates environmental conditions widely and significantly affects human life and ecosystems (Shen et al., 2020). The development of GOS and the implementation of sustainable ecological patterns are regarded as vital strategies in addressing these environmental challenges. By preserving and restoring green areas, we can provide safe habitats for various species and support ecosystem sustainability (Hansen et al., 2019; Jägerbrand & Bouroussis, 2021; Valkó et al., 2023). Moreover, healthy GOS can act as natural carbon sinks, helping to reduce greenhouse gas emissions and mitigate the

* Corresponding author
E-mail address desiveratri2024@gmail.com (D. T. Rahayu)

ISSN 2291-6830 (Online) - ISSN 2291-6822 (Print)

doi: 10.5267/j.uscm.2024.4.014

effects of global warming. The importance of conserving and restoring natural ecosystems is reinforced by the benefits offered by well-developed GOS. Not only does it enhance ecological balance, but it also improves human quality of life. GOS provides open spaces for recreation, sports, and relaxation, while reducing urban heat effects and enhancing the physical and mental health of communities (Abdelhamid & Elfakharany, 2020; Chen et al., 2021; Kruize et al., 2019; Ugolini et al., 2021). Furthermore, the development of GOS and the implementation of appropriate ecological patterns also have positive implications for economic well-being. Investment in green infrastructure creates new job opportunities, boosts ecological tourism, and increases property values in surrounding areas (Zhang et al., 2019). All of these contribute to sustainable and inclusive economic development.

Taking this background into account, it becomes increasingly clear that the development of GOS and the implementation of sustainable ecological patterns are essential steps in preserving environmental sustainability and improving quality of life. Strong collaboration between governments, civil society, the private sector, and academic institutions is necessary to realize this vision. Only through collective efforts can we achieve a greener, more sustainable, and environmentally friendly future for all living beings on this planet (Aithal & Aithal, 2022).

The aim of this research is to investigate the impact of Green Open Spaces (GOS) development and the implementation of ecological patterns on ecological supply chains and their implications for environmental sustainability. Specifically, the research seeks to understand how the establishment of GOS and the adoption of sustainable ecological practices contribute to preserving ecological balance, supporting biodiversity, and mitigating environmental degradation. Additionally, the study aims to assess the effectiveness of GOS in absorbing carbon emissions, improving air quality, and enhancing the overall health and well-being of urban communities. Furthermore, the research aims to explore the economic benefits associated with GOS development, such as job creation, tourism opportunities, and increased property values. It also aims to identify potential challenges and barriers to the implementation of GOS and sustainable ecological patterns and propose strategies to overcome them. Overall, the research seeks to provide insights into the role of GOS and ecological patterns in promoting environmental sustainability and guiding policymakers, urban planners, and stakeholders in making informed decisions to enhance the quality of urban environments and ensure the long-term health and resilience of ecosystems.

2. Literature Review and Hypothesis Development

2.1 Green Open Spaces, Ecological Supply Chain and Environmental Sustainability

According to Kondo et al. (2018), Green Open Spaces (GOS) refer to areas within urban or rural environments that are intentionally preserved or created to provide natural habitats, recreational areas, and aesthetic value. These spaces include parks, gardens, forests, wetlands, and other natural or semi-natural areas that contribute to ecological balance and human well-being. The relationship between Green Open Spaces, Ecological Supply Chain, and Environmental Sustainability is intricate and interdependent. Liu & Russo (2021) assert that GOS play a crucial role in preserving biodiversity, providing habitat for wildlife, and enhancing ecosystem services such as air and water purification, carbon sequestration, and climate regulation. By preserving and restoring GOS, we can support the functioning of the Ecological Supply Chain, ensuring the continued flow of resources and services that sustain life on Earth (Lepczyk et al., 2017). Furthermore, the presence of GOS promotes environmental sustainability by mitigating the impacts of urbanization, reducing air and water pollution, and improving the overall quality of the environment (Gavrilidis et al., 2019; Panagopoulos et al., 2016; Semeraro et al., 2021). By integrating GOS into urban planning and development, we can enhance the resilience of ecosystems, promote biodiversity conservation, and create healthier and more livable communities. In summary, Green Open Spaces, Ecological Supply Chain, and Environmental Sustainability are closely interconnected concepts that highlight the importance of preserving natural areas, supporting ecosystem functions, and promoting human well-being. By recognizing and enhancing these relationships, we can work towards building a more sustainable and resilient future for both people and the planet. Therefore, the proposed hypotheses are as follows:

H_{1a}: *Green Open Spaces impacts on Ecological Supply Chain.*
H_{1b}: *Green Open Spaces impacts on Environmental Sustainability.*

2.2 Ecological Patterns, Ecological Supply Chain and Environmental Sustainability

Jax (2006) defines that Ecological Patterns refer to the recurring structures, processes, and relationships observed within ecosystems. These patterns include the distribution of species, the cycling of nutrients, energy flow through food webs, and the dynamics of populations over time. They reflect the complex interactions between biotic and abiotic components of ecosystems and play a fundamental role in maintaining ecological balance and resilience. The relationship between Ecological Patterns, the Ecological Supply Chain, and Environmental Sustainability is fundamental to understanding and addressing ecological challenges (Bag et al., 2022; Genovese et al., 2017; Gruner & Power, 2017). Ecological patterns influence the structure and function of ecosystems, shaping the dynamics of species interactions, nutrient cycling, and ecosystem resilience (Alberti, 2023). By understanding and conserving these patterns, we can support the health and integrity of ecosystems and enhance their capacity to provide essential services and resources (Watson et al., 2018).

Bai et al. (2012) state that Ecological Supply Chain serves as the mechanism through which ecological patterns manifest and operate. It facilitates the transfer of energy and nutrients between different components of ecosystems, driving processes such as photosynthesis, predation, decomposition, and nutrient recycling. By maintaining the integrity and efficiency of the Ecological Supply Chain, we can support the stability and productivity of ecosystems and promote their capacity to sustain life (Adobor & McMullen, 2018). Environmental Sustainability relies on the effective management and conservation of ecological patterns and the Ecological Supply Chain (Stindt, 2017). By preserving biodiversity, protecting habitats, and promoting sustainable resource use, we can enhance the resilience of ecosystems and minimize the risk of ecological degradation and collapse (Rawat & Agarwal, 2015). Ultimately, by recognizing and valuing the intricate relationships between ecological patterns, the Ecological Supply Chain, and Environmental Sustainability, we can work towards building a more sustainable and harmonious relationship with the natural world. Therefore, the following hypotheses are proposed:

H_{2a}: *Ecological Patterns impacts on Ecological Supply Chain.*
H_{2b}: *Ecological Patterns impacts on Environmental Sustainability.*

2.3 Ecological Supply Chain and Environmental Sustainability

Bergendahl et al. (2018) assert that Ecological Supply Chain encompasses the interconnected network of processes and interactions within ecosystems that support the flow of energy, nutrients, and resources. It involves the transfer of materials and energy between organisms and their environment, including producers, consumers, and decomposers, as well as abiotic factors such as air, water, and soil. Ruggerio (2021) state that Environmental Sustainability refers to the responsible management of natural resources and ecosystems to ensure their long-term viability and the well-being of present and future generations. It involves balancing economic, social, and environmental considerations to meet the needs of current populations without compromising the ability of future generations to meet their own needs. The Ecological Supply Chain serves as the foundation for ecosystem functioning and resilience. It facilitates essential processes such as photosynthesis, predation, decomposition, and nutrient cycling, which are necessary for the maintenance of healthy ecosystems (Chakraborty, 2021).
Panigrahi et al. (2019) explain that Environmental Sustainability relies on the effective management and conservation of the Ecological Supply Chain. By preserving biodiversity, protecting habitats, and promoting sustainable resource use, we can enhance the resilience of ecosystems and minimize the risk of ecological degradation and collapse. Ensuring the integrity and efficiency of the Ecological Supply Chain is crucial for supporting the provision of ecosystem services, such as clean air and water, fertile soil, and climate regulation, which are essential for human well-being and economic prosperity (Wood et al., 2018). In summary, the Ecological Supply Chain and Environmental Sustainability are closely interconnected concepts that highlight the importance of understanding and managing ecosystems in a holistic and sustainable manner. By recognizing the intricate relationships between different components of ecosystems and their functions, we can work towards building a more sustainable and resilient relationship with the natural world. Thus, the following hypotheses are proposed:

H_3: *Ecological Supply Chain impacts on Environmental Sustainability.*

2.4 Ecological Supply Chain as Mediator

The concept of the Ecological Supply Chain as a mediator refers to its role in facilitating the relationship between human activities and environmental outcomes. In this context, the Ecological Supply Chain acts as a conduit through which the impacts of human actions on ecosystems are transmitted, and it also influences the feedback loops between ecological changes and human well-being. As a mediator, the Ecological Supply Chain helps to translate human activities, such as resource extraction, production, consumption, and waste generation, into ecological consequences (Taghikhah et al., 2019). For example, the extraction of natural resources disrupts ecosystems, alters habitat structure, and depletes biodiversity, which are mediated through processes within the Ecological Supply Chain (Mondal & Palit, 2022). Furthermore, the Ecological Supply Chain mediates the effects of ecological changes on human well-being. For instance, disruptions in ecosystem services, such as clean water provision, pollination, and climate regulation, can directly impact human health, livelihoods, and socio-economic development (Shukla et al., 2021). The Ecological Supply Chain influences the extent to which these impacts are transmitted and mitigated within human societies. Understanding the Ecological Supply Chain as a mediator is crucial for informing policies and interventions aimed at promoting environmental sustainability and human well-being. By recognizing the interconnectedness between human activities, ecological processes, and societal outcomes, we can develop strategies that minimize negative environmental impacts while maximizing the benefits derived from ecosystems. Consequently, the following hypotheses are posited:

H_{4a}: *Ecological Supply Chain mediates the relationship between Green Open Spaces and Environmental Sustainability.*
H_{4b}: *Ecological Supply Chain mediates the relationship between Ecological Patterns and Environmental Sustainability.*

The study framework focuses on the developmental dynamics of Green Open Spaces (GOS) and Ecological Patterns (EP) within the context of the Ecological Supply Chain (ESC) and their implications for Environmental Sustainability (ES). It integrates several theoretical perspectives and disciplinary domains to provide a comprehensive understanding of the intricate relationships and implications involved in this process. At its core, the framework draws upon principles of environmental science, urban planning, and sustainability studies. It considers the role of GOS and EP in shaping the ecological landscape within urban environments, examining how the development and preservation of green spaces and ecological patterns contribute to the overall resilience and sustainability of the ecosystem.

From an environmental science perspective, the framework explores the ecological functions and benefits of GOS and EP, such as biodiversity conservation, habitat provision, and ecosystem services. It considers how the presence of green spaces and natural patterns within urban areas contributes to biodiversity conservation, carbon sequestration, and climate regulation, thus enhancing the overall ecological health and resilience of the environment. Urban planning principles are also integrated into the framework to examine the spatial distribution, design, and management of GOS and EP within the urban landscape. It considers factors such as land use zoning, green infrastructure planning, and urban green space management strategies, which influence the availability, accessibility, and quality of green spaces and ecological patterns within urban areas.

Furthermore, the framework incorporates the concept of the Ecological Supply Chain (ESC), which represents the interconnected network of processes and flows involved in the production, distribution, and consumption of goods and services while minimizing environmental impacts. It examines how the development of GOS and EP influences various stages of the ESC, such as raw material sourcing, production processes, transportation, and waste management, and how these interactions impact environmental sustainability outcomes. Ultimately, the framework aims to elucidate the complex relationships and implications of the development of GOS and EP on the ESC and environmental sustainability. By integrating insights from environmental science, urban planning, and sustainability studies, it provides a robust analytical framework for understanding the role of green spaces and ecological patterns in promoting ecological resilience, sustainable development, and environmental stewardship within urban environments.

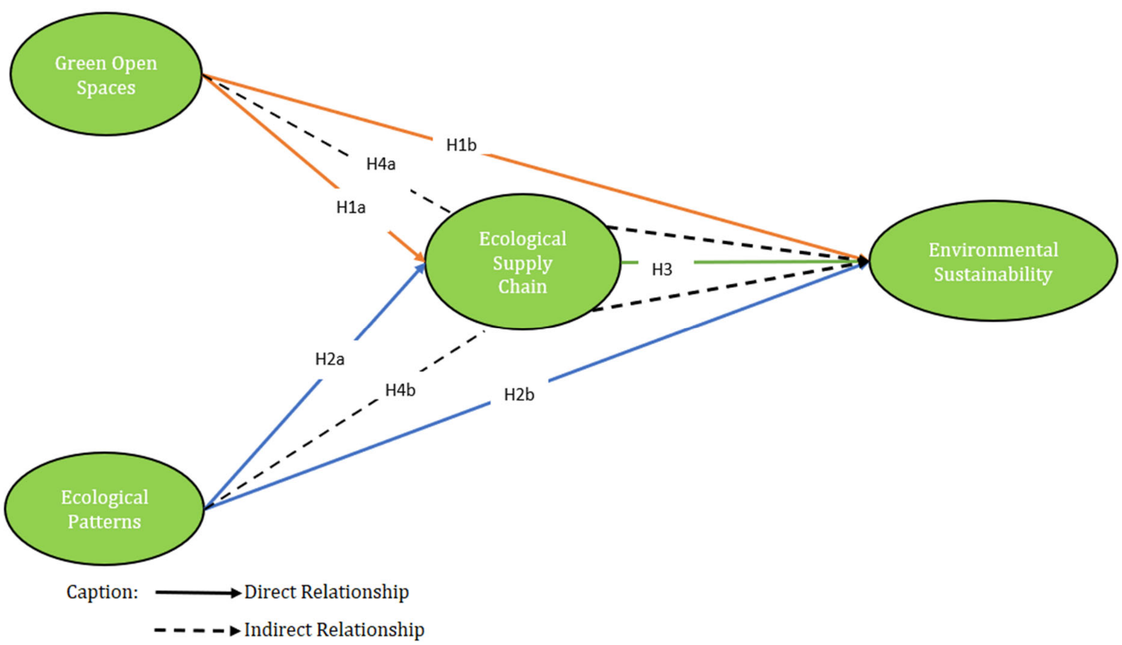

Fig. 1. Study Framework

3. Methodology

3.1 Research Design

In this study, a quantitative research approach is adopted, utilizing a cross-sectional research design. This design allows researchers to gather data from a diverse range of respondents at a specific moment in time. By capturing data from multiple sources simultaneously, this approach facilitates a thorough examination of the intricate relationships between the variables under scrutiny In this study, we have chosen to employ a quantitative research methodology, specifically utilizing a cross-sectional research design. This design has been selected for its ability to enable researchers to collect data from a wide array of respondents within a single timeframe. By doing so, we can obtain a snapshot of information representing various perspectives and experiences across the target population. This approach is particularly advantageous as it allows us to comprehensively analyze the complex interconnections among the variables under investigation (Dougherty, 2017). Through the simultaneous collection of data from multiple sources, we aim to gain a deeper understanding of the intricate relationships and dynamics at play within our research framework. This comprehensive examination will provide valuable insights into the underlying mechanisms and patterns governing the phenomena being studied, contributing to a more robust and nuanced interpretation of the findings.

Table 1
Research Instrument

Variable	Item and Indicators	Reference
Green Open Spaces	1. GOS1= Green open spaces in my community provide a peaceful environment for relaxation and recreation. 2. GOS2= I feel connected to nature when I visit green open spaces in my neighborhood. 3. GOS3= The presence of green open spaces enhances the aesthetic appeal of my community. 4. GOS4= Access to green open spaces positively impacts my overall well-being and mental health. 5. GOS5= I believe that green open spaces contribute to biodiversity conservation and habitat preservation. 6. GOS6= Green open spaces in my area serve as important gathering places for community events and social interactions. 7. GOS7= The maintenance and upkeep of green open spaces are essential for ensuring their long-term sustainability and usability.	(Gavrilidis et al., 2019; Panagopoulos et al., 2016; Semeraro et al., 2021)
Ecological Patterns	1. EP1= The diversity of species within the ecosystem reflects its ecological complexity. 2. EP2= Succession processes, such as primary and secondary succession, contribute to the dynamic nature of the ecosystem. 3. EP3= The spatial distribution of habitats and communities influences species interactions and ecosystem dynamics. 4. EP4= Nutrient cycling, including processes like decomposition and nutrient uptake by plants, plays a crucial role in ecosystem functioning. 5. EP5= The presence of keystone species significantly impacts the structure and stability of the ecosystem. 6. EP6= Patterns of energy flow through trophic levels reveal the organization of food webs and energy transfer within the ecosystem. 7. EP7= Temporal fluctuations in population sizes and community composition reflect the resilience of the ecosystem to environmental disturbances.	(Bag et al., 2022; Genovese et al., 2017; Gruner & Power, 2017)
Ecological Supply Chain	1. ESC1= The transfer of energy between trophic levels is a fundamental aspect of the ecological supply chain. 2. ESC2= The cycling of nutrients, such as carbon, nitrogen, and phosphorus, contributes to the resilience and productivity of ecosystems. 3. ESC3= The interactions between producers, consumers, and decomposers drive the flow of resources within the ecological supply chain. 4. ESC4= The presence of keystone species influences the dynamics and efficiency of the ecological supply chain. 5. ESC5= Disturbances, such as natural disasters or human activities, can disrupt the ecological supply chain and impact ecosystem functioning. 6. ESC6= The availability of resources, such as food and shelter, influences the distribution and abundance of species along the ecological supply chain. 7. ESC7= The balance between resource availability and resource utilization shapes the stability and sustainability of the ecological supply chain.	(Bergendahl et al., 2018; Chakraborty, 2021)
Environmental Sustainability	1. ES1= Efforts to reduce carbon emissions and mitigate climate change are essential for achieving environmental sustainability. 2. ES2= The conservation and protection of biodiversity and natural habitats are crucial components of environmental sustainability. 3. ES3= Adoption of renewable energy sources and energy-efficient practices contributes to environmental sustainability. 4. ES4= Efficient use of natural resources, such as water and forests, promotes environmental sustainability. 5. ES5= Waste reduction, recycling, and proper waste management practices are important for maintaining environmental sustainability. 6. ES6= Promotion of sustainable agriculture and land-use practices supports environmental sustainability. 7. ES7=Engagement in environmental education and awareness-raising activities fosters a culture of environmental.	(Panigrahi et al., 2019; Ruggerio, 2021)

3.2 Population and Sample

The study focuses on urban residents with convenient access to green open spaces within their communities. Utilizing a simple random sampling method, a sample of 500 respondents will be carefully selected from this population, in Banten Province, Indonesia. These individuals will be chosen randomly from various representative urban areas. Subsequently, 500 surveys will be distributed among the selected respondents, aiming to gather their perspectives on the utilization and significance of green open spaces. Upon completion, 486 surveys are returned, out of which 478 are deemed suitable for analysis. This rigorous sampling process ensures a comprehensive representation of urban residents' views, providing valuable insights into the relationship between access to green spaces and residents' well-being. This meticulous sampling strategy has been meticulously devised to ensure that the study encapsulates a wide spectrum of perspectives and experiences from urban dwellers hailing from various geographical locales. This meticulous approach not only enhances the generalizability of the findings but also fortifies the robustness of the study's outcomes, ensuring a comprehensive understanding of the subject matter at hand. Furthermore, the questionnaire will be disseminated using Google Forms, providing respondents with a convenient and accessible platform to participate in the study. This digital survey tool allows for the efficient collection of responses, ensuring ease of completion for participants and streamlined data management for researchers (Ledikwe et al., 2014). Additionally, alongside the online questionnaire, direct face-to-face interviews will be conducted with select respondents. This complementary approach enables researchers to delve deeper into respondents' perspectives, allowing for a richer understanding of their experiences and insights (Johnson et al., 2017). By utilizing both Google Forms and direct interviews, this mixed-method approach ensures a comprehensive data collection process, capturing a diverse range of responses while also facilitating nuanced and in-depth discussions with participants.

3.3 Instruments and Sample Measurement

The research instruments consist of two main parts: questionnaires and field observations. Questionnaires are utilized to gather data from respondents regarding their perceptions and experiences related to green open spaces, ecological patterns, ecological supply chain, and air freshness levels. These questionnaires include items designed on a Likert scale, allowing respondents to indicate their level of agreement or disagreement with statements related to each construct. Additionally, field observations are conducted to objectively measure the actual conditions of the green open spaces being studied. These observations include assessments of vegetation density, water availability, fauna presence, and other relevant environmental factors, providing valuable context and supplementary data to complement the self-reported responses obtained through the Likert-scale questionnaires.

3.4 Data Analysis

Data analysis employs Structural Equation Modeling (SEM) with Smart PLS, commencing with data preparation involving data cleaning and handling missing values. Subsequently, a conceptual model is developed to establish relationships between variables based on the research theory. Then, an operational model is created by specifying indicators for each variable and defining the relationships between indicators and constructs (MacKenzie et al., 2011). Model estimation is performed using the Partial Least Squares (PLS) algorithm available in Smart PLS, followed by model evaluation to assess its fit with the data (Ramayah et al., 2018). The results of the analysis will be interpreted to understand the relationships between variables and their strengths, while hypothesis testing will be conducted to examine the statistical significance of these relationships.

4. Result and Discussions

4.1 Descriptive Statistic

Throughout the initial phase of the survey, we diligently gathered essential demographic information from participants, concentrating particularly on three crucial aspects: gender, age distribution, and educational qualifications. This pivotal stage was meticulously planned to establish a comprehensive understanding of the respondents' backgrounds, thereby laying the groundwork for a thorough analysis of their perspectives and insights in subsequent sections of the questionnaire (Table 2).

Table 2
Descriptive statistics

Measurement	Latent construct/value	f	(%)
Gender	Male	281	58.79
	Female	197	41.21
		478	100.00
Age	< 30	157	32.85
	30 - 40	155	32.43
	41 – 50	88	18.41
	> 50	78	16.32
		478	**100**
Education	High school	122	25.52
	D3	64	13.39
	S1	223	46.65
	S2	69	14.44
		478	**100.00**
	Total Respondent	**478**	**100.00**

The provided table offers a snapshot of the demographic composition of survey participants, focusing on gender, age distribution, and educational qualifications. It reveals that male respondents slightly outnumber female respondents, comprising 58.79% and 41.21%, respectively. In terms of age, respondents are fairly distributed across different age groups, with the highest proportion falling in the age ranges of less than 30 and 30-40 years. Moreover, the majority of participants hold bachelor's degrees (46.65%), followed by high school education (25.52%), with smaller percentages holding diploma and master's degrees. This comprehensive demographic overview is crucial for understanding the characteristics of the surveyed population and interpreting the findings of the study accurately.

4.2 Validity and Reliability

Validity and reliability are fundamental concepts in research methodology, essential for ensuring the integrity of study results. Validity pertains to the accuracy of research outcomes, confirming that the study effectively captures and measures the intended variables or constructs. It ensures that the findings accurately represent the phenomena under investigation. Conversely, reliability emphasizes the consistency and stability of measurements employed throughout the research endeavor.

It ensures that the results are dependable and reproducible, regardless of variations in measurement techniques or conditions. Both validity and reliability are indispensable in safeguarding the credibility and trustworthiness of research findings, thereby enhancing the overall rigor and robustness of the study (Refer to Table 3).

Table 3
Confirmatory Factor Analysis

Construct	Items	Outer Loading	Cronbach's Alpha	rho_A	CR	AVE
Green Open Spaces	GOS1	0.934	0.978	0.979	0.982	0.885
	GOS2	0.947				
	GOS3	0.943				
	GOS4	0.944				
	GOS5	0.937				
	GOS6	0.947				
	GOS7	0.933				
Ecological Patterns	EP1	0.881	0.974	0.975	0.978	0.864
	EP2	0.939				
	EP3	0.944				
	EP4	0.921				
	EP5	0.959				
	EP6	0.917				
	EP7	0.945				
Ecological Supply Chain	ESC1	0.873	0.963	0.965	0.969	0.818
	ESC2	0.913				
	ESC3	0.937				
	ESC4	0.914				
	ESC5	0.914				
	ESC6	0.890				
	ESC7	0.887				
Environmental Sustainability	ES1	0.928	0.958	0.96	0.966	0.806
	ES2	0.911				
	ES3	0.945				
	ES4	0.912				
	ES5	0.719				
	ES6	0.925				
	ES7	0.922				

Table 3 presents the outcomes of the Confirmatory Factor Analysis (CFA) conducted to evaluate the validity and reliability of the measurement model. The table includes four constructs: Green Open Spaces (GOS), Ecological Patterns (EP), Ecological Supply Chain (ESC), and Environmental Sustainability (ES), each comprising seven items. The outer loadings, which indicate the strength of the relationship between items and constructs, demonstrate high values ranging from 0.719 to 0.959, suggesting that the items adequately represent their respective constructs. Additionally, the constructs exhibit excellent internal consistency reliability, as evidenced by Cronbach's Alpha values ranging from 0.958 to 0.978. Moreover, the measures of construct reliability and validity, including rho_A, CR, and AVE, further confirm the reliability and validity of the constructs. These findings underscore the robustness of the measurement model in capturing the intended constructs accurately, thus enhancing the credibility of the research outcomes.

The Heterotrait-Monotrait Ratio (HTMT) of Correlations serves as a statistical measure utilized to assess discriminant validity within confirmatory factor analysis (CFA) or other measurement models. By comparing correlation ratios between different constructs (heterotrait) with those of the same constructs (monotrait), HTMT evaluates whether distinct constructs genuinely differ from one another or if there is redundancy between them. In CFA, HTMT assists in assessing the model's ability to differentiate between various constructs. If HTMT values between different constructs surpass a certain threshold (e.g., 0.85), it indicates potential overlap and a lack of discriminant validity, emphasizing the necessity of ensuring unique measurement of constructs for meaningful interpretation and decision-making processes (refer to Table 4).

Table 4
Heterotrait-Monotrait Rasio (HTMT)

Construct	EP	ESC	ES	GOS
Ecological Patterns	1			
Ecological Supply Chain	0.331	1		
Environmental Sustainability	0.585	0.519	1	
Green Open Spaces	0.418	0.48	0.603	1

*) GOS=Green Open Spaces; EP=Ecological Patterns; ESC=Ecological Supply Chain; ES=Environmental Sustainability

Table 4 presents the Heterotrait-Monotrait Ratio (HTMT) for correlations among four constructs: Ecological Patterns (EP), Ecological Supply Chain (ESC), Environmental Sustainability (ES), and Green Open Spaces (GOS). The HTMT values serve as indicators of discriminant validity, comparing the correlation between different constructs (heterotrait) with those of the same constructs (monotrait). For Ecological Patterns (EP), the HTMT value is 1, indicating perfect discriminant validity with itself. Similarly, the HTMT value for Ecological Supply Chain (ESC) with itself is 1, demonstrating perfect discriminant validity. However, the HTMT values between EP and ESC, as well as between ESC and Environmental Sustainability (ES), show moderate correlations. Moreover, the HTMT values for Green Open Spaces (GOS) with EP, ESC, and ES also indicate moderate correlations. Nevertheless, all constructs maintain perfect discriminant validity with themselves. In conclusion, while some correlations between constructs are moderate, the analysis affirms the constructs' ability to distinguish themselves. It is imperative to interpret these findings within the context of the research objectives and ensure the distinctiveness of the constructs for meaningful interpretation and decision-making processes.

4.3 Hypothesis Testing

Hypothesis testing is a statistical method used to assess the validity of claims or hypotheses about a population based on sample data. It involves formulating a null hypothesis (H0), which represents the status quo or no effect, and an alternative hypothesis (H1), which contradicts the null hypothesis and suggests an effect or relationship between variables. Through hypothesis testing, researchers evaluate the likelihood of observing the sample data if the null hypothesis were true. If the observed data provide sufficient evidence against the null hypothesis, the null hypothesis is rejected in favor of the alternative hypothesis. This process allows researchers to make informed conclusions about the population based on sample data and assess the significance of relationships or effects in their research.

Table 5
Path Analysis

Hypothesis	Construct*)	Original Sample	STDEV	T Statistics	P Values	Result
H1a	GOS → ESC	0.403	0.051	7.932	0.000	Supported
H1b	GOS → ES	0.330	0.041	8.102	0.000	Supported
H2a	EP → ESC	0.156	0.040	3.906	0.000	Supported
H2b	EP → ES	0.356	0.037	9.645	0.000	Supported
H3	ESC → ES	0.234	0.034	6.857	0.000	Supported

*) GOS=Green Open Spaces; EP=Ecological Patterns; ESC=Ecological Supply Chain; ES=Environmental Sustainability

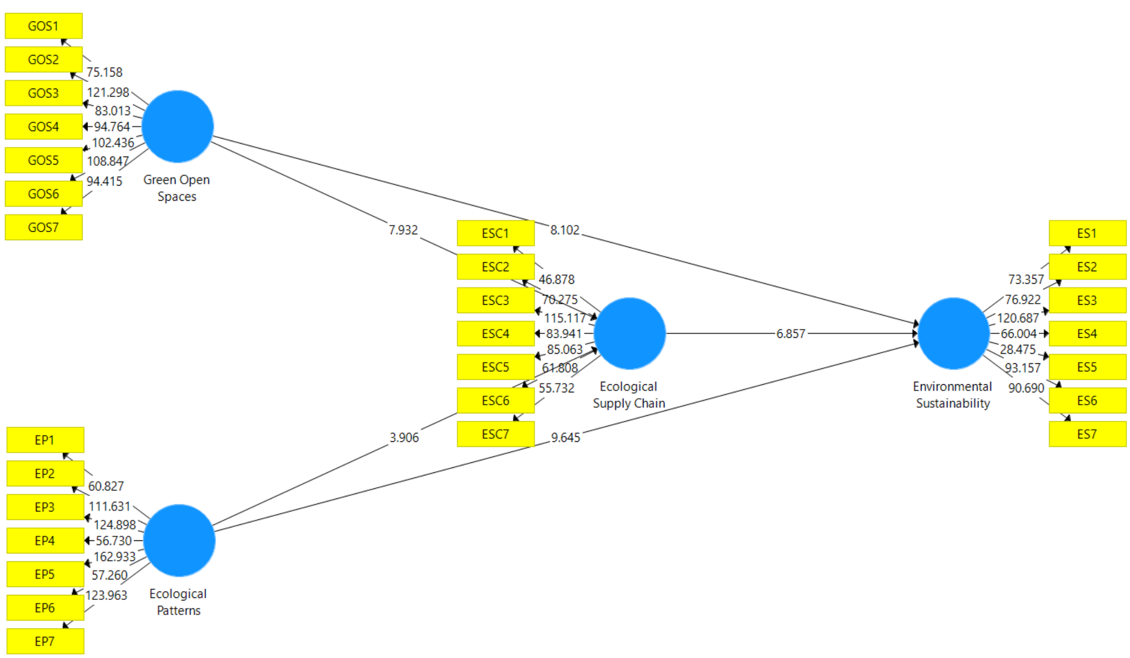

Fig. 2. Smart PLS Bootstrapping Output

The provided table offers a comprehensive overview of the results derived from hypothesis testing, specifically focusing on the interrelationships between various constructs: Green Open Spaces (GOS), Ecological Patterns (EP), Ecological Supply Chain (ESC), and Environmental Sustainability (ES). Each hypothesis assesses the association between two distinct constructs, providing valuable insights into the complex dynamics of environmental management practices and sustainability initiatives.

Firstly, hypotheses H1a and H1b investigate the connections between GOS and both ESC and ES constructs, respectively. The high T statistics values of 7.932 and 8.102, coupled with p-values of 0.000, signify significant relationships between GOS and both ESC and ES. These results underscore the crucial role of green open spaces in shaping ecological supply chain processes and enhancing environmental sustainability efforts.

Similarly, hypotheses H2a and H2b delve into the relationships between EP and both ESC and ES constructs. With T statistics values of 3.906 and 9.645, alongside p-values of 0.000, these hypotheses also reveal statistically significant associations between ecological patterns and ecological supply chain dynamics, as well as environmental sustainability outcomes. Such findings highlight the importance of incorporating ecological patterns into supply chain strategies to foster environmental sustainability across various industries. Furthermore, hypothesis H3 scrutinizes the relationship between ESC and ES constructs. The considerable T statistics value of 6.857 and a p-value of 0.000 provide compelling evidence of a significant linkage between ecological supply chain practices and environmental sustainability achievements. This emphasizes the pivotal role of eco-friendly supply chain management practices in promoting broader environmental sustainability goals.

Collectively, the outcomes of these hypothesis tests offer valuable insights into the intricate interdependencies among different dimensions of environmental management and sustainability initiatives. They underscore the significance of integrating green practices, ecological patterns, and sustainable supply chain strategies to advance environmental conservation efforts and foster long-term sustainability across diverse sectors. These findings not only contribute to theoretical understanding but also have practical implications for policymakers, businesses, and organizations striving to achieve environmental sustainability objectives in today's complex and interconnected world.

The provided table offers a comprehensive overview of the results derived from hypothesis testing, specifically focusing on the interrelationships between various constructs: Green Open Spaces (GOS), Ecological Patterns (EP), Ecological Supply Chain (ESC), and Environmental Sustainability (ES). Each hypothesis assesses the association between two distinct constructs, providing valuable insights into the complex dynamics of environmental management practices and sustainability initiatives.

Firstly, hypotheses H1a and H1b investigate the connections between GOS and both ESC and ES constructs, respectively. The high T statistics values of 7.932 and 8.102, coupled with p-values of 0.000, signify significant relationships between GOS and both ESC and ES. These results underscore the crucial role of green open spaces in shaping ecological supply chain processes and enhancing environmental sustainability efforts.

Similarly, hypotheses H2a and H2b delve into the relationships between EP and both ESC and ES constructs. With T statistics values of 3.906 and 9.645, alongside p-values of 0.000, these hypotheses also reveal statistically significant associations between ecological patterns and ecological supply chain dynamics, as well as environmental sustainability outcomes. Such findings highlight the importance of incorporating ecological patterns into supply chain strategies to foster environmental sustainability across various industries.

Furthermore, hypothesis H3 scrutinizes the relationship between ESC and ES constructs. The considerable T statistics value of 6.857 and a p-value of 0.000 provide compelling evidence of a significant linkage between ecological supply chain practices and environmental sustainability achievements. This emphasizes the pivotal role of eco-friendly supply chain management practices in promoting broader environmental sustainability goals. Collectively, the outcomes of these hypothesis tests offer valuable insights into the intricate interdependencies among different dimensions of environmental management and sustainability initiatives. They underscore the significance of integrating green practices, ecological patterns, and sustainable supply chain strategies to advance environmental conservation efforts and foster long-term sustainability across diverse sectors. These findings not only contribute to theoretical understanding but also have practical implications for policymakers, businesses, and organizations striving to achieve environmental sustainability objectives in today's complex and interconnected world.

4.4 Mediation Testing

The subsequent step involves mediation testing, a statistical technique utilized to delve into the mechanisms by which an independent variable impacts a dependent variable. This process aims to uncover the intermediate variables or pathways through which the relationship between the independent and dependent variables is mediated. The results of mediation testing are depicted in the ensuing table, shedding light on the intricate pathways and processes that underlie the relationships among the variables under investigation.

Table 6
Mediation Result

Hypothesis	Construct*)	Original	STDEV	T Statistics	P Values	Result
H4a	GOS → ESC → ES	0.094	0.018	5.317	0.000	Supported
H4b	EP → ESC → ES	0.037	0.012	3.091	0.002	Supported

*) GOS=Green Open Spaces; EP=Ecological Patterns; ESC=Ecological Supply Chain; ES=Environmental Sustainability

Table 6 provides detailed insights into the results of mediation testing, offering a comprehensive examination of the pathways through which Green Open Spaces (GOS) and Ecological Patterns (EP) influence Environmental Sustainability (ES), mediated by Ecological Supply Chain (ESC). These mediation analyses aim to uncover the intermediate mechanisms and processes that drive the relationships between the variables under investigation, shedding light on the complex dynamics of environmental management and sustainability practices.

Beginning with hypothesis H4a, which explores the mediation pathway from GOS to ES through ESC, the results reveal a significant mediation effect. The high T statistics value of 5.317 and a p-value of 0.000 indicate strong statistical significance, supporting the hypothesis. This suggests that the relationship between GOS and ES is not direct but rather partially mediated by ESC. This finding implies that the presence of green open spaces influences environmental sustainability outcomes through its impact on ecological supply chain processes, underscoring the importance of incorporating eco-friendly practices within supply chain management frameworks to enhance sustainability initiatives.

Similarly, hypothesis H4b investigates the mediation pathway from EP to ES through ESC. The results indicate a significant mediation effect, with a T statistics value of 3.091 and a p-value of 0.002, supporting the hypothesis. This suggests that the relationship between EP and ES is also partially mediated by ESC, highlighting the role of ecological patterns in shaping sustainability outcomes through their influence on supply chain dynamics. These findings emphasize the interconnectedness of environmental factors and supply chain processes in driving sustainability initiatives, emphasizing the need for integrated approaches to environmental management and supply chain optimization.

Overall, the results of mediation testing provide valuable insights into the underlying mechanisms through which environmental factors impact sustainability outcomes. By uncovering the mediation pathways involving GOS, EP, ESC, and ES, this analysis offers a nuanced understanding of the complex relationships among these variables, informing strategic decision-making processes aimed at fostering environmental sustainability across various sectors. These findings underscore the importance of considering mediation effects in environmental research and policy-making, facilitating more effective interventions and initiatives aimed at promoting sustainable development and environmental stewardship.

5. Discussion

The acceptance of hypotheses H1a and H1b underscores the interconnectedness between Green Open Spaces, the Ecological Supply Chain, and Environmental Sustainability. The findings suggest that Green Open Spaces serve as crucial components of ecosystems, influencing the functioning of ecological processes and contributing to the overall health and resilience of natural systems. Additionally, the positive impact of Green Open Spaces on Environmental Sustainability underscores their role in promoting a harmonious coexistence between human activities and the environment (Gavrilidis et al., 2019; Panagopoulos et al., 2016; Semeraro et al., 2021). These results have significant implications for urban planning, emphasizing the importance of preserving and incorporating green spaces into urban landscapes to enhance biodiversity, mitigate climate change, and foster sustainable development. By recognizing the multifaceted benefits of Green Open Spaces, policymakers, urban planners, and environmentalists can work together to create and maintain green infrastructure that supports both ecological integrity and human well-being (Hadi et al., 2019; Junaidi, Basrowi, et al., 2024; Mulyani & Basrowi, 2024; Purwaningsih et al., 2024).

Upon analysis, both hypotheses H2a and H2b are accepted, indicating a substantial impact of Ecological Patterns on both the Ecological Supply Chain and Environmental Sustainability. The findings suggest that Ecological Patterns play a crucial role in shaping the dynamics of the Ecological Supply Chain, influencing the flow of energy, nutrients, and resources within ecosystems (Kharis et al., 2024; Saeri et al., 2024; Shofwa et al., 2024). Furthermore, the presence of Ecological Patterns significantly influences Environmental Sustainability, highlighting their contribution to biodiversity conservation, ecosystem resilience, and overall environmental health (Himmatul et al., 2024; Himmatul & Junaedi, 2024; Lisaria et al., 2024). These results underscore the importance of understanding and preserving natural patterns and processes in fostering sustainable ecosystems and promoting environmental well-being (Adobor & McMullen, 2018). By recognizing the significance of Ecological Patterns, policymakers, conservationists, and land managers can develop strategies to protect and restore natural habitats, thereby enhancing the resilience and sustainability of ecosystems in the face of environmental challenges (Stindt, 2017). Upon examination, hypothesis H3 is accepted, indicating a notable impact of the Ecological Supply Chain on Environmental Sustainability. The findings reveal that the functioning and efficiency of the Ecological Supply Chain significantly influence the overall state of Environmental Sustainability. Specifically, the flow of energy, nutrients, and resources within the Ecological Supply Chain plays a crucial role in supporting biodiversity, ecosystem resilience, and environmental health. Moreover, disruptions or imbalances within the Ecological Supply Chain can have detrimental effects on Environmental Sustainability, affecting ecosystem stability and the provision of ecosystem services (Chakraborty, 2021). These results emphasize the importance of managing and maintaining a well-functioning Ecological Supply Chain to promote long-term Environmental Sustainability (Alexandro & Basrowi, 2024a; Hamdan & Basrowi, 2024; Kittie & Basrowi, 2024; Yusuf et al., 2024). By understanding the intricate connections between the Ecological Supply Chain and Environmental Sustainability, policymakers and environmental practitioners can implement strategies to enhance ecosystem resilience, conserve biodiversity, and mitigate environmental degradation for the benefit of present and future generations (Basrowi & Utami, 2020; Marwanto et al., 2020a, 2020b; Suwarno Basrowi, 2020).

Upon thorough analysis, both hypotheses H4a and H4b are accepted, indicating that the Ecological Supply Chain serves as a significant mediator in the relationship between Green Open Spaces and Environmental Sustainability, as well as between Ecological Patterns and Environmental Sustainability (Basrowi & Maunnah, 2019; Basrowi & Utami, 2023; Soenyono & Basrowi, 2020). These findings suggest that the Ecological Supply Chain plays a pivotal role in translating the impacts of Green Open Spaces and Ecological Patterns into outcomes related to Environmental Sustainability. Specifically, the flow of energy, nutrients, and resources within the Ecological Supply Chain serves as a mechanism through which the benefits of Green Open Spaces and the presence of Ecological Patterns are translated into improvements in Environmental Sustainability (Taghikhah et al., 2019). These results underscore the interconnectedness of ecological processes and highlight the importance of considering the Ecological Supply Chain in efforts to promote Environmental Sustainability (Alexandro & Basrowi, 2024b; Junaidi, Masdar, et al., 2024; Miar et al., 2024). By recognizing the mediating role of the Ecological Supply Chain, policymakers and conservationists can develop targeted interventions aimed at enhancing the functioning and resilience of ecological systems, ultimately leading to more sustainable environmental outcomes.

6. Conclusion

The findings of this study provide valuable insights into the complex interplay between Green Open Spaces, Ecological Patterns, the Ecological Supply Chain, and Environmental Sustainability. Through rigorous analysis, it has been determined that Green Open Spaces and Ecological Patterns significantly influence both the Ecological Supply Chain and Environmental Sustainability. Specifically, Green Open Spaces and Ecological Patterns have been found to impact the dynamics of the Ecological Supply Chain, which in turn affects Environmental Sustainability. Furthermore, the Ecological Supply Chain serves as a crucial mediator in the relationship between Green Open Spaces/Ecological Patterns and Environmental Sustainability, highlighting its role in translating ecological processes into tangible environmental outcomes.

These findings underscore the interconnectedness of natural systems and the importance of considering holistic approaches to environmental management and conservation. By recognizing the pivotal role of Green Open Spaces, Ecological Patterns, and the Ecological Supply Chain, policymakers, urban planners, and conservationists can develop strategies aimed at promoting Environmental Sustainability. These strategies may include the preservation and enhancement of Green Open Spaces, the restoration of Ecological Patterns, and the implementation of measures to improve the functioning of the Ecological Supply Chain. Overall, this study contributes to our understanding of the complex relationships between human activities, ecological processes, and environmental outcomes. By integrating these findings into decision-making processes and conservation efforts, we can work towards a more sustainable future, where ecosystems thrive, biodiversity flourishes, and environmental well-being is prioritized for present and future generations.

6.1 Implication

The implications of this study are far-reaching, touching upon theoretical advancements, practical applications, and societal considerations. The findings contribute significantly to ecological theory by emphasizing the interconnectedness between Green Open Spaces, Ecological Patterns, the Ecological Supply Chain, and Environmental Sustainability. These insights can inform urban planning and conservation efforts, guiding policymakers, planners, and land managers in prioritizing the preservation and enhancement of natural habitats within urban environments. Furthermore, the identification of the mediating role of the Ecological Supply Chain underscores the need for holistic approaches to ecosystem management and sustainability. From a societal perspective, increased awareness of the importance of Green Open Spaces and Ecological Patterns may lead to greater public engagement in conservation initiatives, ultimately benefiting both human communities and natural ecosystems alike.

6.2 Limitation and Recommendation

Despite the valuable insights gained from this study, several limitations should be acknowledged. Firstly, the research focused on a specific geographical area or a limited range of ecosystems, which may limit the generalizability of the findings to other regions or ecosystems with different characteristics. Additionally, the use of self-reported data through surveys and interviews may introduce response biases and subjectivity, potentially impacting the validity of the results. Furthermore, the study may have been constrained by time and resource limitations, affecting the breadth and depth of data collection and analysis.
To address these limitations and further advance knowledge in this field, several recommendations are proposed. Firstly, future research could adopt a multi-site or multi-ecosystem approach to enhance the generalizability of findings across different geographic regions and ecological contexts. Additionally, employing a combination of quantitative and qualitative methods, such as field experiments and long-term monitoring, can provide a more comprehensive understanding of the relationships between Green Open Spaces, Ecological Patterns, the Ecological Supply Chain, and Environmental Sustainability. Moreover, efforts should be made to increase the inclusivity of study populations and ensure diverse representation, thereby enhancing the robustness and applicability of research findings. Finally, allocating sufficient resources

and establishing collaborations with relevant stakeholders can facilitate more extensive and impactful research endeavors in this field, ultimately contributing to more effective conservation and management strategies for promoting environmental sustainability.

References

Abdelhamid, M. M., & Elfakharany, M. M. (2020). Improving urban park usability in developing countries: Case study of Al-Shalalat Park in Alexandria. *Alexandria Engineering Journal*, *59*(1), 311–321. https://doi.org/https://doi.org/10.1016/j.aej.2019.12.042

Adobor, H., & McMullen, R. S. (2018). Supply chain resilience: a dynamic and multidimensional approach. *The International Journal of Logistics Management*, *29*(4), 1451–1471. https://doi.org/10.1108/IJLM-04-2017-0093

Aithal, P. S., & Aithal, S. (2022). Opportunities and Challenges for Green and Eco-Friendly Nanotechnology in Twenty-First Century. In *Sustainable Nanotechnology* (hal. 31–50). https://doi.org/https://doi.org/10.1002/9781119650294.ch3

Alberti, M. (2023). Cities of the Anthropocene: urban sustainability in an eco-evolutionary perspective. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *379*(1893), 20220264. https://doi.org/10.1098/rstb.2022.0264

Alexandro, R., & Basrowi, B. (2024a). Measuring the effectiveness of smart digital organizations on digital technology adoption : An em- pirical study of educational organizations in Indonesia. *International Journal of Data and Network Science*, *8*(1), 139–150. https://doi.org/10.5267/j.ijdns.2023.10.009

Alexandro, R., & Basrowi, B. (2024b). The influence of macroeconomic infrastructure on supply chain smoothness and national competitiveness and its implications on a country ' s economic growth : evidence from BRICS. *Uncertain Supply Chain Management*, *12*(1), 167–180. https://doi.org/10.5267/j.uscm.2023.10.007

Arora, N. K., Fatima, T., Mishra, I., Verma, M., Mishra, J., & Mishra, V. (2018). Environmental sustainability: challenges and viable solutions. *Environmental Sustainability*, *1*(4), 309–340. https://doi.org/10.1007/s42398-018-00038-w

Bag, S., Dhamija, P., Bryde, D. J., & Singh, R. K. (2022). Effect of eco-innovation on green supply chain management, circular economy capability, and performance of small and medium enterprises. *Journal of Business Research*, *141*, 60–72. https://doi.org/https://doi.org/10.1016/j.jbusres.2021.12.011

Bai, C., Sarkis, J., Wei, X., & Koh, L. (2012). Evaluating ecological sustainable performance measures for supply chain management. *Supply Chain Management: An International Journal*, *17*(1), 78–92. https://doi.org/10.1108/13598541211212221

Basrowi, B., & Maunnah, B. (2019). The Challenge of Indonesian Post Migrant Worker's Welfare. *Journal of Advanced Research in Law and Economics; Vol 10 No 4 (2019): JARLE Vol X Issue 4(42) Summer 2019DO - 10.14505//jarle.v10.4(42).07*. https://journals.aserspublishing.eu/jarle/article/view/4716

Basrowi, B., & Utami, P. (2020). Building Strategic Planning Models Based on Digital Technology in the Sharia Capital Market. *Journal of Advanced Research in Law and Economics; Vol 11 No 3 (2020): JARLE Volume XI Issue 3(49) Summer 2020DO - 10.14505/jarle.v11.3(49).06*. https://journals.aserspublishing.eu/jarle/article/view/5154

Basrowi, B., & Utami, P. (2023). Development of Market Distribution through Digital Marketing Transformation Trends to Maximize Sales Turnover for Traditional Beverage Products. *Journal of Distribution Science*, *21*(8), 57–68. https://doi.org/10.15722/jds.21.08.202308.57

Bergendahl, J. A., Sarkis, J., & Timko, M. T. (2018). Transdisciplinarity and the food energy and water nexus: Ecological modernization and supply chain sustainability perspectives. *Resources, Conservation and Recycling*, *133*, 309–319. https://doi.org/https://doi.org/10.1016/j.resconrec.2018.01.001

Bianchini, L., Egidi, G., Alhuseen, A., Sateriano, A., Cividino, S., Clemente, M., & Imbrenda, V. (2021). Toward a Dualistic Growth? Population Increase and Land-Use Change in Rome, Italy. In *Land* (Vol. 10, Nomor 7). https://doi.org/10.3390/land10070749

Bibri, S. E. (2021). Data-driven smart sustainable cities of the future: An evidence synthesis approach to a comprehensive state-of-the-art literature review. *Sustainable Futures*, *3*, 100047. https://doi.org/https://doi.org/10.1016/j.sftr.2021.100047

Chakraborty, S. K. (2021). *Trophic Interactions and Biogeochemical Cycles in River Ecosystem BT - Riverine Ecology Volume 1: Eco-functionality of the Physical Environment of Rivers* (S. K. Chakraborty (ed.); hal. 167–234). Springer International Publishing. https://doi.org/10.1007/978-3-030-53897-2_4

Chen, K., Zhang, T., Liu, F., Zhang, Y., & Song, Y. (2021). How Does Urban Green Space Impact Residents' Mental Health: A Literature Review of Mediators. In *International Journal of Environmental Research and Public Health* (Vol. 18, Nomor 22). https://doi.org/10.3390/ijerph182211746

Dougherty, D. (2017). Grounded Theory Research Methods. In *The Blackwell Companion to Organizations* (hal. 849–866). https://doi.org/https://doi.org/10.1002/9781405164061.ch37

Gavrilidis, A. A., Niță, M. R., Onose, D. A., Badiu, D. L., & Năstase, I. I. (2019). Methodological framework for urban sprawl control through sustainable planning of urban green infrastructure. *Ecological Indicators*, *96*, 67–78. https://doi.org/https://doi.org/10.1016/j.ecolind.2017.10.054

Genovese, A., Acquaye, A. A., Figueroa, A., & Koh, S. C. L. (2017). Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications. *Omega*, *66*, 344–357. https://doi.org/https://doi.org/10.1016/j.omega.2015.05.015

Gruner, R. L., & Power, D. (2017). Mimicking natural ecosystems to develop sustainable supply chains: A theory of socioecological intergradation. *Journal of Cleaner Production*, *149*, 251–264. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.02.109

Hadi, R., Shafrani, Y. S., Hilyatin, D. L., Riyadi, S., & Basrowi, B. (2019). Digital zakat management, transparency in zakat reporting, and the zakat payroll system toward zakat management accountability and its implications on zakat growth acceleration. *International Journal of Data and Network Science*, *8*(1), 103–108. https://doi.org/10.5267/j.ijdns.2018.12.005

Hamdan, H., & Basrowi, B. (2024). Do community entrepreneurial development shape the sustainability of tourist villages? Hamdana*. *Uncertain Supply Chain Management*, *12*(1), 407–422. https://doi.org/10.5267/j.uscm.2023.9.014

Hansen, R., Olafsson, A. S., van der Jagt, A. P. N., Rall, E., & Pauleit, S. (2019). Planning multifunctional green infrastructure for compact cities: What is the state of practice? *Ecological Indicators*, *96*, 99–110. https://doi.org/https://doi.org/10.1016/j.ecolind.2017.09.042

Himmatul, I., & Junaedi, A. (2024). *International Journal of Data and Network Science Understanding Roblox ' s business model and collaborative learning on participation in the deci- sion-making process : implications for enhancing cooperative literacy*. *8*, 1247–1260. https://doi.org/10.5267/j.ijdns.2023.11.009

Himmatul, I., Nugroho, I., Mardian, T., Syakina, D., Suryo, A., Sutoto, A., & Junaidi, A. (2024). *Uncertain Supply Chain Management Enhancing company performance and profitability through agile practices : A comprehensive analysis of three key perspectives*. *12*, 1205–1224. https://doi.org/10.5267/j.uscm.2023.11.014

Jägerbrand, A. K., & Bouroussis, C. A. (2021). Ecological Impact of Artificial Light at Night: Effective Strategies and Measures to Deal with Protected Species and Habitats. In *Sustainability* (Vol. 13, Nomor 11). https://doi.org/10.3390/su13115991

Jax, K. (2006). Ecological Units: Definitions and Application. *The Quarterly Review of Biology*, *81*(3), 237–258. https://doi.org/10.1086/506237

Johnson, M., O'Hara, R., Hirst, E., Weyman, A., Turner, J., Mason, S., Quinn, T., Shewan, J., & Siriwardena, A. N. (2017). Multiple triangulation and collaborative research using qualitative methods to explore decision making in pre-hospital emergency care. *BMC Medical Research Methodology*, *17*(1), 11. https://doi.org/10.1186/s12874-017-0290-z

Junaidi, A., Basrowi, B., Sabtohadi, J., Wibowo, A. M., Wiboho, S. S., Asgar, A., Pramono, E. P., & Yenti, E. (2024). The role of public administration and social media educational socialization in influencing public satisfaction on population services : The mediating role of population literacy awareness. *International Journal of Data and Network Science*, *8*(1), 345–356. https://doi.org/10.5267/j.ijdns.2023.9.019

Junaidi, A., Masdar, A. Zum, Basrowi, B., Robiatun, D., Situmorang, J. W., Lukas, A., Asgar, A., Herlina, L., Manulu, L. P., & Payung, L. (2024). Uncertain Supply Chain Management Enhancing sustainable soybean production in Indonesia : evaluating the environmental and economic benefits of MIGO technology for integrated supply chain sustainability. *Uncertain Supply Chain Managemen*, *12*(1), 221–234. https://doi.org/10.5267/j.uscm.2023.10.003

Kharis, A., Masyhari, A., Suci, W., & Priatnasari, Y. (2024). *Uncertain Supply Chain Management Optimizing state revenue through government-driven supply chain efficiency and fair corporate taxation practices*. *12*, 659–668. https://doi.org/10.5267/j.uscm.2024.1.018

Kittie, S., & Basrowi, B. (2024). Environmental education using SARITHA-Apps to enhance environmentally friendly supply chain efficiency and foster environmental knowledge towards sustainability. *Uncertain Supply Chain Management*, *12*(1), 359–372. https://doi.org/10.5267/j.uscm.2023.9.015

Kondo, M. C., Fluehr, J. M., McKeon, T., & Branas, C. C. (2018). Urban Green Space and Its Impact on Human Health. In *International Journal of Environmental Research and Public Health* (Vol. 15, Nomor 3). https://doi.org/10.3390/ijerph15030445

Kruize, H., van der Vliet, N., Staatsen, B., Bell, R., Chiabai, A., Muiños, G., Higgins, S., Quiroga, S., Martinez-Juarez, P., Aberg Yngwe, M., Tsichlas, F., Karnaki, P., Lima, M. L., García de Jalón, S., Khan, M., Morris, G., & Stegeman, I. (2019). Urban Green Space: Creating a Triple Win for Environmental Sustainability, Health, and Health Equity through Behavior Change. In *International Journal of Environmental Research and Public Health* (Vol. 16, Nomor 22). https://doi.org/10.3390/ijerph16224403

Ledikwe, J. H., Grignon, J., Lebelonyane, R., Ludick, S., Matshediso, E., Sento, B. W., Sharma, A., & Semo, B. (2014). Improving the quality of health information: a qualitative assessment of data management and reporting systems in Botswana. *Health Research Policy and Systems*, *12*(1), 7. https://doi.org/10.1186/1478-4505-12-7

Lepczyk, C. A., Aronson, M. F. J., Evans, K. L., Goddard, M. A., Lerman, S. B., & MacIvor, J. S. (2017). Biodiversity in the City: Fundamental Questions for Understanding the Ecology of Urban Green Spaces for Biodiversity Conservation. *BioScience*, *67*(9), 799–807. https://doi.org/10.1093/biosci/bix079

Lisaria, R., Prapanca, D., Amatul, S., & Arifin, K. (2024). *Uncertain Supply Chain Management Forging a resilient pathway : Uncovering the relationship between the supply chain sustainability and the tax compliance , and the sustainable future of the micro , small , and medium enterprise*. *12*, 1097–1112. https://doi.org/10.5267/j.uscm.2023.11.023

Liu, O. Y., & Russo, A. (2021). Assessing the contribution of urban green spaces in green infrastructure strategy planning for urban ecosystem conditions and services. *Sustainable Cities and Society*, *68*, 102772. https://doi.org/https://doi.org/10.1016/j.scs.2021.102772

Ma, H., Pu, S., Liu, S., Bai, Y., Mandal, S., & Xing, B. (2020). Microplastics in aquatic environments: Toxicity to trigger ecological consequences. *Environmental Pollution*, *261*, 114089. https://doi.org/https://doi.org/10.1016/j.envpol.2020.114089

MacKenzie, S. B., Podsakoff, P. M., & Podsakoff, N. . (2011). Construct measurement and validation procedures in MIS and behavioral research: integrating new and existing techniques. *MIS Quarterly*, *35*(2), 293–334.

Marwanto, I. G. G. H., Basrowi, B., & Suwarno, S. (2020a). The Influence of Culture and Social Structure on Political Behavior in the Election of Mayor of Kediri Indonesia. *International Journal of Advanced Science and Technology*, *29*(05 SE-Articles), 1035–1047. http://sersc.org/journals/index.php/IJAST/article/view/9759

Marwanto, I. G. G. H., Basrowi, & Suwarno. (2020b). The Influence of Culture and Social Structure on Political Behavior in the Election of Mayor of Kediri Indonesia. *International Journal of Advanced Science and Technology*, *29*(05 SE-Articles), 1035–1047. http://sersc.org/journals/index.php/IJAST/article/view/9759

Miar, M., Rizani, A., Pardede, R. L., & Basrowi, B. (2024). Analysis of the effects of capital expenditure and supply chain on economic growth and their implications on the community welfare of districts and cities in central Kalimantan province. *Uncertain Supply Chain Management*, *12*(1), 489–504. https://doi.org/10.5267/j.uscm.2023.9.003

Mondal, S., & Palit, D. (2022). *Chapter 2 - Challenges in natural resource management for ecological sustainability* (M. K. Jhariya, R. S. Meena, A. Banerjee, & S. N. B. T.-N. R. C. and A. for S. Meena (ed.); hal. 29–59). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-12-822976-7.00004-1

Mulyani, S., & Basrowi, B. (2024). The effect of environmentally oriented leadership and public sector management quality on supply chain performance : The moderating role of public sector environmental policy. *Uncertain Supply Chain Management*, *12*, 471–480. https://doi.org/10.5267/j.uscm.2023.9.005

Panagopoulos, T., González Duque, J. A., & Bostenaru Dan, M. (2016). Urban planning with respect to environmental quality and human well-being. *Environmental Pollution*, *208*, 137–144. https://doi.org/https://doi.org/10.1016/j.envpol.2015.07.038

Panigrahi, S. S., Bahinipati, B., & Jain, V. (2019). Sustainable supply chain management. *Management of Environmental Quality: An International Journal*, *30*(5), 1001–1049. https://doi.org/10.1108/MEQ-01-2018-0003

Purwaningsih, E., Muslikh, M., Suhaeri, S., & Basrowi, B. (2024). Utilizing blockchain technology in enhancing supply chain efficiency and export performance , and its implications on the financial performance of SMEs. *Uncertain Supply Chain Management*, *12*(1), 449–460. https://doi.org/10.5267/j.uscm.2023.9.007

Ramayah, T., Cheah, J., Chuah, F., Ting, H., & Memon, M. A. (2018). Partial least squares structural equation modeling (PLS-SEM) using smartPLS 3.0. *An updated guide and practical guide to statistical analysis*, 967–978.

Rawat, U. S., & Agarwal, N. K. (2015). Biodiversity: Concept, threats and conservation. *Environment Conservation Journal*, *16*(3 SE-Original Articles), 19–28. https://doi.org/10.36953/ECJ.2015.16303

Ruggerio, C. A. (2021). Sustainability and sustainable development: A review of principles and definitions. *Science of The Total Environment*, *786*, 147481. https://doi.org/https://doi.org/10.1016/j.scitotenv.2021.147481

Saeri, M., Burhansyah, R., Kilmanun, J. C., & Hanif, Z. (2024). *Uncertain Supply Chain Management Strategic resilience : Integrating scheduling , supply chain management , and advanced operations techniques in production risk analysis and technical efficiency of rice farming in flood-prone areas*. *12*, 1065–1082. https://doi.org/10.5267/j.uscm.2023.12.002

Semeraro, T., Scarano, A., Buccolieri, R., Santino, A., & Aarrevaara, E. (2021). Planning of Urban Green Spaces: An Ecological Perspective on Human Benefits. In *Land* (Vol. 10, Nomor 2). https://doi.org/10.3390/land10020105

Shen, M., Huang, W., Chen, M., Song, B., Zeng, G., & Zhang, Y. (2020). (Micro)plastic crisis: Un-ignorable contribution to global greenhouse gas emissions and climate change. *Journal of Cleaner Production*, *254*, 120138. https://doi.org/https://doi.org/10.1016/j.jclepro.2020.120138

Shofwa, Y., Hadi, R., Isna, A., & Amaludin, A. (2024). *Uncertain Supply Chain Management Harmonization of social capital and philanthropic culture : A catalyst for smooth household supply chains and successful economic development*. *12*, 1053–1064. https://doi.org/10.5267/j.uscm.2023.12.003

Shukla, K., Shukla, S., Upadhyay, D., Singh, V., Mishra, A., & Jindal, T. (2021). *Socio-Economic Assessment of Climate Change Impact on Biodiversity and Ecosystem Services BT - Climate Change and the Microbiome: Sustenance of the Ecosphere* (D. K. Choudhary, A. Mishra, & A. Varma (ed.); hal. 661–694). Springer International Publishing. https://doi.org/10.1007/978-3-030-76863-8_34

Singh, R. L., & Singh, P. K. (2017). *Global Environmental Problems BT - Principles and Applications of Environmental Biotechnology for a Sustainable Future* (R. L. Singh (ed.); hal. 13–41). Springer Singapore. https://doi.org/10.1007/978-981-10-1866-4_2

Soenyono, S., & Basrowi, B. (2020). Form and Trend of Violence against Women and the Legal Protection Strategy. *International Journal of Advanced Science and Technology*, *29*(05 SE-Articles), 3165–3174. http://sersc.org/journals/index.php/IJAST/article/view/11636

Stindt, D. (2017). A generic planning approach for sustainable supply chain management - How to integrate concepts and methods to address the issues of sustainability? *Journal of Cleaner Production*, *153*, 146–163. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.03.126

Suwarno Basrowi, I. G. G. H. M. (2020). Technology of Qualitative Analysis to Understand Community Political Behaviors in Regional Head Election in Wates District, Kediri, Indonesia. *International Journal of Advanced Science and Technology*, *29*(05 SE-Articles), 2624–2635. http://sersc.org/journals/index.php/IJAST/article/view/11159

Taghikhah, F., Voinov, A., & Shukla, N. (2019). Extending the supply chain to address sustainability. *Journal of Cleaner Production*, *229*, 652–666. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.05.051

Ugolini, F., Massetti, L., Pearlmutter, D., & Sanesi, G. (2021). Usage of urban green space and related feelings of deprivation during the COVID-19 lockdown: Lessons learned from an Italian case study. *Land Use Policy*, *105*, 105437.

https://doi.org/https://doi.org/10.1016/j.landusepol.2021.105437
Valkó, O., Fekete, R., Molnár V, A., Halassy, M., & Deák, B. (2023). Roadside grassland restoration: Challenges and opportunities in the UN decade on ecosystem restoration. *Current Opinion in Environmental Science & Health*, *34*, 100490. https://doi.org/https://doi.org/10.1016/j.coesh.2023.100490
Wassie, S. B. (2020). Natural resource degradation tendencies in Ethiopia: a review. *Environmental Systems Research*, *9*(1), 33. https://doi.org/10.1186/s40068-020-00194-1
Watson, J. E. M., Evans, T., Venter, O., Williams, B., Tulloch, A., Stewart, C., Thompson, I., Ray, J. C., Murray, K., Salazar, A., McAlpine, C., Potapov, P., Walston, J., Robinson, J. G., Painter, M., Wilkie, D., Filardi, C., Laurance, W. F., Houghton, R. A., … Lindenmayer, D. (2018). The exceptional value of intact forest ecosystems. *Nature Ecology & Evolution*, *2*(4), 599–610. https://doi.org/10.1038/s41559-018-0490-x
Wood, S. L. R., Jones, S. K., Johnson, J. A., Brauman, K. A., Chaplin-Kramer, R., Fremier, A., Girvetz, E., Gordon, L. J., Kappel, C. V, Mandle, L., Mulligan, M., O'Farrell, P., Smith, W. K., Willemen, L., Zhang, W., & DeClerck, F. A. (2018). Distilling the role of ecosystem services in the Sustainable Development Goals. *Ecosystem Services*, *29*, 70–82. https://doi.org/https://doi.org/10.1016/j.ecoser.2017.10.010
Yusuf, Z. F. A., Yusuf, F. A., Nuryanto, U. W., & Basrowi, B. (2024). Assessing organizational commitment and organizational citizenship behavior in ensuring the smoothness of the supply chain for medical hospital needs towards a green hospital : Evidence from Indonesia. *Uncertain Supply Chain Management*, *12*(1), 181–194. https://doi.org/10.5267/j.uscm.2023.10.006
Zain, A. F. M., Pribadi, D. O., & Indraprahasta, G. S. (2022). Revisiting the Green City Concept in the Tropical and Global South Cities Context: The Case of Indonesia . In *Frontiers in Environmental Science* (Vol. 10).
Zhang, F., Chung, C. K. L., & Yin, Z. (2019). Green infrastructure for China's new urbanisation: A case study of greenway development in Maanshan. *Urban Studies*, *57*(3), 508–524. https://doi.org/10.1177/0042098018822965