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SUSTAINABLE NATURAL RESOURCE MANAGEMENT IN VIETNAM: INVESTIGATING THE ROLE OF OPERATIONS MANAGEMENT IN REDUCING ENVIRONMENTAL EXTERNALITIES

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Abstract: *The research objective was to establish the impact of operations management, entrepreneurial orientation, and technological innovation capabilities on environmental externalities with the mediating effect of sustainable natural resource management in Vietnam's travel and tourism industry. For this purpose, data was collected from 320 senior managers of Vietnam's travel and tourism industry through purposive sampling techniques. Data was analyzed through Smart PLS 4 employing the PLS-SEM technique. The structural model results show that operation management, entrepreneurial orientations, and technology innovation capabilities significantly improve environmental externalities. Also, sustainable natural resource management significantly improves the environmental externalities. The indirect effect results show that sustainable natural resource management is partially mediated among operations management, entrepreneurial innovation technological innovation capabilities, and environmental externalities. The study with these findings emphasized that businesses must implement sustainable operational practices together with eco-friendly entrepreneurial initiatives and technological applications as strategies to protect the environment. The policy guidance proposes economic rewards alongside regulatory backing and innovative technology solutions to develop sustainable tourism. This study added a new understanding of sustainability studies by delivering practical advice that*

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will guide businesses alongside policy designers and academic researchers toward the promotion of responsible tourism methods.

Keywords: *Sustainable Natural Resource Management, Operations Management, Environmental Externalities, Entrepreneurial Orientation, Technological Innovations Capabilities*

1. Introduction

The development in the tourism and travel sectors makes it more attractive in the Southeast Asian destination which drives substantive economic progress and entrepreneurial opportunities (Hoàng, 2024). The combination of the various natural environments with the cultural wealth and expanding cities make the country an important tourist place (Quang & Thuy, 2024). As Vietnam's economic growth engine Vietnam's tourism sector reached 9.2% of GDP in 2019 and demonstrates expectations of continued further expansion (Nguyen et al., 2023). Despite the contribution of the tourism sector from an economic perspective, still it threatens ecosystem stability and long-term environmental sustainability (Duong et al., 2025). Various important environmental consequences like deforestation, high water usage, transportation emissions, and generated waste have occurred alongside this progress as confirmed by Ali et al. (2021). The negative externalities of tourism development pose serious risks to Vietnam's natural landscapes, biodiversity, and local communities. The discipline of sustainable natural resource management (SNRM) exists to integrate economic factors with environmental and social considerations as a mechanism to protect ecological integrity throughout tourism expansion (Carlos Rodr´ıgue et al., 2024). SNRM combines resource-efficient methods with circular economy models together with green supply chain practices as its main approaches. Vietnam's government supports sustainability in tourism yet faces uneven application of effective SNRM policies especially among SMEs engaged with tourism services according to (Feng & Jalali, 2024). Based on findings, the pressing need for SNRM practices stands at the top of current environmental agendas.

Prior literature highlighted that operations management creates solutions for environmental problems through better resource efficiency and waste reduction procedures as well as introducing environmentally sustainable technologies (Panigrahi et al., 2023). Using lean and green operational approaches Vietnam's tourism industry achieves noticeable environmental impact reduction and retains economic performance. The implementation of numerous policy initiatives and sustainability frameworks has yet to deliver a solid empirical foundation for operations management actions that reduce environmental externalities (Feng & Jalali, 2024). Other studies also highlighted that operations management within tourism requires designing business processes that optimize efficiency and reduce environmental footprints according to (Marin-Garcia & Alfalla-Luque, 2019). The practices of sustainable operations management aim to remove waste generation while eliminating inefficiencies and blending green network supply chain methods. Travel agencies along with hotels and resorts that deploy energy-efficient frameworks together with water conservation processes and recycling waste mechanisms achieve substantial reductions in carbon emissions (Lisi, 2015). The tourism industry benefits from lowered emissions through vehicles powered by electricity alongside route

optimization methods and carbon offsetting strategies according to (Mondal et al., 2024). Thus, based on previous evidence, research focused on bow operations management practices supports to sustainable natural resource management maturity to improve environmental externalities in Vietnam's tourism field.

Furthermore, entrepreneurial orientation (EO) also refers to a firm's strategic posture toward innovation, proactiveness, and risk-taking. In Vietnam's tourism sector entrepreneurial leadership guides the initiation of environmental projects while implementing sustainable business approaches and tackling ecological obstacles (Lumpkin & Dess, 1996). Proactive tourism companies foresee impending environmental regulations so they implement sustainability ahead of their competition and innovative tourism businesses invest in clean tech alongside sustainable hotel designs and ecological tourist experiences. Businesses use risk-taking behavior to fund sustainable changes as they navigate financial risks. Previous research results demonstrate that Vietnamese tourism businesses demonstrate insufficient sustainability-oriented entrepreneurial direction because they focus more on immediate financial results rather than sustainable environmental progress (Nguyen et al., 2023). Based on previous studies' evidence, research focuses on assessing the dynamic between entrepreneurial orientation and environmental outcomes together with SNRM strategies to improve the environmental externalities in Vietnam's tourism sector.

On the other hand, technology innovation capabilities are also important to increase the SNRM which improves the environmental externalities. This argument is supported by prior studies that emphasized that natural resource management today depends upon technological innovations and advancements that supply capabilities for data analytics decision-making and automated systems (Feng & Jalali, 2024). Advanced technology innovation capabilities help Vietnam's tourism industry boost its sustainability standards by using smart resource tracking systems together with renewable energy sources and green waste management methods (Feng & Jalali, 2024). Through the integration of IoT sensors alongside AI evaluation systems tourism enterprises receive instant energy and water utilization data which enables resource optimization (Carlos Rodr´ıgue et al., 2024). Tourism businesses can further decrease their environmental footprint through their implementation of solar and wind power along with other renewable resources (Ismail et al., 2013). Technology in waste management through AI waste sorting combined with composting and upcycling operations helps decrease landfill contributions by supporting circular economic efforts (Lisi, 2015). Both electric buses and bike-sharing programs represent sustainable mobility solutions that minimize carbon emissions from tourism operations (Mondal et al., 2024). Vietnam's tourism sector struggles to embrace these technologies because high costs hinder their implementation while technical skill shortages and insufficient government backing prevent scalable adoption (Migdadi, 2020). Based on prior studies evidences, this research evaluates technological innovation capacities as drivers for SNRM implementation and environmental externalities reduction.

With the significance of operations management, technological innovations, and entrepreneurial orientations for the environmental externalities through improving SNRM, extant studies still have various gaps. For instance, previous studies were conducted on the direct effect of operations management, technological innovations, and entrepreneurial orientations on environmental sustainability (Garrido et al.,

2024; Ibrahim et al., 2025; Melnyk et al., 2003; Song et al., 2024; Xie et al., 2024; Yaghoubi Farani et al., 2024). On the other hand, extant studies also focused on the direct effect of SNRM on environmental externalities with limited attention to mediating effects (Anas et al., 2024; Wei et al., 2024). Therefore, to address previous gaps, the study aimed to test the mediating influence of SNRM among operations management, technological innovations, entrepreneurial orientations, and environmental externalities. Furthermore, prior studies also focused on other countries with limited attention to Vietnam's travel and tourism sector. Therefore, this study addresses the previous gaps, research objective was to establish the impact of operations management, entrepreneurial orientation, and technological innovation capabilities on environmental externalities with the mediating effect of sustainable natural resource management in Vietnam's travel and tourism industry. The current study applies both empirical data and sophisticated analytical methods to create a linkage between sustainable theory application and its execution in Vietnam's dynamic tourism environment. Furthermore, research findings also contributed to Vietnam's need to establish sustainability-focused policies, which will raise responsible tourism behaviors. Tourism businesses should also receive financial rewards like tax breaks and subsidies alongside grant money to motivate their adoption of sustainable resource management practices. The study was further divided into four further sections.

2. Literature Review

Industry stakeholders throughout the world tourism market now pay increased attention to Sustainable Natural Resource Management because of its effectiveness at reducing harmful environmental effects while supporting long-lasting economic and social gains. The heavy use of natural resources for water management along with land and energy production poses sustainability issues across Vietnam's leading tourism industry (Nguyen et al., 2023). Studies indicate the essential integration of operational management approaches with entrepreneurial attributes and technological capability enhancements within tourism operations contributes to minimizing environmental external impacts (Lutfi et al., 2024). Past research established direct effects from these sustainability factors but a research gap persists about the mediating influence of SNRM for reducing environmental externalities (Carlos Rodr´ıgue et al., 2024).

2.1 Operations Management and Environmental Externalities

Operations management is an important driving force that helps to increase the sustainable tourism industry (Duong et al., 2025). With proper operations management, the environmental externalities improved with process improvement operations minimize waste to increase efficiency (Panigrahi et al., 2023). Furthermore, lean and green strategic operational practices adoption allow tourism businesses to enhance the effectiveness of resource conservation while promoting external sustainability performance (Ismail et al., 2013). Further, organizations with an effective operational blueprint achieve superior energy management while they maintain responsible waste elimination practices and enhanced transportation logistics leading to decreased environmental impacts (Panigrahi et al., 2023). Equally, Zu and Cong (2022) claimed that strategies like inventory control limit long-term benefits, emphasizing the growing need for a well-mannered and well-structured

sustainable environment approach. Additionally, Gill et al. (2019) findings indicate that supplier collaboration and eco-friendly design not only reduce waste management and carbon emission but also improve the operational performance of a company. Based on previous studies and relationships the following hypothesis is formulated below:

H1: *Operations Management significantly improves the environmental externalities.*

2.2 Entrepreneurial Orientation and Environmental Externalities

Entrepreneurial orientation (EO) drives sustainability which firms must enforce through effective sustainable resource management systems to reduce environmental externalities as per Nguyen et al. (2023). The research from Nguyen et al. (2023) indicates tourism entrepreneurs who engage in risk-taking activities produce environmental damage when sustainability fails to remain their priority. According to research when companies blend corporate social responsibility (CSR) efforts with environmental stewardship in their EO strategies they can control environmental externalities effectively (Mondal et al., 2024). Additionally, a study by Wu and Yu (2024) examined the influence of EO on environmental sustainability and reported that companies exhibit highly innovation-oriented entrepreneurs were more likely to utilize sustainable production techniques and pollution control measures. Their study found that EO increases environmental sustainability by anticipating and mitigating environmental risks before they escalate. Furthermore, (Hoàng, 2024) study also found a significant relationship between EO and environmental externalities through adopting circular economy practices which indicates that EO raises a culture of environmental responsibility and innovation. These empirical studies highlighted that EO is an important indicator of increasing environmental externalities. Based on previous studies and relationships the following hypothesis is formulated below:

H2: *Entrepreneurial orientations significantly improve the environmental Externalities.*

2.3 Technological Innovation capabilities and Environmental externalities

Technology innovations show the ability of the firms which helps to improve the new technologies to increase the firm's environmental sustainability to meet current and expected future needs (Zahra & George, 2002). Technology innovations consist of knowledge management along with technology integration to improve environmental externalities (Wu & Yu, 2024). Other authors also highlighted that technological innovation capabilities are better positioned to adapt to environmental challenges, reduce operational inefficiencies, and enhance sustainability practices (Ma et al., 2024). Firms with high technological innovation capabilities can mitigate negative environmental externalities by developing eco-friendly products, optimizing resource usage, and implementing cleaner production techniques (Chen et al., 2021). Furthermore, Wu and Yu (2024) study also highlighted that firms with advanced technological capabilities were more likely to adopt environmental innovations, leading to lower emissions and improved resource efficiency. In another study, Wang and Liu (2020) also found the significant impact of technology innovations on environmental externalities. Based on previous studies and relationships following hypothesis is formulated below:

H3: *Technological innovation capabilities significantly improve the environmental externalities.*

2.4 Sustainable natural resource management and environmental externalities

Sustainable natural resource management (SNRM) represents the strategic utilization of natural resources to meet the current needs of the economy (WCED, 1987). The SNRM consisted of various practices like reforestation, and sustainable land management (Daily, 1997). Extant studies emphasized that SNRM improves the environmental externalities (Pigou, 1920). If the SNRM is poorly managed then it could remove the negative externalities such as deforestation, water scarcity, pollution, and biodiversity loss, which can have long-term economic and ecological impacts (Hardin, 1968). Barbier's study highlighted that SNRM through land and water management on environmental outcomes and found that countries implementing conservation-oriented policies experienced reduced soil erosion, improved water quality, and enhanced biodiversity protection. (Ma et al., 2024) study also examined how various sustainable resource management improves environmental externalities. In addition, Zhu et al. (2024) explored that firms integrating sustainable resource management into their business operations tend to minimize negative environmental externalities while ensuring long-term environmental externalities. Based on previous studies and relationships the following hypothesis is formulated below:

H4: *Sustainable natural resource management significantly improves the environmental externalities.*

2.5 Mediating Role of SNRM between Operations Management and Environmental Externalities

SNRM serves as a critical intermediary in the relationship between OM and environmental externalities. Operations Management enhances resource efficiency but the impact on environmental reduction hangs on firms' structured application of Sustainable Natural Resource Management practices according to Carlos Rodr´ıgue et al. (2024). Research demonstrates tourism businesses integrating Operations Management with sustainability initiatives along with biodiversity protection and waste management achieve substantial environmental impact improvement (Migdadi, 2020). However, Porter and Linde (1995) asserted that without proper sustainable resource management, the primary goal of operations management focuses on process optimization, productivity enhancement, and cost reduction may result in negative environmental externalities like pollution, biodiversity loss, and resource depletion. Furthermore, a study by Shaheen et al. (2022) suggested that SNRM integrates eco-friendly policies, circular economy principles, and responsible resource utilization strategies to ensure that operational activities align with environmental sustainability. By adopting SNRM practices, organizations can minimize waste, lower carbon footprints, and enhance long-term resource availability, contributing to improved environmental outcomes. Additionally, Shaheen et al. (2022) conducted a study that identified that SNRM plays a mediating role when firms implement sustainable resource strategies into their operations management, ensuring that environmental well-being cannot be compromised for business efficiency. Zhu et al. (2017) study further highlighted that firms having well-structured SNRM policies significantly reduce greenhouse gas emissions and industrial wastes which increase the environmental externalities. In the same vein, Govindan et al. (2020) also found that companies with more sustainable resource policies increase through operational

management which could lead to improved environmental externalities. Jinru et al. (2022) found a significant mediating effect of SNRM and found a significant impact which shows the strength of this mediating effect. Based on previous studies and relationships the following hypothesis is formulated below:

H5: *Sustainable natural resource management mediates the relationship between operations management and environmental externalities.*

2.6 Mediating Role of SNRM between Entrepreneurial Orientation and Environmental Externalities

Sustainability-focused entrepreneurial firms use structured resource management frameworks as essential tools to transform EO activities into measurable environmental advantages (Lutfi et al., 2024). Ismail et al. (2013) contend that companies, that embed SNRM strategies into their small business operations, achieve higher rates of emission and waste reduction success. According to other studies entrepreneurial orientation (EO) with an innovation-oriented mindset, risk-taking, and proactive approach, firms are motivated to explore new strategies for long-term environmental sustainability and competitive advantage (Alkharafi et al., 2024; Kazemi et al., 2019; Lumpkin & Dess, 1996). However, without sustainable resource management, entrepreneurial activities may contribute to environmental degradation through excessive resource consumption and waste generation (Covin & Slevin, 1991). SNRM integrates environmentally responsible practices, such as circular economy principles, renewable resource utilization, and eco-friendly production methods, to ensure that entrepreneurial initiatives align with environmental sustainability (Hart & Dowell, 2011). The adoption of entrepreneurial orientation increases the SNRM which improves the environmental uncertainties where firms can mitigate the adverse externalities associated with entrepreneurial ventures while enhancing efficiency and long-term viability. Sarkis et al. (2011) confirmed that entrepreneurial orientations enhance the effectiveness of sustainable operations in minimizing negative environmental externalities. Jinru et al. (2022) found a significant mediating effect of SNRM and found a significant impact which shows the strength of this mediating effect. Based on previous studies and relationships following hypothesis is formulated below:

H6: *Sustainable Natural Resource Management mediates the relationship between Entrepreneurial Orientation and Environmental Externalities.*

2.7 Mediating role of SNRM between technological innovation capabilities and environmental externalities

Technological innovations with advanced tools increase the innovation capabilities which allow the companies to optimize the resources which increases the sustainability program (Hoàng, 2024; Streimikiene et al., 2007) also highlighted that technological innovation increases the company's capacity to monitor waste management and automated pollution controls deliver stronger environmental results under comprehensive SNRM frameworks. Zhu et al. (2017) empirical study also found that technological innovations reduced industrial waste and carbon emissions when implementing circular economy principles and sustainable resource utilization. In the same vein, Govindan et al. (2020) also provided evidence that firms implementing technological innovation capabilities improved resource efficiency and reduced pollution which emphasizes the mediating role of sustainable SNRM. Other studies

confirm that sustainable environmental policies are becoming more efficient in mitigating environmental externalities when structured with a sustainable resource management framework (Hackett & Dissanayake, 2014; Streimikiene et al., 2007). Jinru et al. (2022) found a significant mediating effect of SNRM and found a significant impact which shows the strength of this mediating effect (Figure 1). Based on previous studies and relationships the following hypothesis is formulated below:

H7: *Sustainable natural resource management mediates the relationship between technological innovation capabilities and environmental externalities.*

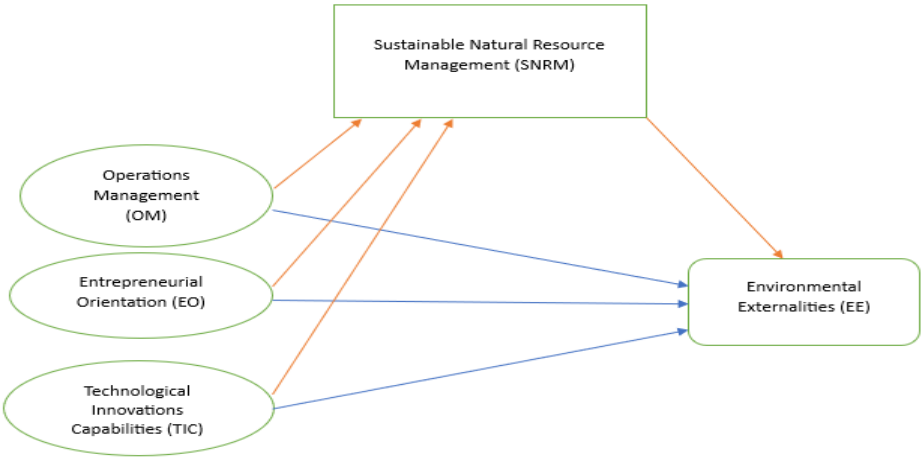

Figure 1: Theoretical Framework

3. Methodology

This study uses a quantitative approach according to positivist theory to test established hypotheses measured by empirical evidence from theoretical backgrounds. Through survey-collected data, this study examines Operations Management (OM), Entrepreneurial Orientation (EO), Technological Innovation Capabilities (TIC) functions in Sustainable Natural Resource Management (SNRM) along with their influence on Environmental Externalities (EE) within Vietnam's travel and tourism sector. This method produces systematic measurements that help understand interactions between these elements inside sustainability models. Researchers use snapshot studies to analyze variable connections at unique time points because these studies require less commitment compared to long-term analysis methods. The research methodology supports analysis objectives together with effective variables measurement and analysis.

3.1 Research Design

Through a deductive research framework, this study bases its hypotheses on existing literature along with theoretical models which researchers then evaluate using structured analysis of survey data. This research utilizes quantitative cross-sectional surveys to provide systematic measurement capabilities for constructing relationships. For analysis between constructs PLS-SEM (Partial Least Squares Structural Equation Modeling) examines both direct and indirect relationships

together with mediation effects. Researchers validated their choice of PLS-SEM since it efficiently processes intricate models with smaller sample sizes which makes it effective for structural path analysis. The study models theoretical connections between five constructs which include OM regarding Entrepreneurial Orientation, Technological Innovation Capability next to Social Network Relationship Management as a mediating factor, and Environmentally Friendly Design to identify how they contribute toward sustainable tourism outcomes.

3.2 Instrumentation and Measurements

The study maintained reliability and validity with a structured questionnaire whose measurement items came from established validated scales in earlier research. The analysis of Operations Management (OM) incorporated a seven-item measurement scale (Ismail et al., 2013), along with Panigrahi et al. (2023) developed. Twelve questionnaire items from research conducted by Awang et al. (2010), and Lumpkin and Dess (1996) enabled the study to evaluate entrepreneurial orientation (EO). The research measured technological innovation capabilities (TIC) using 7 survey items based on the studies by Yam et al. (2011) and Migdadi (2020). The study assessed sustainable natural resource management (SNRM) with a 3-item scale by Carlos Rodr´ıgue et al. (2024), Harmon and Gerald (2007), and Ismail et al. (2013), while environmental externalities (EE) used a 4-item measurement tool from (Lisi, 2015), and (Lutfi et al., 2024). The survey rated all items from "strongly disagree" to "strongly agree" on a five-point Likert scale except for TIC which used seven steps on its scale.

3.3 Sampling and Data Acquisition

Senior managers along with executive-level leaders from Vietnam's travel sectors including hotel operations travel agencies eco-tourism firms and tourism regulators form this study's defined target population. Purposive sampling methodologies determined a sample size of 320 managers who served both as decision-makers and direct participants in sustainability projects. The research combined virtual and physical channels for survey distribution to achieve maximum response rates. Survey analysis benefited from 320 reliable questionnaires which were selected from 400 delivered questionnaires once incomplete and poor-quality submissions were eliminated. Using G*Power software researchers calculated the appropriate sample size for robust PLS-SEM analysis according to Chin's 1998 methodology. Structured survey administration included an initial pilot examination of 30 participants that improved instrument clarity while establishing content validity and reliability.

3.4 Data Analysis

The research utilized PLS-SEM alongside SmartPLS 4.0 software to evaluate proposed hypotheses and investigate SNRM as a mediator. The analysis followed a two-step approach: Researchers conducted measurement-modeling analysis for reliability assessment along with convergent and discriminant validity examination followed by structural modeling evaluation, which reviewed path coefficients and indirect effects combined with model fit. The study assessed reliability through both Cronbach's Alpha and Composite Reliability (CR) measurements in combination with convergent validity evaluation, which relied on Average Variance Extracted (AVE). Both Fornell-Larker tests and analysis of the Heterotrait-Monotrait (HTMT) ratio are effective in the

validation of discriminant validity. To determine the significance of path coefficients, the researchers conducted their analysis by using 5000 bootstrapped resamples. By using the Latent Marker Variable (MLMV) model which improves objective outcomes, the researchers reduce common method bias (Podsakoff et al., 2003).

3.5 Results

The study's Table 1 shows results from the Convergent Validity Test which examines both the consistency and reliability among the study's constructed measures.

Table 1: Convergent Validity Test

	Constructs	Items	Loading	Alpha	CR	AVE
Environmental externalities	EE	EE1	0.812	0.781	0.831	0.621
		EE2	0.791			
		EE3	0.762			
		EE4	0.743			
Entrepreneurial Orientation	EO	EO1	0.834	0.822	0.863	0.632
		EO2	0.822			
		EO3	0.832			
		EO4	0.783			
		EO5	0.774			
		EO6	0.752			
		EO7	0.733			
		EO8	0.714			
		EO9	0.724			
		EO10	0.745			
		EO11	0.764			
		EO12	0.793			
Operational Management	OM	OM1	0.852	0.814	0.853	0.643
		OM2	0.834			
		OM3	0.813			
		OM4	0.792			
		OM5	0.774			
		OM6	0.752			
		OM7	0.734			
Sustainable natural resource management	SNRM	SNRM1	0.842	0.794	0.834	0.613
		SNRM2	0.812			
		SNRM3	0.784			
Technology innovation capabilities	TIC	TIC1	0.854	0.832	0.844	0.623
		TIC2	0.835			
		TIC3	0.832			
		TIC4	0.784			
		TIC5	0.763			
		TIC6	0.742			
		TIC7	0.714			

Convergent validity verification takes place by measuring three different model parameters that achieve the necessary minimum values (Hair et al., 2019). The measurement model results show strong reliability and validity because each factor loading ranges between 0.71 and 0.85, exceeding the 0.70 threshold for indicator reliability (Hair et al., 2019). Internal consistency is confirmed by Cronbach's Alpha (α) values between 0.781 and 0.832 which are above the acceptable 0.70 threshold

(Nunnally & Bernstein, 1994). Composite Reliability (CR) values range from 0.831 to 0.863, which exceeds the recommended 0.70 threshold, and these values indicate high construct reliability (Fornell & Larcker, 1981). Furthermore, Average Variance Extracted (AVE) values exceed 0.60 which meets the 0.50 criterion that confirms convergent validity (Hair et al., 2019). These above values recommend that each construct fulfill the requirements of convergent validity.

The Fornell-Larcker Criterion provided in Table 2 evaluates discriminant validity by comparing constructs' AVE square roots against their cross-correlations according to (Fornell & Larcker, 1981). Discriminant validity shows confirmation when diagonal values (square root of AVE) exceed their corresponding off-diagonal correlation values across the same row and column. The square root of AVE for each construct is greater than the below values and these findings support strong discriminant validity because construct values surpass inter-construct correlation measures to confirm conceptual uniqueness between each construct. The above results are predicted in Table 2 below.

Table 2: Fornell and Larcker

Constructs	EE	EO	OM	SNRM	TIC
EE	**0.788**				
EO	0.452	**0.796**			
OM	0.471	0.491	**0.802**		
SNRM	0.398	0.431	0.457	**0.783**	
TIC	0.423	0.446	0.478	0.409	**0.789**

Furthermore, the discriminant validity assessment of construct correlations was also measured from the Heterotrait-Monotrait Ratio analysis (HTMT). Discriminant validity appears strong when HTMT values remain below 0.85 while values of 0.90 or greater create multicollinearity concerns (Henseler et al., 2015). Table 3 depicts results showing that all values fall well beneath the 0.85 boundary, which verifies conceptual separateness among the constructs. The evidence shows that discriminant validity problems do not exist thus each latent construct functions as a distinct concept while remaining separate without significant overlapping measurements. This strengthens the robustness of the measurement model, ensuring that the structural model results will be statistically reliable and valid for hypothesis testing in PLS-SEM.

Table 3: HTMT

Constructs	EE	EO	OM	SNRM	TIC
EE	—				
EO	0.651	—			
OM	0.678	0.701	—		
SNRM	0.589	0.643	0.674	—	
TIC	0.612	0.667	0.692	0.605	—

3.6 Structural Model

After the assessment of the model, the next step is to test the study hypothesis. The structural model results show the positive and significant direct impact of OM on EE (β = 0.423, p = 0.001). This relationship suggested that effective operations management plays a crucial role in reducing tourism-induced environmental challenges. Similarly, EO exhibits a positive and significant effect on EE (β = 0.314, p = 0.006) which highlights that entrepreneurial-driven travel businesses adopting innovative, sustainability-focused strategies can contribute to environmental conservation. Furthermore, the positive and significant impact of TIC on EE (β = 0.381,

p = 0.002) has been found. This relationship emphasizes the role of advanced technological capabilities in mitigating environmental damage which demonstrates that smart tourism technologies, automation, and AI-driven energy management contribute to sustainable outcomes. Additionally, SNRM's positive and significant influence on EE (β = 0.293, p = 0.004) reinforces that structured sustainability practices in Vietnam's tourism sector effectively control ecological degradation and promote responsible tourism.

The mediation effects further support the role of sustainability-driven practices in improving environmental outcomes. OM and EE relationship is partially mediated through SNRM (β = 0.224, p = 0.014). This relationship suggested that incorporating sustainability-focused operations amplifies environmental benefits by reducing carbon footprints and excessive resource consumption. Likewise, EO's positive and significant mediation effect via SNRM (β = 0.263, p = 0.009) indicates that tourism entrepreneurs who integrate sustainability within their business models achieve better environmental outcomes. Additionally, the positive and significant mediation of TIC through SNRM (β = 0.301, p = 0.003) also demonstrates that technology-driven sustainability measures enhance the ecological sustainability of Vietnam's travel sector. These positive and significant findings suggest that Vietnam's tourism industry must focus on sustainable operations, entrepreneurship, and technological advancements to ensure long-term environmental resilience and responsible growth. Above discussed results are mentioned in Table 4 and Figure 2.

Table 4: Regression Results

Relationship	Original sample	T Statistics	P value	Supported
OM → EE	0.423	3.562	0.001	Yes
EO → EE	0.314	2.743	0.006	Yes
TIC → EE	0.381	3.125	0.002	Yes
SNRM → EE	0.293	2.892	0.004	Yes
OM → SNRM → EE	0.224	2.451	0.014	Yes
EO → SNRM → EE	0.263	2.617	0.009	Yes
TIC → SNRM → EE	0.301	2.913	0.003	Yes

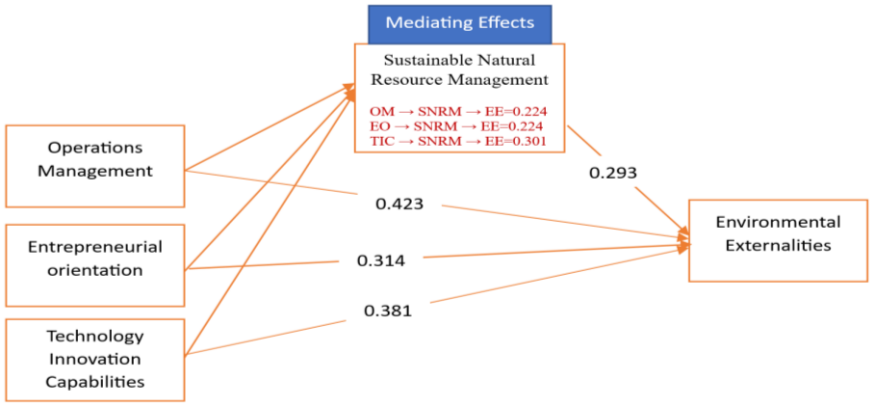

Figure 2: Beta Values

4. Discussion

The study sought to investigate the effect of operations management (OM),

entrepreneurial orientation (EO), and technological innovation capabilities (TIC) on sustainable natural resource management (SNRM) practices and environmental externalities (EE) reduction in Vietnam's travel and tourism industry. The study findings indicate that there is a positive significant impact of operations management OM on EE in Vietnam's travel sector. These findings confirmed that well-structured and sustainability-focused operations in Vietnam played an integral role in mitigating the ecological footprint in the tourism sector. The study findings are consistent with several empirical studies (Magon et al., 2018) that illustrated that operations management significantly increases environmental sustainability. These findings highlighted that such results are in the context of Vietnam, where tourism is rapidly expanding, and the importance of environmentally responsible operations cannot be overstated. The influx of tourists places significant pressure on natural resources, waste disposal systems, and energy consumption. Therefore, businesses must incorporate eco-friendly operational strategies to ensure a more sustainable tourism sector. Based upon the above arguments, to maintain long-term environmental and economic stability tourism enterprises in Vietnam must integrate sustainable operations into their core business models.

In addition to OM, EO also has a positive and significant relationship with the environmental sustainability of the tourism sector in Vietnam. This result highlights the central role of innovation-oriented entrepreneurship in promoting sustainable and culturally responsible tourism practices. Historically, entrepreneurs who adopt sustainability as a core business value tend to develop eco-friendly solutions, such as green hospitality services, eco-lodges, and carbon-neutral tour packages. The study findings are in line with previous studies that demonstrated that environmental awareness, knowledge, and skills enable entrepreneurs to promote sustainable consumption patterns, drive the development of green infrastructure, and motivate tourists to adopt eco-friendly practices (John, 2025b; Sharma, 2024; Song & Han, 2023). These findings highlighted that in Vietnam where eco-tourism is gaining popularity, sustainable entrepreneurship can cater to the growing demand for green tourism while minimizing environmental harm. Furthermore, Innovative tourism startups that invest in renewable energy solutions, sustainable travel accommodations, and eco-conscious business models contribute to a more balanced relationship between tourism and nature. Therefore, it is emphasized that with the increasing emphasis on sustainability in global tourism, enterprises in Vietnam must prioritize environmental protection using sustainability-focused entrepreneurial activities that could increase their competitive advantage.

The study findings also illustrated that technological innovation capabilities have a positive significant impact in reducing environmental issues within the tourism sector of Vietnam. The findings suggest that eco-innovation technology plays an important role in promoting pro-environmental tourism practices and meeting the increasing demand for responsible tourism. The findings collaborate with previous studies that demonstrated that tourism businesses leveraging digital innovations could reduce operational inefficiencies which could enhance environmental monitoring, and promote sustainable resource consumption (Fatema et al., 2024; Sutarman et al., 2023). Moreover, Rane et al. (2024) also argued that AI-powered predictive analytics can assist businesses in developing eco-conscious strategies tailored to minimize their environmental footprint. These findings highlight that by recognizing these advantages, it is stated that Vietnam's tourism sector has to invest actively in

technological innovation capabilities as it aligns with sustainability goals. Therefore, the integration of digital tools into core business operations enables the tourism sector to enhance its sustainability efforts while maintaining a competitive advantage in a diverse global market.

Furthermore, the findings also claim that sustainable SNRM significantly and positively contributes to mitigating environmental harm in the travel and tourism industry. This finding highlights that sustainable business practices are facilitated by efficient resource management strategies like carbon-neutral tourism initiatives, biodiversity conservation, and responsible water consumption. Due to the lack of these efficient resource management strategies, Vietnam which is famous for its rich natural landscapes and cultural heritage faces increasing challenges in preserving its environment due to high tourist volumes. Consequently, without proper management, tourism-related activities can lead to deforestation, habitat destruction, and water pollution (Sutarman et al., 2023). However, implementing structured SNRM policies ensures that tourism growth does not come at the cost of environmental degradation. Previous research supports this argument, emphasizing that sustainable resource management not only reduces ecological harm but also improves long-term business sustainability (Nwaogbe et al., 2025). The finding is also consistent with John (2025a) who stated that when companies prioritize responsible resource consumption and conservation initiatives then they could contribute to the broader goals of environmental protection and sustainable tourism development. Therefore, Vietnam's tourism sector must strengthen its commitment to resource conservation by implementing stricter environmental policies, promoting eco-certifications, and collaborating with government agencies to ensure compliance with sustainability regulations.

In addition to direct impact, the mediation effect of SNRM further explained the relationship of OM, EO, TIC, and EE. The findings reveal that OM has a significant positive effect on environmental sustainability through the mediating role of SNRM. The effectiveness of OM, EO, and TIC was significantly enhanced when complemented by structured sustainability policies under SNRM. The findings emphasized the importance of sustainable policies such as efficient resource utilization, waste reduction, and improving environmental sustainability to align with sustainability goals. Furthermore, it indicated that well-mannered operations reduce ecological harm and ensure long-term sustainability. The findings are supported by the argument of Probojakti et al. (2025) who reported that integrating sustainable policies in an operational framework raises competitive advantage, more responsible resource consumption, and resilience. As this mediating effect has been tested first time. Therefore, this relationship could not be supported directly but in various studies, it has been highlighted that sustainable natural resources improve the environmental externalities (Hu et al., 2024; Sulistiawati, 2025). Jinru et al. (2022) found a significant mediating effect of SNRM and found a significant impact which shows the strength of this mediating effect. Thus, for Vietnam tourism sector, it is crucial to adopt eco-friendly strategies to support sustainable growth, preserve natural resources, and reduce environmental harm.

In addition to OM SNRM also positively and significantly mediates the relationship between EO and EE. This finding implies that entrepreneurs having strong innovation-based entrepreneurial mindsets are more likely to implement sustainable business

policies which leads to superior environmental outcomes. The importance of this finding lies in validating how proactive and risk-taking entrepreneurs adapt their business strategies to sustainable trends and actively engage in eco-friendly innovation to reduce environmental harm. The findings collaborate with prior research suggesting that innovation-oriented entrepreneurship leads to the creation of long-term benefits, waste reduction, and optimum resource consumption (Asad et al., 2023; Baquero, 2025; Razzaque et al., 2024). Given the importance of these insights, tourism enterprises in Vietnam have to utilize entrepreneurial strategies that integrate sustainability policies to ensure competitive advantage while contributing to environmental conservation and sustainable tourism development.

Furthermore, the findings also illustrate that SNRM positively and significantly mediates the relationship between TIC and EE. It means that companies that invest more in technologies tend to implement more efficient resource management strategies while reducing negative environmental impacts. Furthermore, the finding emphasizes the critical role of technological innovation in improving sustainable efforts through advancement in Automation, Artificial intelligence (AI), advanced technology, and the Internet of Things (IoT). This finding aligns with the previous studies (Agbelusi et al., 2024; Javaid et al., 2022) suggesting that technological innovation minimizes carbon footprints and drives sustainability by improving waste management and optimizing resource consumption. Research further supports the argument that firms that invest more in green technology and smart systems are more likely to enhance their sustainability performance (Rehman Khan et al., 2022). Based on the above discussion, the tourism sector of Vietnam should adopt eco-friendly technologies to improve operational efficiency, reduce their carbon footprints, and contribute to the long-term sustainability of the sector.

5. Theoretical and Policy Implications

The study contributes significantly to the literature on sustainable tourism by investigating the impact of operations management (OM), Entrepreneurial Orientation (EO), Technological innovation capabilities (TIC), and sustainable natural resource management (SNRM) on environmental externalities (EE). The positive significant impact of OM on EE extends resource-based and stakeholder theories which confirms that companies with well-structured and well-planned sustainability-oriented operations tend to exhibit sustainable environment awareness. On the other hand, innovation theory supports the positive impact of EO on environmental externalities highlighting that risk-taking and proactive entrepreneurship can reshape the tourism sector by driving eco-friendly innovations. In addition, the findings on TIC's role in mitigating environmental issues contributed to the technology acceptance model by demonstrating that advanced digital solutions enhance sustainability efforts and optimize resource efficiency. Moreover, the mediating role of SNRM contributed to institutional and ecological modernization theories by highlighting that structured sustainability policies amplify the effects of OM, EO, and TIC in achieving environmental goals. In turn, these findings contributed to the notion that sustainability-driven operational strategies should not viewed in isolation but as interconnected components that collectively strengthen environmental sustainability. Generally, the study contributes to the theoretical literature by integrating operational, entrepreneurial, and technological dimensions within sustainability, giving new

directions to future researchers to further extend the research on environmentally sustainable and responsible tourism practices.

The study practically contributed to helping the policymakers to establish in Vietnam's tourism industry sustainability-focused policies, which will raise responsible tourism behaviors. The study results contributed that tourism businesses should receive financial rewards like tax breaks and subsidies alongside grant money to motivate their adoption of sustainable resource management practices. Tax relief and subsidies should push businesses to pursue waste reduction efficient energy use and water saving which maintains both operational output and sustainable focus. On the other hand, the study also contributed to helping to create public-private partnerships between tourism businesses and government and research organizations need enhancement to create effective collaborative networks. Through these collaborations, both businesses and stakeholders can gain access to platforms that share knowledge about sustainable tourism innovations, introducing them to the newest sustainable tactics available. Tourism businesses must document their environmental performance indicators via mandatory sustainability reporting frameworks which include data on carbon emissions together with energy usage and waste reduction actions. These initiatives will drive industry-wide corporate responsibility together with enduring sustainable practices.

6. Conclusion

The research objective was to establish the impact of operations management, entrepreneurial orientation, and technological innovation capabilities on environmental externalities with the mediating effect of sustainable natural resource management in Vietnam’s travel and tourism industry. Data was analyzed through Smart PLS 4 employing the PLS-SEM technique. The structural model results show that operation management, entrepreneurial orientations, and technology innovation capabilities significantly improve environmental externalities. Also, sustainable natural resource management significantly improves the environmental externalities. The indirect effect results show that sustainable natural resource management is partially mediated among operations management, entrepreneurial innovation technological innovation capabilities, and environmental externalities. The study with these findings emphasized that businesses must implement sustainable operational practices together with eco-friendly entrepreneurial initiatives and technological applications as strategies to protect the environment. The study practically contributed to helping the policymakers establish in Vietnam's tourism industry sustainability-focused policies, which will raise responsible tourism behaviors. The study also contributed to helping to create public-private partnerships between tourism businesses and government and research organizations that need enhancement to create effective collaborative networks.

7. Directions for Future Research

Although this study offers important findings about sustainable natural resource management in tourism applications they represent starting points requiring future research efforts to extend our exploration and strengthen sustainability strategy

execution. One key area for future investigation is sector-specific sustainability analysis, focusing on eco-tourism, luxury tourism, and adventure tourism to understand how sustainability practices vary across different business models. Another important avenue for research is conducting longitudinal studies to examine how operations management, entrepreneurial orientation, and technological innovation capabilities evolve over time in influencing sustainable natural resource management. A long-term perspective would provide deeper insights into the effectiveness of sustainability interventions and help businesses make informed decisions on sustainability strategies. Cross-cultural studies should also be considered to assess how institutional, economic, and cultural differences impact sustainability adoption in the tourism sector. Comparative research between Vietnam and other tourism-driven economies would provide best practices and policy recommendations that can be adapted to local contexts.

Exploring additional mediating and moderating variables would further enrich the understanding of sustainability-driven tourism. Variables such as organizational culture, leadership styles, environmental regulations, and digital transformation could be examined to better understand the mechanisms driving sustainable natural resource management. Future research should also assess the role of digital transformation in promoting sustainability. The rapid adoption of AI, big data analytics, and smart tourism solutions provides an opportunity to evaluate how digital business models can enhance resource efficiency and environmental conservation in the tourism sector. Understanding these technological advancements would help businesses develop more effective sustainability strategies and contribute to a greener tourism industry.

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