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## ABSTRACT

The research aimed to examine the impact of sustainable risks on supply chain performance with the mediating effect of risk mitigation in food companies. The study also tested the moderating influence of supply chain management. Quantitative data through self-administered surveys were collected from 282 employees using a convenient sampling technique. Smart PLS used for inferential statistics, and SPSS is used for demographics. The study results show that economic, social, and environmental risks have a significant impact on supply chain performance. Further mediating effect results also show that risk mitigation partially mediates among all sustainability risk factors and supply chain performance. Supply chain management also significantly moderates between sustainable risk factors and risk mitigation strategies. These study findings showed that sustainable risk factors contributed to increasing the supply chain performance when they are properly managed. The study results also contributed a significant role in risk mitigation as a bridge to improve the supply chain performance. The research also uncovers the significant moderating effect of supply chain management in strengthening the relationship between sustainability risks and mitigation efforts. In order to achieve resilient and sustainable supply chain performance, food firms can benefit greatly from these insights.

## 1. Introduction

In the current dynamic and globalized environment, optimizing supply chain performance (SCP) is crucial for organizations to stay ahead of the competition [1]. It shows the reflection of how the companies are efficiently and effectively flow their goods from manufacturer/supplier to the end consumer [64]. A better SCP reduces the company's operational costs, improves product quality, accelerates delivery times, and enhances customer satisfaction [23]. Bourai et al. [12] also highlighted that organizations with strong SCP are more agile in adapting to shifting customer needs, navigating market volatility, and staying competitive in a global marketplace. Cook et al. [17] also emphasized that SCP is not merely a logistical concern but a strategic enabler of business value

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creation. Companies that invest in improving SCP can achieve greater operational excellence, strengthen relationships with suppliers and partners, which improve the company's competitive advantage [64]. In this context, managing SCP has evolved from a back-end support function to a core component of strategic business decision-making. Consequently, this study aims to examine the factors that could improve the SCP.

SCP is effective due to various factors, but in the current dynamic environment, SCP is still increasingly threatened by the emerging sustainable risks (SUR) practices [38]. These sustainable risk-related factors could impose various disruptions in the organization's supply chain continuity by affecting the availability of raw material, production capacity, and corporate reputation [59]. If the companies is relying those environment factors good which are not complaint then it could may face legal actions, consumer boycotts, or even blacklisting by investors due to unethical practices or environmental harm. Raheel Shah et al. [52], Waqas et al. [70] also highlighted that SUR are now among the most complex challenges in global supply chains, particularly due to the interconnected nature of global networks and the increasing demand for transparency and accountability. As governments tighten environmental and social regulations and consumers grow more conscious of ethical sourcing, failure to mitigate these risks can lead to significant financial losses and could also decrease the companies' SCP [34]. It has been highlighted in the literature that the management of SUR significantly improves the SCP [52]. Other researchers also found SUR significant impact the SCP [52]. These studies emphasize that companies must treat SUR as a central concern for the improvement of SCP. Therefore, the study focused on how sustainable risk factors could improve the SCP.

Literature supported the view that supply chain management (SCM) has occurred as a vital approach, embedding eco-friendly and socially responsible principles into every facet of the supply chain to drive business sustainability [17]. Other authors also enforced that SCM played an important role in addressing SUR by embedding proactive strategies which in turn strengthen RM efforts [28]. SCM consisted of various environmentally friendly practices, like as energy-efficient transportation, reducing carbon footprints, managing waste and emissions, and promoting circular economy models which leads to improving the companies' SCP [61]. SCP in the companies also ensures fair labor practices, worker safety, and supplier compliance with human rights standards [58]. Furthermore, SCM also plays a vital role in enhancing visibility and traceability, which allows firms to monitor suppliers and identify risk points in real-time [17]. Collaboration with suppliers and stakeholders is also crucial because it raises information sharing, joint problem-solving, and innovation [10]. Boonlua et al. [11] also further highlighted that Proactive risk management and strategic alliances empower organizations to develop agile supply chains that can effectively navigate disruptions, minimize losses, and maintain continuity. Other studies also highlighted that companies through adopt a strong SCM framework will not only protect themselves from their potential risks, but it will also strengthen their long term value creation which leads to improved company RM strategies [26]. Negri et al. [44] also emphasized that managing sustainability through integrated supply chain practices reduces vulnerability to disruptions and enhances resilience. On the other hand, Shaw et al. [60] highlighted that SCM act as key enabler for improving environmental and social performance through structured mitigation strategies. The extant literature highlights that SCM is a key enabler to improve the RM strategies. Therefore, study focused on using a SCM is a key moderating variable between SUR and RM strategies.

It is has been discussed that when the companies managed their risk mitigation (RM) strategies then it leads to improve the SCP Raheel Shah et al. [52], because RM strategies helps to serve a critical mechanism which links to the sustainable risk practices with the performance outcomes by reducing exposure to environmental, regulatory, and social threats. Can Saglam et al. [13] also

argued that organizations that actively mitigate SUR experience improved agility, resilience, and continuity, all of which contribute to superior performance outcomes. Other studies also highlighted that sustainable business practices can bolster risk management approaches, such as supplier diversification and scenario planning, while investments in green technologies can minimize vulnerabilities and improve responsiveness to disruptions. Settembre-Blundo et al. [59] which is leading to improve the SCP. These findings enforcing that RM strategies a mediating variable is essential for the study because it explains how sustainable practices translate into measurable performance gains. This is also supported with Golicic et al. [26], who affirmed that without proper RM, sustainability efforts may remain superficial and fail to deliver tangible benefits. Therefore, integrating RM as a mediating variable could provide a comprehensive framework for understanding how sustainability initiatives can directly and indirectly drive improvements in SCP.

Although studies have been conducted on the relationship between SUR, RM strategies, supply chain management, and SCP. Still, these studies have various gaps that need to be addressed in further study. For example, majority of studies have been conducted to examine either sustainability practices or risk management in isolation effect on SCP while often neglecting the integrative role of mediating variables such as RM [31; 55]. Additionally, most empirical research focuses on specific country with limited evidence on general contexts where supply chain vulnerabilities to environmental, regulatory, and social risks are more pronounced [39; 46]. Therefore, this study filled this gap to conduct a study on the food sectors. In addition, various studies have been also conducted on SUR and SCP with a limited attention on the moderating effect of SUR [4; 50]. In this regards, this study contributed supply chain as moderating variable between SUR and RM strategies to improve the food companies SCP. On the other hand, prior studies also conducted on sustainable factors namely environment, social, and economic with a limited attention in the context of risk to improve the SCP [63]. Therefore, this study contributed to address this limitations after adding sustainable as an independent variable with risks factors to improve SCP of food companies. This study addresses these critical gaps by empirically investigating the mediating effect of RM between SUR and SCP of food companies. The study also tested the moderating effect of SUR between SUR and SCP.

The study has practical significance in various ways that could help to both supply chain managers and policy makers of food industry. The study results for the supply chain managers highlighted the importance of integrating RM strategies and strengthening SCM practices to enhance SCP amid growing environmental, social, and economic risks. Managers are encouraged to adopt a more strong approach by treating sustainability risks not in isolation but in combination with proactive RM and robust SCM systems to ensure resilience, agility, and continuity. On the other hand, policymakers can also benefit from the study by recognizing the critical role of regulatory support, sustainability incentives, and risk governance frameworks in enabling food companies to address complex supply chain vulnerabilities. The study emphasizes the need for policies that promote sustainable practices, support capacity building in RM, and encourage the integration of SCM strategies across the food sector. Together, these insights contribute to building a more secure, sustainable, and performance-driven supply chain ecosystem.

## **2. Literature Review**

### *2.1 Sustainable Risks in Supply Chain Performance*

The sustainable risks (SUR) are those risks that could impact to the supply chain process ability in operation effectively [29]. In the prior literature, SUR becomes an important factor in various business practices to improve their performance [9]. SUR has been divided into various three basic

categories environmental, social and economics [45]. These risks can compromise operational efficiency, damage corporate reputation, strain stakeholder relationships, and hinder regulatory compliance. In this regards, companies after managing these risks could develop strong supply chain process that could improve the company's performance [7]. Other author also highlighted that SUR helps to minimize the risk of the companies which could lead to improve the SCP [33]. These researchers highlighted that SUR is an integral factor improve the SUR.

Among the SUR, environmental risk (ER) consisted of various uncertainties which are arising due to the fluctuations in the market that could minimize the companies SCP [53]. Factors such as inflation, and changes in the global economic climate could lead to unpredictable costs, reduced demand, and supply shortages [6]. On the other hand, ER also includes the risk of financial instability in the supply chain partners that could affect the company's ability in fulfilling their orders and also maintaining the consistent supply chain flows [34]. It is also highlighted that ER is required for the firms to improve the cost efficiency, financial health, that could improve the SCP [6]. It is emphasized in the extant literature that ER is crucial for maintaining profitability while contributing to broader sustainability goals, which may include responsible production practices and minimizing waste and resource consumption [20]. This is the reason, economic dimension becomes crucial for SCP because it directly influences cost control, financial stability, and the ability to invest in RM strategies. Empirically, Smorodinskaya et al. [62] study found significant role of SUR to improve SCP. Similarly, Baldwin and Freeman [7] discussed how volatility in the global economy, such as rising raw material prices or shifts in consumer demand, exacerbates the challenges supply chains face in maintaining performance. The impact of economic risks is further illustrated by Kamalahmadi et al. [35], who found that firms with flexible supply chain networks and diversified supplier bases were better equipped to mitigate the impact of economic disruptions, which leads to improved SCP. These previous studies have shown that economic sustainability is an important factor which is leading to improve the SCP of the companies.

The other SUR dimension is the social risk (SR) which is consisted of various factors like labor disputes, unethical practices that could minimize the corporate reputation or operational efficiency in supply chain process [36]. The SR is closely related to the human rights, labor conditions, and various ethical sourcing practices [14]. These risks can result in consumer backlash, legal action, or regulatory scrutiny. As supply chains increasingly extend across global networks, the responsibility to uphold ethical standards in the supply chain becomes crucial for a firm's sustainability [68]. Social sustainability involves safeguarding workers' rights, promoting safe and equitable working conditions, and nurturing strong ties with local communities [65]. Firms that integrate SR management into their supply chain strategy tend to strengthen their long-term competitive advantage through proper handling compliance with social regulations and promoting ethical business practices [57]. SR is also particularly significant in industries such as apparel, electronics, and food, where supply chains often span multiple countries with varying labor standards [36]. Chaudhuri et al. [16] also support the view that social risks undermine the efficiency and performance of supply chains. They found that companies addressing social sustainability issues, such as improving labor conditions and enhancing transparency, experienced fewer disruptions and were able to maintain steady SCP. Furthermore, Fritz [25] shows that ethical sourcing and supplier engagement can reduce social risks and improve overall supply chain resilience by promoting positive relationships with suppliers and stakeholders, which, in turn, enhances long-term performance.

Environmental risk (EnvR) involves various potential risks that negatively affect climate change, natural disasters, resource depletion, and pollution on supply chain operations [56]. Environmental sustainability is an important consideration for firms, as environmental risks can disrupt production,

logistics, and the availability of raw materials [34]. These risks also include regulatory changes related to environmental protection, such as stricter emissions standards or waste management policies [45]. Companies are increasingly adopting green logistics, sustainable sourcing, and resource-efficient manufacturing practices to mitigate environmental risks. The ability to manage environmental risks not only reduces disruptions but also enhances a company's reputation by aligning with consumer demand for environmentally responsible products [34]. Furthermore, ER improves SCP by reducing waste, enhancing resource efficiency, and contributing to the protection of natural resources, which are vital for long-term operational success [36]. Batra [8] empirically examined how environmental factors like extreme weather events and resource scarcity negatively affect supply chains, especially in those industries which are totally reliance on the natural resources such as agriculture, manufacturing, and energy. Rani et al. [54] also emphasized that EnvR those which are related to climate change require companies to adopt more proactive sustainability practices, such as risk assessments, resource-efficient technologies, and diversified sourcing strategies, to mitigate their impact. They also found that such environmentally sustainable practices increase the company's SCP. Another study confirmed that implementing EnvR significantly enhances SCP [56]. They suggested that additional studies in other developing countries could provide valuable insights to enhance SCP. In keeping view previous discussion, following direct hypothesis are depicted below,

**H1:** Economic risk has significant influence on Supply chain performance.

**H2:** Social risk has significant influence on Supply chain performance.

**H3:** Environmental risk has significant influence on Supply chain performance.

## *2.2 Moderating Role of Supply Chain Management*

The association between SUR (SUR) and RM (RM) is not clear, which highlights that there is a need for a relationship in another context. Supply chain management (SCM) as a moderating variable between SUR and RM could be used that is suggested by [2]. SCM with different strategies, namely diversification, collaborative relationships, and flexible production, can significantly reduce the negative influence of SUR on the SCP [40] through handling risks. If the companies is relying those environment factors good which are not complaint then it could may face legal actions, consumer boycotts, or even blacklisting by investors due to unethical practices or environmental harm. Al-Shboul [2] also highlighted that SUR are now among the most complex challenges in global supply chains, particularly due to the interconnected nature of global networks and the increasing demand for transparency and accountability. As governments tighten environmental and social regulations and consumers grow more conscious of ethical sourcing, failure to mitigate these risks can lead to significant financial losses and could also decrease the companies' SCP [73].

Other researchers also highlighted that strong SCM also significantly improves the strong relationship along with their suppliers, which could help to mitigate the economic risks of market fluctuations by ensuring that they have multiple sources of supply [43]. Another study also highlighted that incorporating sustainable practices in the SCM, companies could improve their resilience against social and environmental risks [44]. Another study of Ngo et al. [45] highlighted that SCM practices increase the risk management of companies, which leads to improved SCP. Furthermore, SCM practices emphasize that companies to adopt those factors which increase the culture of sustainability in the organizations to lead the SCP. The SCM as a moderating variable has been tested in various studies, which also strengthens the acceptability of SCM as a moderating variable for the current study [17]. Therefore, this study has used the SCM as a moderating variable. Following hypothesis are depicted below,

**H4:** Economic risk has a significant influence on risk mitigation strategies with moderating effect

of Supply chain management.

**H5:** Social risk has a significant influence on risk mitigation strategies with moderating effect of Supply chain management.

**H6:** Environmental risk influence significantly on risk mitigation strategies with moderating effect of Supply chain management.

### *2.3 Mediating role of risk mitigation strategies*

Prior literature highlighted that SUR factors and the SCP relationship could be explored clearly when there is a third variable that could work as a bridge [45]. Therefore, this study added RM as a mediating variable between SUR and SCP. It has been discussed that when the companies managed their RM strategies then it leads to improve the SCP Raheel Shah et al. [52], because RM strategies helps to serve a critical mechanism which links to the SUR practices with the performance outcomes by reducing exposure to environmental, regulatory, and social threats. Other researchers also highlighted that implementing RM can buffer the direct impact of SUR on SCP [3]. It is also emphasized that companies who are strong in their sustainability then companies could reduce the impact of SUR such as price fluctuations and supply shortages. In the same vein, the companies are effectively using the sustainable strategies then it could improve the RM strategies to improve the SCP [75]. Can Saglam et al. [13] found that firms that implemented effective RM strategies, such as diversification and flexible supply chain design, were better able to manage the negative effects of risks on SCP. Similarly, Um and Han [67] demonstrated that RM strategies not only reduce the severity of risks but also improve the overall efficiency and resilience of supply chains which leads to improve SCP. These previous studies emphasize that RM is an important mediating variable between SUR and SCP, and following hypothesis formulated below,

**H7:** Risk mitigation strategies significantly improves the Supply chain performance.

**H8:** Economic risk has significant influence on Supply chain performance with mediating effect of Risk mitigation strategies.

**H9:** Social risk has significant influence on Supply chain performance with the mediating effect of Risk mitigation strategies.

**H10:** Environmental risk has a significant influence on Supply chain performance with the mediating effect of Risk mitigation strategies.

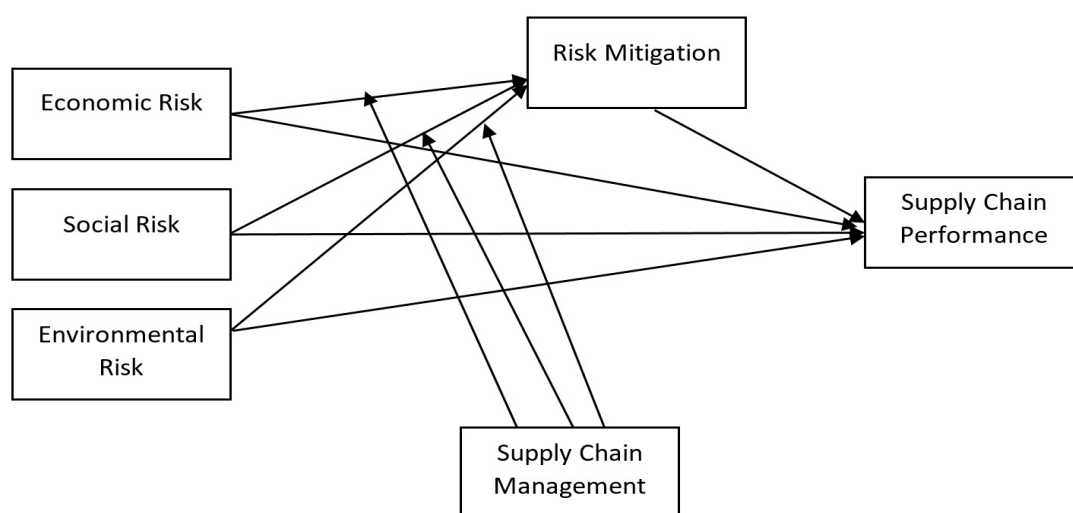
## **3. Research Methodology**

The research investigated the influence of SUR on the SCP of food companies. The mediating role of RM and the moderating role of SCM were also tested. Researchers employed the quantitative research approach. Quantitative research provides clear, measurable data, enabling statistical analysis for objective conclusions. It enhances reliability through structured methods and large sample sizes [21]. In the literature, cross-sectional and longitudinal research design approaches are used. Cross-sectional research design applied where data collected in one time frame [41]. Meanwhile, longitudinal design tracks data over a longer period, allowing researchers to observe changes and trends over time [5]. Cross-sectional research design provides quick, cost-effective insights into relationships between variables collected data in one time through a self-administered questionnaire [37]. Therefore, researchers employed the cross-sectional research design.

### *3.1 Research Instrument Development*

The survey instrument was adopted from prior studies. Sustainable risks were comprised from three dimensions, namely economic risks, social risks and environmental risks. From these

dimensions economic risks, which is conceptualized under supply risk and it was measured by 8 items of [45]. The strength of supply risk under the dimension of economic risk lies in its potential to disrupt production, increase costs, and destabilize market competitiveness due to price volatility, scarcity, or geopolitical factors [45]. Furthermore, social risk was composed of 12 items [45]. Furthermore, environmental risk comprises 6 items [45]. Supply chain performance comprises from 10 items [51]. The study evaluated supply chain management based on three aspects of adaptive capabilities: managing risks, reconfiguring resources, and maintaining flexibility. Among these dimensions, risk management measured from 4 items, resources configuration comprises from 4 items, and supply chain flexibility is measured from 3 items, SCM items taken from [47]. The researchers proposed that adaptive supply chain management is a more effective approach than traditional SCM, enabling companies to better navigate rapid changes and uncertainties by enhancing flexibility, responsiveness, and resilience. Lastly, risk mitigation strategies were comprised of 4 items [18]. Each of these items ranked on five-point Likert scale. The above-discussed variables are depicted in Figure 1 below.



**Fig.1.** Conceptual Framework

### 3.2 Population and Sampling Technique

The study population shown the individuals which shared the specific characteristics of the individuals for the research purpose [15]. A strong population selection ensures that the sample accurately represents the broader group, enhancing the study results validity. The population of the study is the employees of food sector. A strength of using employees from the food sector as the study population is their direct industry experience, which provides relevant and practical insights into sector-specific issues. From this population, 360 employees were selected to represent the whole population. The respondents were selected using a convenient sampling technique. Convenient sampling allows for quick, easy, and cost-effective data collection from readily accessible participants [27]. The questionnaire was distributed among 350 respondents, among those 290 were returned back, and from those 282 were valid analysis of current study. Data analysis SPSS and Smart PLS 4 software employing Partial Least Square (PLS)-Structural Equation modeling (SEM).

## 4. Data Analysis and Results

### 4.1 Demographic Profile

This segment in Table.1 shows participants profile which is highlighting the characteristics of the

282 respondents. The sample consisted of 60.3% male respondents and 39.7% female respondents. In terms of age, the largest group was aged between 26–35 years (42.6%), followed by 36–45 years (31.2%), with smaller proportions under 25 (12.4%) and above 45 (13.8%). Regarding work experience, most respondents had between 6–10 years (38.7%) or 1–5 years (36.2%) of experience, while 25.2% had over a decade of professional background. Educationally, the sample was well-qualified, with 46.1% holding a bachelor's degree, 43.3% having a master's degree, and 10.6% possessing a PhD or higher. This composition suggested that the sample comprises a relatively experienced and educated workforce that is suitable for evaluating perceptions related to supply chain risks and performance.

**Table 1**

Respondents characteristics

| Variable        | Categories         | N   | Percentage |
|-----------------|--------------------|-----|------------|
| Gender          | Male               | 170 | 60.3%      |
|                 | Female             | 112 | 39.7%      |
| Age             | Below 25           | 35  | 12.4%      |
|                 | 26–35              | 120 | 42.6%      |
|                 | 36–45              | 88  | 31.2%      |
|                 | Above 45           | 39  | 13.8%      |
|                 |                    |     |            |
| Experience      | 1 to 5 Years       | 102 | 36.2%      |
|                 | 6 to 10 Years      | 109 | 38.7%      |
|                 | More than 10 Years | 71  | 25.2%      |
| Education Level | Bachelor's         | 130 | 46.1%      |
|                 | Master's           | 122 | 43.3%      |
|                 | PhD or higher      | 30  | 10.6%      |

#### 4.2 Measurement Model

In the Smart PLS, the measurement model that also know the outer loadings evaluated the association among observed indicators and their underlying latent constructs to ensure reliability and validity [49]. Factor loadings are crucial, as they indicate how well each indicator represents its underlying construct. Typically, a loading of 0.70 or higher is considered acceptable, signifying strong reliability [32]. Cronbach's alpha measures internal consistency, with values greater than 0.70 typically indicating acceptable reliability [1]. However, composite reliability (CR) is often preferred in PLS-SEM due to its sensitivity to indicator loadings, with an ideal threshold of 0.70 or higher [32]. Additionally, average variance extracted (AVE) measures convergent validity where values recommended is greater than 0.5 [24]. If the study fulfills the above criteria's then it is considered that study fulfills the requirements of convergent validity.

**Table 2**

Reliability & Validity

|      | Alpha | CR    | (AVE  |
|------|-------|-------|-------|
| ER   | 0.948 | 0.956 | 0.709 |
| EnvR | 0.961 | 0.968 | 0.835 |
| RC   | 0.806 | 0.873 | 0.633 |
| RIM  | 0.807 | 0.846 | 0.583 |
| RM   | 0.741 | 0.849 | 0.652 |
| SCF  | 0.722 | 0.809 | 0.591 |
| SCP  | 0.974 | 0.977 | 0.809 |
| SR   | 0.983 | 0.982 | 0.821 |

**Note:** “economic risk-ER, social risk-SR, environmental risk-EnvR, Risk mitigation-RM, risk management-RIM, supply chain flexibility-SCF, supply chain performance-SCP”.



Above findings which are meeting the thresholds values shown in Table.2 and Figure 2.

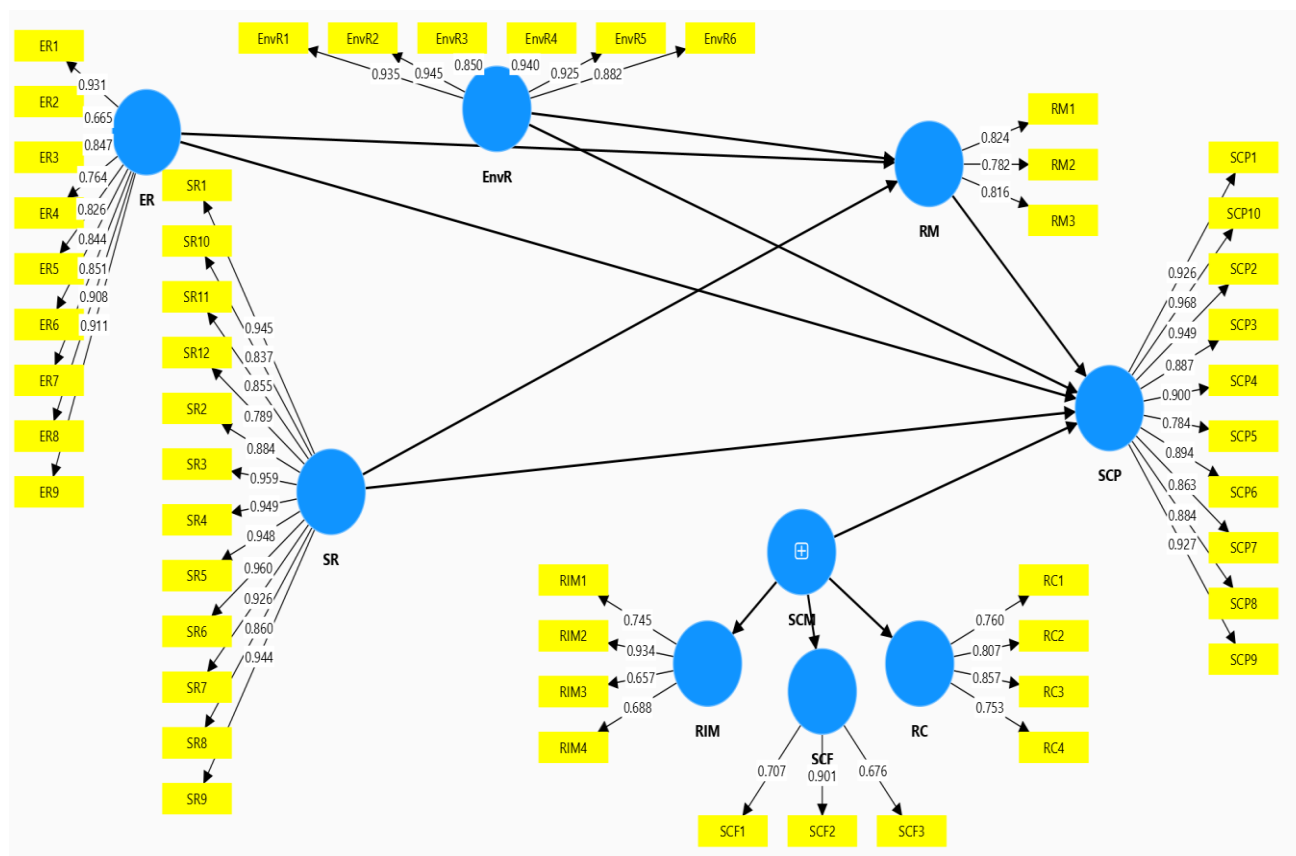


Fig.2. Factor Loadings

Besides, discriminant validity of the construct is assessed through Fornell and Larcker criteria. Fornell and Larcker's criteria show that diagonal values should be greater than from value below [24]. Table 3 results show that all above-diagonal values are greater than below values and it is highlighting discriminant validity,

Table 3

Discriminant Validity

|      | ER    | EnvR  | RC    | RIM   | RM    | SCF   | SCP   | SR    |
|------|-------|-------|-------|-------|-------|-------|-------|-------|
| ER   | 0.842 |       |       |       |       |       |       |       |
| EnvR | 0.494 | 0.914 |       |       |       |       |       |       |
| RC   | 0.334 | 0.016 | 0.795 |       |       |       |       |       |
| RIM  | 0.171 | 0.144 | 0.094 | 0.764 |       |       |       |       |
| RM   | 0.207 | 0.164 | 0.069 | 0.336 | 0.808 |       |       |       |
| SCF  | 0.421 | 0.322 | 0.627 | 0.166 | 0.476 | 0.768 |       |       |
| SCP  | 0.128 | 0.342 | 0.637 | 0.515 | 0.466 | 0.386 | 0.945 |       |
| SR   | 0.505 | 0.539 | 0.396 | 0.153 | 0.241 | 0.523 | 0.169 | 0.906 |

#### 4.3 Structural Model Results

The section in Table 4 shows the results of direct effect hypothesis results. The PLS-SEM results show that economic risk (ER) and supply chain performance (SCP) relationship is statistically significant. Similarly, social risk also shows a positive effect on SCP. Environmental risk (Envr) also positively significantly affects to SCP. Risk mitigation also has a positive significant impact on SCP. Direct effect results are presented in the Table.4 below,

**Table 4**

Direct Effects

| Path       | Original sample | T-Statistics | p-value |
|------------|-----------------|--------------|---------|
| ER → SCP   | 0.228           | 4.211        | <0.001  |
| SR → SCP   | 0.143           | 2.877        | 0.004   |
| EnvR → SCP | 0.167           | 3.354        | 0.001   |
| RM → SCP   | 0.341           | 6.567        | <0.001  |

Table 5 shows moderation results. The results shown a significant positive interaction between ER and RM. Further results have shown that the interaction of SR and SCM positively significantly influences the RM. Similarly, further results show a significant interaction between EnvR and RM. These findings emphasize significance role SCM in RM and improving SCP through improve sustainability factors.

**Table 5**

Moderation Effects

| Interaction Path | Original Sample | T-Statistics | P-value |
|------------------|-----------------|--------------|---------|
| ER × SCM → RM    | 0.120           | 2.201        | 0.028   |
| SR × SCM → RM    | 0.135           | 2.589        | 0.010   |
| EnvR × SCM → RM  | 0.111           | 2.067        | 0.039   |

Table 6 depicts results highlighting the results of mediating, where the results show that ER influences SCP through RM, which indicates a significant partial mediation effect. Similarly, further results also demonstrate that SR positively significantly affects SCP through RM, which also suggests partial mediation. Lastly, further results highlight that EnvR influences SCP through RM, which indicates a partial mediation effect as well. These results emphasize the crucial role of RM strategies in improving SCP by addressing economic, social, and environmental risks in the food industry.

**Table 6**

Mediating effect

| Mediation Path  | Indirect Original Sample | T-Statistics | P-Value | Mediation Type |
|-----------------|--------------------------|--------------|---------|----------------|
| ER → RM → SCP   | 0.132                    | 3.890        | <0.001  | Partial        |
| SR → RM → SCP   | 0.106                    | 3.211        | 0.001   | Partial        |
| EnvR → RM → SCP | 0.114                    | 3.444        | 0.001   | Partial        |

#### 4.4 Model Fitness

This section shown the results of model fitness. The model fitness results shows the dependent variable R square is 0.612 which indicates that 61.2% of the variation in SCP can be explained by the model, while the Q<sup>2</sup> of 0.411 signifies an acceptable level of predictive relevance. Similarly, for RM, the R<sup>2</sup> value of 0.466 shows that 46.6% of its variation is explained by the model, and its Q<sup>2</sup> of 0.328 indicates decent predictive power. Therefore, the model fit is considered acceptable, as indicated by the SRMR value of 0.058, which is below the threshold of 0.08 [32]. Overall, the model demonstrates satisfactory explanatory power and predictive relevance, with notable effects on both SCP and RM. The above discussed results are depicted in Table 7.

**Table 7**

Model Fitness

| Dependent Variable | R <sup>2</sup> | Q <sup>2</sup> |
|--------------------|----------------|----------------|
| SCP                | 0.612          | 0.411          |
| RM                 | 0.466          | 0.328          |

Model Fit (SRMR): 0.058 — acceptable (threshold < 0.08)

## 5. Discussion

This research aimed to examine the impact of sustainable risks (SUR) on supply chain performance (SCP) in the food industry. Additionally, it explored the mediating role of risk mitigation (RM) and the moderating role of supply chain management (SCM). The study's results offer valuable insights for food companies seeking to enhance their supply chain resilience and performance in a rapidly changing market. Both of direct and indirect effect results were tested. First, the direct effect analysis revealed that economics risk (ER) positively influences SCP in the food industry. This relationship shows that food companies face significant challenges arising from economic uncertainties such as market fluctuations, price volatility, and financial crises, which might effects to SCP. The result is relevant with a previous study where they highlighted that ERs, particularly in the global market can disrupt food supply chains, especially in areas involving perishability and commodity price dependence. Yang and Wang [72] same results with significant impact of ER on SCP. Therefore, to mitigate the ERs, food companies could diversify their suppliers and adopt hedging strategies to protect themselves from market instability [22]. Furthermore, financial planning and scenario forecasting are essential in adapting to unexpected economic downturns. Therefore, the findings emphasize the importance of food companies taking practical actions to enhance enterprise resilience, thereby maintaining supply chain stability and ensuring sustained performance.

Furthermore, it has also highlighted the significant role of SR for SCP of food companies. This results is highlighting the significance of addressing social factors such as labor conditions, consumer health concerns, and ethical sourcing to improve SCP. SRs in the food industry can include issues such as supply chain transparency, labor strikes, and changes in consumer preferences related to sustainability [48]. Companies that don't effectively manage these risks expose themselves to operational setbacks, damage to their reputation, and potential loss of customer confidence. This finding is consistent with study of Zhou et al. [74], who argue that embracing social responsibilities, including fair labor standards and responsible sourcing, can foster customer loyalty and fortify a brand's reputation. These findings supporting that food companies should focus on SR management because it could help to improve their SCP by embedding social responsibility into their supply chain strategies, including adopting fair trade policies, ensuring worker safety, and aligning production with consumers' growing ethical expectations. By doing so, they can also mitigate SRs that could increase the competitiveness in the international market.

The study results further highlighted significant role of EnvR on SCP. These findings highlighting that food companies are properly managing their EnvR, which is leading to improve their SCP. The result supported with the following study Raheel Shah et al. [52] increase significant influence of EnvR on SCP. Historically, various EnvR like climate change, resource scarcity, and stricter environmental regulations are increasingly critical for companies [71]. This risk can severely affect food production and lead to shortages, price volatility, or delays in supply chains. This argument is supported with Davis et al. [19] who emphasizes the vulnerability of food supply chains to EnvR, particularly in agriculture. To manage these risks, this study results highlighting that companies should focus on sustainable sourcing practices, reducing carbon footprints, and investing in eco-friendly production technologies. Implementing sustainable practices will not only reduces the impact of EnvR but also enhances supply chain resilience by creating more flexible, sustainable systems. Companies that embrace environmentally responsible practices can not only mitigate these risks but also appeal to consumers increasingly concerned about the ecological footprint of their purchases that could enhance the performance of company and long-term competitive advantage.

Further results also highlight significant role of RM strategies on the SCP of food industry. This

result emphasizes the crucial role of RM in enhancing SCP. In the literature, it has been found that companies should building contingency plans, diversifying suppliers, and using technology for risk monitoring which is significant for global supply chains [42]. This result supports the findings of previous study by Tukamuhabwa [66], which stress that RM practices are integral to achieving supply chain resilience. They also suggested that companies that prioritize risk management strategies are more resilient to challenges and can maintain efficient, adaptable supply chains that respond effectively to shifting market conditions. As food supply chains are particularly susceptible to disruptions, therefore companies must take a proactive approach to identify, assess because RM strategies help companies navigate various disruptions whether economic, social, or environmental without significantly impacting performance. When the food companies RM strategies system is improved then it could also be increase the competitive advantage of the food companies.

The findings further highlight the mediating effect of RM in the relationship between various sustainable risks and SCP. The results revealed that RM partially mediates these relationships, which indicates that RM are key in translating risk exposure into improved supply chain performance. This emphasizes how crucial RM is as a tool for improving supply chain resilience. These findings shown that when the risk factor are effectively managed through the RM strategies then they have a reduced negative impact on SCP. This finding aligns with earlier research, such as Waqas et al. [69], which indicated that companies that proactively manage sustainable risks through RM strategies, such as supplier diversification or financial hedging, are better able to maintain performance despite market volatility. This association could not be directly substantiated by the same study because the mediating effect of RM techniques was investigated for the first time. In this regards, in various study RM strategies used a mediating variable and found the partial mediation, which strengthen the mediation of RM strategy for the current study. These findings highlight that food companies should have sustainable risk factor to imply RM strategies. For this purpose, companies could include building strong relationships with suppliers to ensure consistency, developing alternative sourcing plans, and investing in financial risk management tools. This allows companies to respond flexibly to price fluctuations or market downturns, ensuring stable supply chains and reducing the impact of ERs on SCP.

The study outcomes further highlighted the positive significant moderating effect of SCM on the relationship between sustainable risks and SCP of food industry. The SCM as a moderating variable has been tested in various studies, which also strengthens the acceptability of SCM as a moderating variable for the current study [17]. These results showed that SCM practices such as supplier relationship management, demand forecasting, and logistics optimization significantly moderate the relationship between economic, social, and EnvRs and RM. The interaction of SCM also revealed that effective SCM practices can help to improve RM strategies in the face of economic uncertainties. Traditionally, it has been found that when the companies focused on the SCM practices through supplier collaboration, demand forecasting, and risk monitoring allow companies to anticipate and respond to economic disruptions more effectively which leads to improve the SCP. This argument is further supported with the view of Gružas and Burinskienė [30] who highlighted that companies with strong SCM capabilities are better able to withstand market volatility. Therefore, in the food industry, implementing SCM practices such as ethical sourcing and supplier audits can ensure that sustainable risks are adequately addressed, ultimately leading to better SCP.

## **6. Implications**

The study contributed in various ways. Firstly, stud results contributed a growing body of literature through confirming that ER, SR, and EnvR significantly influence SCP in the food industry.

This reinforces and extends the sustainable SCM framework especially for food sector, which remains underexplored in emerging markets. Extant studies have discussed the broad role of sustainable risks, but this study specifically validates their direct impact on SCP, highlighting the importance of managing them holistically. Thus, the study advances theoretical understanding by empirically validating that sustainable risk dimensions are not only relevant but also strategically significant for performance outcomes. Secondly, research results contributed to theory by identifying RM as a mediating mechanism that explains how sustainable risks are translated into improved performance. While RM has often been discussed as a managerial practice, this study provides theoretical grounding for RM as a construct that partially mediates the relationship between risks and performance, suggesting that its presence is critical for achieving resilience. This is a novel contribution as prior studies have not formally tested RM as a mediator in this context. By positioning RM at the center of this framework, the study opens pathways for further academic inquiry into how risk-handling strategies operationalize sustainability within supply chains. Lastly, research contributed SCM as a moderating variable which is strengthening the relationship between sustainable risks and RM. This shows SCM capabilities significance particularly in turbulent environments. The integration of SCM as a moderator offers a strong perspective to resource-based and dynamic capability theories, suggesting that firms with mature SCM systems can extract more value from RM efforts. This theoretical insight is particularly important for industries characterized by volatility and complexity, such as the food sector.

The study also has some practical implications. Firstly, study results are clearly contributing to offering clear guidance for the practitioners of the food industry which his highlighting that managing sustainable risk is essential for improving SCP. Managers should not view these risks in isolation but as interconnected elements that influence operational outcomes. For instance, addressing labor issues or resource shortages not only mitigates risk but also strengthens consumer trust and regulatory compliance. Therefore, practitioners should adopt comprehensive risk assessment tools and integrate sustainability into every tier of their supply chain decision-making process. Secondly, study results also contributed to practices. Through illustrating the central role of RM strategies in converting risk exposure into improved performance. Food companies must proactively build strong RM systems to safeguard their operations. This suggests that rather than reacting to crises, firms should establish preemptive risk management policies tailored to the specific characteristics of sustainable risks. Practically, this includes deploying digital tools for real-time risk tracking and ensuring supplier contracts include clauses that account for social and environmental responsibilities. Thirdly, study results also contributed to helping the policy makers and industry stakeholders in encouraging companies to integrate sustainability and risk management into national food supply strategies. They can also use study findings as evidence to promote policies that require or incentivize environmental compliance, social responsibility, and financial risk disclosure within food industry supply chains. Study findings could also help maintain public-private partnerships through providing training, funding, or technological support for SMEs aiming to implement sustainable risk and SCM. These institutional efforts will raise a more resilient and competitive national food system.

## **7. Conclusion and Future Directions**

The research tested the impact of SUR on SCP with the mediating effect of RM in food companies. The study also tested the moderating influence of SCM. Smart PLS used for inferential statistics, and SPSS is used for demographics. The study results show that ER, SR, and EnvR have a significant influence on SCP. Further mediating effect results also show that RM partially mediates among all sustainability risk factors and SCP. SCM also significantly moderates between sustainable

risk factors and RM strategies. These study results showed that sustainable risk factors contributed to increasing the SCP when they are properly managed. The study results also contributed a significant role in RM as a bridge to improve the SCP. The research also found strengthening moderating effect of SCM in strengthening the relationship between sustainability risks and mitigation efforts. These insights provide valuable guidance for food companies aiming to build resilient and sustainable SCP. The study with significant contributions still has some limitations. The study conducted on food industry, ignoring to the sectors like the textile or service sector. Therefore, future research could be conducted on another sector to increase the research reliability. In other words, study also conducted on cross cross-sectional research design. Future studies could examine longitudinal research design as a means of addressing this limitation.

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