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Article

# Climate Change Risk Management Strategies: The Case of Small and Medium Scale Enterprises in Southwest Nigeria

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**Abstract** The study determined the critical variables inducing the choice of mitigation and adaptation methods adopted by the Small and Medium Scale Enterprises (SMEs) against the effect of climate change on their enterprises in Southwest Nigeria. A multistage sampling procedure was employed to choose 200 SMEs Managers/Chief Executive Officers (100 mitigating climate change and 100 not mitigating) as respondents for the study. Descriptive statistics and a multinomial regression model were employed to investigate the data collected. The findings show that the mean age of Managers/CEOs mitigating climate change was 41.8 years, and the level of education of climate change mitigating Managers/CEOs (80.0%) was significantly different from the non-mitigating (50.0%). The net profit margin ratio for the mitigating SMEs was 32.04%, and 17.83% for the non-mitigating SMEs. The multinomial logit model showed that income, enterprise experience, access to credit, enterprise size, and enterprise type significantly induced the choice of climate change mitigation approaches used by the SMEs in the study area. The study suggested that government and Non-Governmental Organizations (NGOs) should assist SMEs by enhancing their income-generating ability to ameliorate the impact of climate alteration over the years on their enterprises.

**Keywords** climate change; small and medium enterprises (SMEs); climate change risk management strategies; multinomial logit model; Southwest Nigeria

## 1. Introduction

According to the Bank of Industry (BoI), Nigeria [1], small and medium enterprises (SMEs) are majorly distinct as businesses with no revenue exceeding 100 million Naira (\$224,099.68) per annum or less than 200 employees. Empirical evidence by the BoI revealed that almost 96% of Nigerian firms fall within the category of SMEs, as against 53% in the US and 65% in Europe. About 90% of Nigerian manufacturing firms fall within the category of SMEs with respect to the number of enterprises in Nigeria and most developing countries. In Nigeria and other emerging countries, such firms' input to the Gross Domestic Product (GDP) is between 3% and 5%, as against 40% and 50% in developed countries [1]. Therefore, there is an urgent need to take action to guide against the impact of climate alteration over the years on SMEs' productivity and profitability by considering sustainable mitigating and adaptation strategies that will guide against the loss of jobs and a decrease in the GDP.

Likewise, one of the mechanisms that could foster GDP growth in Nigeria is the growth of SMEs within the context of an increase in the productivity and profitability of SMEs. The growth of SMEs is known to be a critical development strategy that positively impacts the national, regional, and local economies of any nation. It improves the citizens' welfare through job and wealth creation. It enhances the quality of life of the citizens [2]. The role of SME development and economic diversification of most developed countries is in quantum, and developing countries can take a clue from such an example [1].

In most cases, in advanced countries, SMEs are responsible for providing jobs for more than 90% of the citizens working outside the administrative and executive sectors of the economy.

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## Highlights of Science

This scenario, in most cases, keeps the unemployment figure very low and helps generate domestic and export income that helps boost the economy [3]. The authors [4] opined that the growth and development of SMEs are critical to the economic development of any nation. Given this, the World Bank's assessment of small firms' activities attested to the commitment of the international organization to the expansion and development of the SMEs sector as a key component in its approach to ensure economic growth, job creation, and enhance the welfare of the citizens of emerging countries of the world.

Climate change denotes an alteration in a climate that can be ascribed directly or indirectly to human actions that change the atmospheric configuration of the earth, which primes to global warming. This alteration can impact the ecosystem as a whole, which naturally impacts negatively on human systems and often threatens human growth and the social and economic development of a nation as a whole [5]. In most cases, SMEs are also impacted negatively by the negative impact of climate alteration over the years, and this has become a global phenomenon. Much empirical evidence attested to climate alteration over the years, creating many problems in developing countries. Baglee et al. confirmed that SMEs lost US\$15bn in Russia due to the devastation of crops such as wheat caused by drought and wildfires [6]. Furthermore, in 2016, climate change induced the destruction of many crop products in the United States agribusiness sector. This development increased the price of food crops and the scarcity of raw materials for producing many agricultural-based products [7].

Therefore, there is a critical need for the government at all levels to pay attention to SMEs since they have the largest share of employment, contribute to GDP growth, and can create more jobs in Nigeria. Hence, this paper assessed the climate change phenomena that affect the operation of SMEs, the methods employed by SMEs to ameliorate the impact of climate alteration over the years on their business enterprises, the profitability of the SMEs and the factors that induce the choice of methods employed by the SMEs were also determined. The study will enhance the preparation of well-organized and implementable guidelines that will assist SMEs and guide the government at all levels to take sustainable action that will help alleviate the impact of climate alteration over the years on the smooth operation of SMEs and enhance their profitability and productivity. This will enhance their sustainability with respect to their contribution to the national GDP and job creation in Nigeria and other developing countries.

The rest of the paper is organized as follows. The literature review is in Section 2, and the conceptual framework of the study is given in Section 3. The materials and methods are broached in Section 4. The results are presented in Section 5. An elaborate discussion of the results is provided in Section 6, and the conclusion and policy implications are given in Section 7.

## 2. Literature Review and Conceptual Framework of the Study

Skouloudis et al. examine flooding experience, features, and how the micro-, small- and medium-sized enterprises (MSMEs) respond to this critical climate change phenomenon in Greece [8]. The study also considered the resilience ability and strategies used in building resilience. The study leveraged quantitative analysis based on relevant literature on how such MSMEs can withstand, adapt or mitigate the impact of flooding in Greece. Eighty-two MSME's managers and Chief Executive Officers (CEOs) who had recently experienced flood were sampled for the study. The findings revealed that most of the CEOs of the MSME's are not properly preparing their firm to mitigate the impacts of flooding on their organization. Again, likewise, flooding is the commonest and most damaging climate change phenomenon affecting over 250 million people all over the world, including SMEs. Flooding is the most common, widespread, and destructive natural peril, leading to colossal damage to assets and loss of huge capital [9].

Hillmann et al. study on the benefits of building organizational resilience using climate change as a case using multiple regression analysis to study the relationship between resilience capabilities and different measures of financial performance [10]. The study reveals that building organizational resilience is beneficial as it enables an organization to mitigate the contests of climate change and positively impacts the organization's finance. The negative impact of climate alteration over the years on SMEs globally is constructed by organizational structure and economic changes [5]. This explains why it is imperative to study the negative impact of climate alteration in Nigeria and other developing countries over the years on SMEs by identifying the adaptive capacity and mechanism used by the SMEs based on their internal structure. The common climatic phenomena must be analyzed to ensure that the SMEs adopt the right mitigation

and adaptive approach. Hence, both inherent and external factors must be considered to potentially counteract the negative impacts of environmental shocks. For example, an SME with a strong internal management system and recording high profit can better cope with climate shocks comparatively. All these are the literature gap that this study intends to consider.

Furthermore, in the Intergovernmental Panel on Climate Change (IPCC) framework, individuals and businesses (SMEs) are exposed to climate change effects with an external dimension. At the same time, both the individual and businesses have sensitivity and adaptive capacity that are internal in dimension. Therefore, diverse socio-economic and climate change phenomena settings are considered for analyzing SMEs and climate change risk management strategies in this study. According to [11], business sectors and their income are impacted negatively by climate unpredictability and alteration over the years. The income of SMEs has been threatened because of climate alteration over the years, particularly in most emerging countries, where there is limited research on how to adjust and ameliorate the impact of climate alteration over the years [12]. Therefore, the climate alteration variables considered in the Climate Change and Business Organization (CCBO) framework negatively impact the organizational structure and performance. It equally affects the organization, infrastructure, economic assets, and human resources and negatively impacts the health of the organization's staff. All these culminate in to decrease in organizational productivity and profitability in both the short and long run [13]. Furthermore, in most cases, it leads to a shortage of raw materials used in the production process and often increases the cost of production [14].

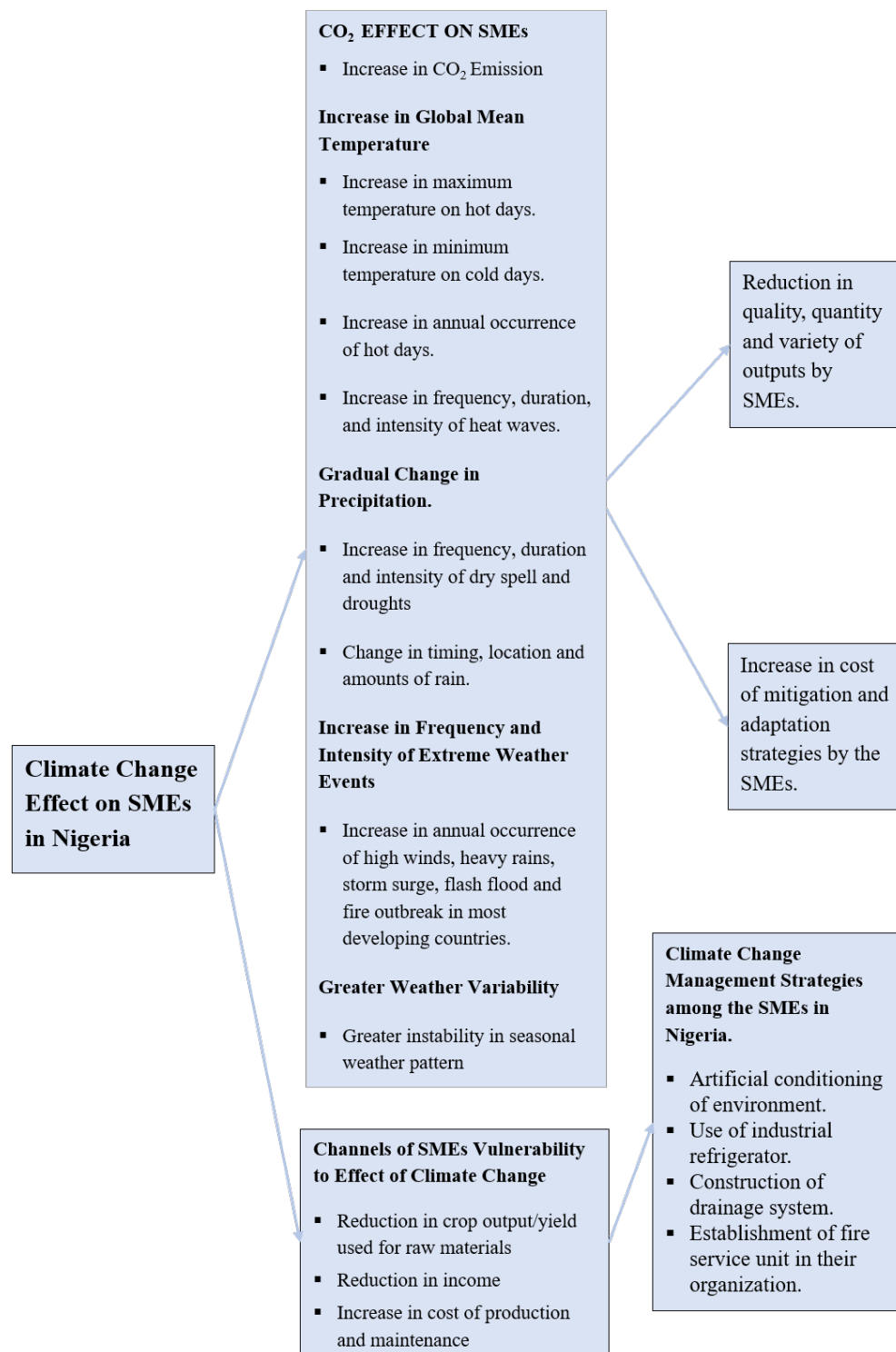
In addition, climate alteration over the years often leads to alteration in the average levels of key climate elements such as rainfall, temperature, sunlight, and humidity, which often induces weather shocks [13,15]. The diagrammatic method for changes in the weather elements is in Figure 1. Firstly, environmental changes lead to reduced agricultural outputs/yield used as raw materials for production by SMEs. Secondly, it reduces SMEs' income, and thirdly, it leads to an increase in the cost of production and maintenance of infrastructure in some cases. Due to economic shock that is often associated with climate alteration in most cases. SMEs reorganize their available resources to enable them to ameliorate the negative influence of climate alteration over the years on their enterprise. Therefore, this may likely impact the SMEs by reducing the quantity and quality of varieties of output by the SMEs and increasing in cost of production as a result of an increase in the cost of mitigation and adaptation strategies of SMEs to climate change.

Secondly, the production-related impact may also be probable if the raw materials cost, transportation cost of the raw materials, and other production costs are directly or indirectly affected by climate alteration events like drought and flood. Hence, production resources are downsized [16]. Therefore, there is a high tendency to reduce in quantity, quality, and variety of output by the SMEs. This account for the reason why the prices of some products are very high during the rainy or dry season in most developing countries. The production cost of such commodities continuously varies with seasons (rainy or dry season) [17]. This negative direct impact on production costs is noteworthy. It can be observed as a reason for the poor financial performance of most SMEs in developing countries.

Thus, climate change amelioration methods have become imperative for SMEs to mitigate the impact of the climate change shock on their businesses. SMEs use various adaptive measures to curtail the negative influence of climate change shocks on their production activities in different parts of the world [18]. In some tropical regions of Sub-Sahara Africa (SSA) like Nigeria, such mitigation and adaptive strategies include artificial environmental conditioning, industrial refrigerators, construction of drainage systems, and establishment of fire service units in their organization [19]. Artificial environmental conditioning and industrial refrigerators help to cool the production environment. This development will ensure the preservation of the raw materials, especially the agricultural produce and some other raw materials that need to be under a certain temperature. In tropical regions, the atmospheric temperature is primarily high, becoming unpredictable because of climate alteration over the years [20]. The increase in temperature is damaging to the preservation of agricultural outputs. Hence, most SMEs using agricultural outputs as raw materials ensure they are kept under a low atmospheric temperature to preserve them for production [21]. So, to achieve preservation, most SMEs make use of artificial conditioning of the environment or use industrial refrigerator.

Likewise, due to incessant fire outbreaks during the dry season in many developing countries due to increased atmospheric temperature, most SMEs usually incur additional costs to establish fire service units in their organization [22]. This will enable them to combat fire outbreaks easily.

It has been established that due to the unpredictability of rainfall because of climate change, flood is a common phenomenon in Sub-Sahara Africa (SSA) [23]. Hence, most SMEs' result is to construct drainages to prevent flood effects on their production environment. All the measures to alleviate the negative influence of climate change shock on SMEs impinge on the business income and invariably reduce the organization's profit.



**Figure 1.** The channels of (SMEs) vulnerability to climate change. Source: adapted from [11].

### 3. Materials and Methods

#### 3.1. Study Area, Source of Data, Sample Techniques, and Size

The study was carried out in Lagos and Oyo States, respectively. The two states were intentionally chosen for the study because they have the maximum SMEs record in Southwest Nigeria [7]. In the two states, there are 70 Local Government Areas (i.e., Lagos State has 37 and Oyo State has 33 Local Government Areas). The population of the two states is 204,435,005 (i.e., Lagos is 14,862,111 and Oyo is 5,580,894) (National Population Commission [24]). Primary information was employed for this study. The primary information was collected using a well-structured survey form. The information gathered through the survey form included the socio-economic features of the Manager/Chief Executive Officer (CEO) of the SMEs, the size of the SMEs, the perceived climatic events impacting their enterprise, the risk management approaches employed by the SMEs in mitigating the climate alteration over the years and the revenue of the SMEs.

A multistage sampling procedure was employed to choose the respondents. Firstly, there was an intentional choice of two states (Lagos and Oyo) since the two states have the maximum number of SMEs in Southwest Nigeria [7]. Lagos State has the highest number of SMEs, with a total of 8395 (11.5% of total SMEs in the country), trailed by Oyo State, 6131 (8.4% of total SMEs in the country). Secondly, two Local Government Areas (LGAs) in the capital of each state (Ikeja LGA and Eti-Osa LGA in Lagos State and Ibadan Southwest LGA and Ibadan Northwest LGA in Oyo State) were chosen for the study. Thirdly, a random selection of five communities in each of the LGAs was carried out. In each community, five SMEs Managers/Chief Executive Officers (CEOs) who mitigate the impact of climate change and five who are not mitigating the impact of climate change participated in the study from each community, making a total sample size of 100 SMEs Managers/Chief Executive Officers (CEOs) who mitigated the effect of climate change and 100 SMEs Managers/CEOs who did not mitigate the effect of climate change participated as respondents for the study. Data were collected through Google Forms and email. Hence, no physical contact was initiated in conformity with COVID-19 regulations in Nigeria and other parts of the world.

#### 3.2. Data Analysis

Descriptive statistics, including frequency distribution, mean, and percentages, were employed to describe the socio-economic characteristics of the SMEs' Managers/CEOs, climate alteration over the years, events that impacted negatively on SMEs within the last five years, and the approaches employed by the SMEs to ameliorate the impact of climate change on their business enterprises.

#### 3.3. Profitability Measurement

Net Income (NI), and Net Profit Margin Ratio (NPMR) assessment were carried out to determine the profitability of SMEs that mitigated the effect of climate change and non-mitigating climate change SMEs in the study area, as defined in Equations (1) and (2).

$$NI = TR - TC \quad (1)$$

$$NPMR = (Net\ Income \div Revenue) \times 100H \quad (2)$$

As employed by [25], the NPMR assessment was carried out to determine the impact of climate change on SMEs' profitability. NPMR was employed for the study since it clearly represents the firm's profitability. Hence, it is an accurate technique of comparing firm profitability by comparing all the variables, and it empirically enhances the possibility of comparing the financial achievement of two or more firms during a particular time, notwithstanding their sizes (i.e., large, medium, or small scale).

The Multinomial Logit Model (MLM) was employed to examine the variables that induced SMEs' choice of climate change risk management approaches. The SMEs' decision on the choice of climate change risk management approaches was considered under the general framework of utility or profit maximization. A linear random utility model was adopted. This linear random utility model is frequently used as a framework in ascertaining SMEs' decisions on the choice of climate change risk management approaches and is specified as Equation (3):



$$\Upsilon_{ij} + \beta'_j X_{ij} + \varepsilon_{ij} \tag{3}$$

where  $\Upsilon_{ij}$  is the utility of SMEs  $i$  derived from climate change risk management method  $j$ ,  $X_{ij}$  is a vector of variables that influence the choice of a particular climate change risk management method  $j$ , and  $\beta'_j$  is a set of parameters that show the negative influence of changes in  $X_{ij}$  on  $\Upsilon_{ij}$ . The disturbance terms  $\varepsilon_{ij}$  are presumed to be autonomously and identically distributed. If a particular climate change risk management approach  $j$  is chosen, then  $\Upsilon_{ij}$  is the maximum among all possible utilities defined in Equation (4).

$$\Upsilon_{ij} > \Upsilon_{ik}, k \neq j \tag{4}$$

If  $\Upsilon_i$  is a random variable that specifies the choice made. MNL form of the multiple choices problem is stated thus as Equation (5):

$$\text{Prob}(\Upsilon_{i=j}) = \frac{e^{\beta'_j x_j^i}}{\sum_{j=1}^j e^{\beta'_j x_j^i}}, j = 0, 1, 2 \dots j \tag{5}$$

Calculating Equation (5) offers a set of probabilities for the  $j + 1$  climate change risk management approach for SMEs managers/CEOs with characteristics denoted by  $X_{ij}$ . The equation can be normalized by presuming that  $\beta_0 = 0$ . So, the probabilities can be calculated as Equations (6) and (7):

$$\text{Prob}(\Upsilon_{i=j}) = \frac{e^{\beta'_j x_j^i}}{1 + \sum_{j=1}^j e^{\beta'_j x_j^i}} \tag{6}$$

$$\text{Prob}(\Upsilon_{i=0}) = \frac{1}{1 + \sum_{j=1}^j e^{\beta'_j x_j^i}} \tag{7}$$

Normalizing on any other probabilities gives the following log-odds ratio in Equation (8):

$$\ln \left[ \frac{p_{ij}}{p_{ik}} \right] = X'_i (\beta_k - \beta_j) \tag{8}$$

The dependent variable is the log of one alternative relative to the base/reference alternative. Unfortunately, the MNL model coefficients are difficult to interpret. Hence, the marginal effects of the explanatory variables on the choice of climate change risk management approaches are mostly derived as Equation (9), considering artificial conditioning of the environment, using the industrial refrigerator, construction of drainage system, and establishment of a fire service unit in their organization:

$$m_i \frac{dP_i}{dX_j} = P_j \left[ \beta_j - \sum_{k=0}^j P_k \beta_k \right] = P_j [\beta_j - \beta] \tag{9}$$

where  $\beta_0$  = Intercept or constant;  $\beta_j$  = Vector of parameter estimates;  $j = 1, 2, 3, 4$ .

With reference to a similar study by [13], the independent variables that were used are:

- $X_1$  = Age of the Managers/CEOs (Years);
- $X_2$  = Gender of the Managers/CEOs (1 = male, 0 = female);
- $X_3$  = Level of Education of the Managers/CEOs (Years);
- $X_4$  = SMEs Income (Naira);
- $X_5$  = Enterprise Experience (Years);
- $X_6$  = Access to Credit (Yes = 1, No = 0);
- $X_7$  = Enterprise Size (No. of Employees);
- $X_8$  = Marital Status of the Managers/CEOs (1 = Married, Single = 2, Widow = 3);
- $X_9$  = Enterprise Type (Sole proprietor = 1, Partnership = 2, Limited Liability = 3).

#### 4. Results

##### 4.1. Socio-economic Characteristics of the Respondents

Table 1 gives the variables list in the econometric analysis. Table 2 shows the result of the demography of the Managers/CEOs mitigating climate change and those not mitigating climate

change. In ascertaining the significance of the differences between the demography result of the Managers/CEOs mitigating climate change and those not mitigating, t-test statistics were used with respect to some household and enterprise-level characteristics. Therefore, those characteristics that were significant were reported. The mean age of Managers/CEOs mitigating climate change was 41.8 years, and those not mitigating were 59.6 years. The level of education of climate change mitigating Managers/CEOs (80.0%) was significantly different from the non-mitigating (50.0%). As shown in Table 2, 15.0 years was the mean enterprise experience of the climate change mitigating Managers/CEOs and 27.0 years for the non-mitigating. The climate change mitigating Managers/CEOs had 22 staff, and the non-mitigating had 29. Fifty-five percent of the climate change mitigating Managers/CEOs had access to credit, and 49% non-mitigating had access to credit.

**Table 1.** Variables list in the econometric analysis.

Variable	Description	Measurement
<b>Independent Variables</b>		
<i>Personal Characteristics</i>		
Gender	Sex of household head	(Male = 1, Female = 0)
Age	Age of respondents	Years
Level of Education	Education of respondents	Years
Marital Status	If the respondents are married or not	(1 = Married, Single = 2, Widow = 3)
Enterprise experience	How long have been managing SMEs	Years
<i>Institutional Variables</i>		
Access to credit	If had received informal credits	(Yes =1; No = 0)
Enterprise size	Number of employees in the SMEs	Number
Enterprise Type	If the SME is a Sole proprietor, Partnership, or Limited Liability	Sole proprietor = 1, Partnership = 2, Limited Liability = 3
SME Income.	SME annual turnover	Naira

Source: Author (2022).

**Table 2.** Respondents’ distribution by socio-economic characteristics.

Variable	Climate Change Mitigating SMEs		Climate Change Non-Mitigating SMEs		Difference
	Mean	Main Indicator	Mean	Main Indicator	
Age	41.8 years	90.0% falls below or equals 40 years (active)	59.6 years	51.0% falls below or equals 40 years (active)	-17.8 years **
Education Level		80.0% had tertiary education		50.0% had tertiary education	30.0% ***
Household Size (Number)	5 persons	90.0% had a household size between 1 and 5 persons as a family member	9 persons	40.0% had a household size between 1 and 5 persons as a family member	-4 persons
Marital Status		65.0% married		100% married	-35.0%
Enterprise Experience (Years)	15.0 years	52.0% have above ten years of experience	27.0 years	84.0% have above ten years of experience	-12.0 years *
Enterprise Size (Number of staff)	22	95.0% equal to or above two hectares	29	35.0% on equal to or above two hectares	-7.0 staff *
Access to Credit	55	60.0% had access to more than ₦5million (\$11,199.96) as loan from financial institutions.	49	55.0% had access to more than ₦5million (\$11,199.96) as loan from financial institutions.	6 **

\*10%, \*\*5%, and \*\*\*1% significance levels. Source: Field Survey, 2022.

#### 4.2. Estimation of Effects of Climate Change on the Profitability of SMEs

Table 3 shows the five-year average costs and return in Naira and dollars for climate change-mitigating and non-mitigating SMEs. The total variable costs for climate change mitigating SMEs and non-mitigating SMEs were ₦41,566,520(\$93,108.71) and ₦42,732,270 (\$95,719.98), respectively. For climate change-mitigating SMEs, the cost of raw materials was 38.12% of the total cost and was the highest variable cost. The salary and wages were 12.69% of the total cost, and the cost of mitigating climate change was 8.90% of the total cost. The total fixed cost for the mitigating SMEs was ₦5,264,940 (\$11,793.43), and ₦9,312,350 (\$20,859.60) for the non-mitigating SMEs. The total revenue, the total sales of SMEs for mitigating and non-mitigating SMEs,



was ₦68,910,600 (\$154,959.43), and ₦63,334,200 (\$141,931.74), respectively. The gross margin for mitigating SMEs was ₦27,344,080 (\$61,278.00), and for the non-mitigating SMEs was ₦20,601,930 (\$46,168.86). The net income of both mitigating SMEs and non-mitigating SMEs was estimated as ₦22,079,140 (\$49,479.28), and ₦11,289,580 (\$25,299.91) respectively. The net profit margin ratio for the mitigating SMEs was 32.04%, and 17.83% for the non-mitigating SMEs.

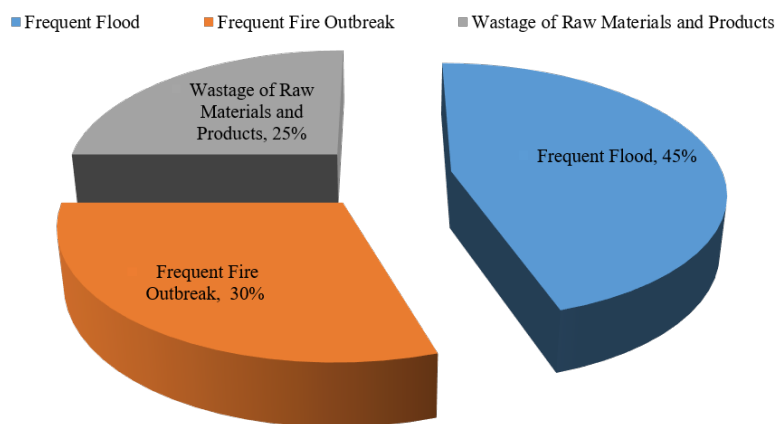
**Table 3.** Five years average annual cost and return analysis of SMEs in the study area.

Items	Climate Change Mitigating SMEs			Climate Change Non-Mitigating SMEs			Difference	
	Mean ₦ (000)	\$(000)	% of TC	Mean ₦ (000)	\$(000)	% of TC	₦ (000)	\$(000)
<b>Total Revenue (TR)</b>	<b>68,910.60</b>	<b>154.43</b>		<b>63,334.20</b>	<b>141.93</b>		<b>5576.4</b>	<b>(12.5) ***</b>
<b>Cost Variable</b>								
Raw materials	17,020.00	38.12	36.34	18,671.10	41.82	35.88	-1651.10	(-3.70) **
Salary & Wages	5664.71	12.69	12.10	6801.82	15.24	13.07	-1137.11	(-2.55) **
Mitigating Climate Change	3975.25	8.90	8.49	-	-	-		
Packaging	3864.71	8.66	8.25	4978.12	11.15	9.57	-1113.41	(-2.49)
Power	3111.76	6.97	6.64	3109.17	6.96	5.97	2.59	(0.01)
Advertisement	2250.00	5.04	4.80	2733.71	6.12	5.25	-483.71	(-1.08)
Communication	2184.62	4.89	4.66	2709.23	6.07	5.21	-524.61	(-1.18)
Transportation	1725.12	3.86	3.68	1954.45	4.38	3.76	-229.33	(-0.52) *
Tax and Levy	850.38	1.90	1.82	523.33	1.17	1.01	327.05	(0.73)
Stationery	418.85	0.94	0.89	818.56	1.84	1.57	-399.71	(-0.9)
Bank Charges	501.12	1.12	1.07	432.78	0.97	0.83	68.34	(0.15)
<b>TVC</b>	<b>41,566.52</b>	<b>93.10</b>	<b>88.74</b>	<b>42,732.27</b>	<b>95.72</b>	<b>82.11</b>		
<b>(A) Fixed Items</b>		5.53						
Depre. Cost of Building	2467.71	4.83	5.27	2891.10	6.48	5.56	-423.39	(-0.95) *
Depre. Cost of Equipment	2152.78		4.60	2811.25	6.30	5.40	-658.47	(-1.47) **
Depre. Cost of Furniture Fittings	644.45	1.44	1.39	798.75	1.79	1.53	-154.30	(-0.35)
<b>TFC</b>	<b>5264.94</b>	<b>11.79</b>	<b>11.26</b>	<b>9312.35</b>	<b>14.57</b>	<b>17.89</b>	<b>-4047.41</b>	<b>(-2.78) **</b>
<b>TC (A + B)</b>	<b>46,831.46</b>	<b>104.90</b>	<b>100</b>	<b>52,044.62</b>	<b>116.58</b>	<b>100</b>	<b>-5213.16</b>	<b>(-11.68) **</b>
<b>Gross Margin (TR – TVC)</b>	<b>27,344.08</b>	<b>61.28</b>		<b>20,601.93</b>	<b>46.17</b>		<b>6742.15</b>	<b>(15.11)</b>
<b>Net Income (TR – TC)</b>	<b>22,079.14</b>	<b>49.48</b>		<b>11,289.58</b>	<b>25.30</b>		<b>10,789.56</b>	<b>(24.18) ***</b>
<b>Net Profit Margin Ratio (NI/TR) × 100 =</b>	<b>32.04%</b>			<b>17.83%</b>			<b>14.21%</b>	

Source: Computed from Field Survey Data, 2022. Exchange rate: ₦446.43 = \$1; ₦ = Naira; \$ = USD; Depre= Depreciation  
\* 10%, \*\* 5%, and \*\*\* 1% significance levels

#### 4.3. Climate Change Phenomena Affecting SMEs and Mitigation and Adaptation Methods Employed SMEs

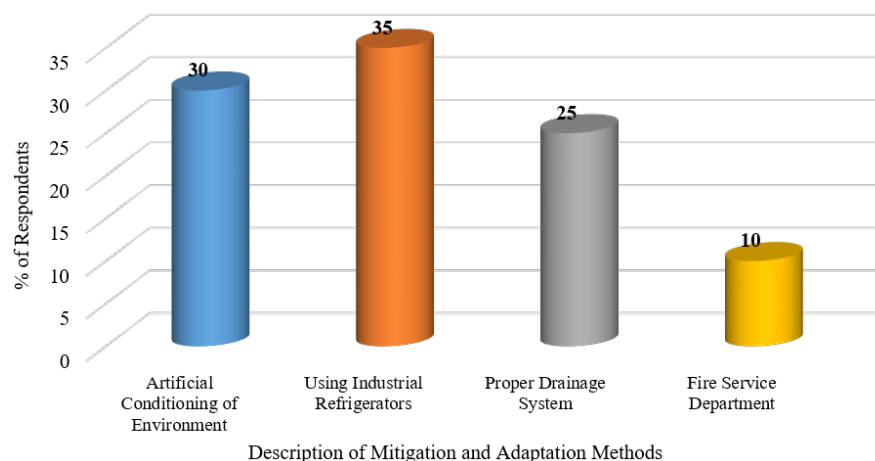
Figure 2 presents the climatic change phenomena impacting negatively on the climate change mitigating and non-mitigating SMEs within the last five years as agreed by the Managers/CEOs of the SMEs. About 45.0% of the respondents concurred that floods negatively impact their business organization due to the incessant and irregular rainy periods. Thirty percent opined that they were impacted negatively by incessant fire outbreaks because of prolonged dry seasons, and 25.0% said they were impacted negatively by the wastage of raw materials and products because of heat due to excessive rising temperatures during the harmattan period.



**Figure 2.** Climate change phenomena affecting SMEs within the last five years.

#### 4.4. Mitigation and Adaptation Methods Employed by SMEs

Figure 3 presents the approaches used by mitigating climate change Managers/CEOs to ameliorate the effect of climate change on various enterprises. As shown in the Figure, 30.0% of them used artificial conditioning of the environment, 35.0% ensured effective and efficient preservation of raw materials and final products using industrial refrigerators, 25.0% provided drainage systems, and 10.0% provided fire service units in their organization.



**Figure 3.** Description of mitigation and adaptation methods employed by mitigating SMEs.

#### 4.5. Multinomial Logit Analysis of the Factors Influencing Risk Management Methods Adopted by SMEs

The results of the MNL model in Table 4 show how the socio-economic characteristics of the climate change-mitigating SMEs Managers/CEOs influenced the mitigation and adaptation approaches used to ameliorate the impact of climate change on their enterprises. The mitigation and adaptation approaches in the MNL model choice set are: (a) Artificial conditioning of the environment; (b) Use of industrial refrigerators; (c) Provision of drainage system; and (d) Provision of fire service units which are the frequently used mitigation and adaptation methods by the SMEs to alleviate the impact of climate alteration over the years on their enterprises. The Table shows the results of the MNL Regression model. As shown by  $\chi^2$  statistics (302.89), the likelihood ratio statistic is significant at 1% significance, signifying that the model has strong explanatory power. In all cases, the calculated coefficients should be compared with the base category of the use of industrial refrigerators. The marginal effect of the multinomial logit model on factors inducing the choice of mitigation and adaptation methods by the respondents is also shown in the Table. This shows the effect of a unit change in the explanatory variables on the choice of mitigation and adaptation strategies with respect to the base category (Use of industrial refrigerators) in the study area. The use of industrial refrigerators as the based category was because it is the most used mitigation and adaptation method to ameliorate the impact of climate alteration over the years by the mitigating Managers/CEOs of SMEs, as shown in Figure 2.

**Table 4.** Estimated multinomial logit analysis of the factors inducing risk management methods employed by SMEs.

Explanatory Variables	Artificial Conditioning of the Environment		Provision of Drainage System		Provision of the Fire Service Department	
	Coeff.	Marginal Effect	Coeff.	Marginal Effect	Coeff.	Marginal Effect
AGE (X <sub>1</sub> )	0.491 (0.476)	0.623 (1.427)	0.816 (0.682)	0.466 (0.969)	0.741 (1.395)	0.452 (1.138)
GEN (X <sub>2</sub> )	1.172 (1.631)	0.339 (1.616)	2.894 (3.830)	0.211 (1.904)	0.676 (1.450)	1.907 (0.922)
EDU (X <sub>3</sub> )	0.217 (1.475)	0.015 (0.084)	1.084 (2.818)	3.244 (6.111)	0.255 (0.389)	1.189 (1.871)
INC (X <sub>4</sub> )	1.723 ** (0.552)	0.389 ** (0.045)	7.561 ** (3.093)	0.094 ** (0.004)	3.987 *** (1.118)	0.729 *** (0.017)
ENT EX (X <sub>5</sub> )	4.295 ** (2.106)	0.213 ** (0.084)	3.903 ** (1.830)	6.412 ** (3.076)	6.056 * (2.949)	0.127 * (0.098)
ACC (X <sub>6</sub> )	1.348 ** (0.649)	0.038 ** (0.001)	2.902 ** (1.361)	1.087 ** (0.016)	4.841 ** (2.198)	3.983 ** (1.504)
ENT SI (X <sub>7</sub> )	0.158 (0.125)	0.0169 (0.068)	0.317 ** (0.139)	0.467 ** (0.150)	1.390 ** (0.581)	0.596 ** (0.214)
MAR (X <sub>8</sub> )	1.415 (2.315)	3.551 (1.459)	2.235 (3.504)	1.309 (1.026)	1.965 (1.633)	1.069 (1.704)
ENT TY (X <sub>9</sub> )	2.498 ** (1.001)	0.202 ** (0.061)	6.845 ** (2.909)	0.615 ** (0.289)	2.463 *** (0.363)	0.149 *** (0.013)
<b>Intercept</b>	5.216 (2.032)		0.924 (0.716)		1.324 (0.074)	
<b>Base category</b>	Use of industrial refrigerator					
<b>Number of observations</b>	200					
<b>X<sup>2</sup> ratio test</b>	302.89 ***					
<b>Pseudo R-Square (Cox and Snell; Nagelkerke; McFadden)</b>	<b>0.69; 0.57; 0.49</b>					

Source: own research and processing. Model fitting information, AIC criterion: 1275; Hannan-Quinn criterion: 1289; Log Likelihood: 1197

\*\*\* Statistically Significant at 1%; \*\* Statistically Significant at 5%; \* Statistically Significant at 10%.

## 5. Discussions

### 5.1. Socio-economic Characteristics of the Respondents

The mean of the mitigating and non-mitigating Managers/CEOs of the SMEs implies that most of the sampled SMEs are handled by vibrant and relatively young individuals in their economically active age bracket [26]. However, the non-mitigating Managers/CEOs were much older relative to the mitigating Managers/CEOs. So, the mitigating Managers/CEOs are expected to be more productive than the non-mitigating Managers/CEOs [27]. A higher percentage of Managers/CEOs mitigating climate change had tertiary education. This will enhance their understanding and the need to ameliorate the negative influence of climate alteration over the years on their enterprises. This bolsters the findings of [26] that education enhances managers' productivity by enhancing their ability to appropriate knowledge and information to manage business risk. This will enable him/her to maximize their output in the competitive enterprise structure. Therefore, the application of new technologies and innovations will not be difficult. They can make better use of research findings and use such to improve their organization and increase organization profit [28]. There is a high possibility of such being fortified with prerequisite skills essential for managing their enterprise activities using modern technologies and innovations.

More than 50% of the respondents had more than ten years of experience in managing business enterprises. The mean enterprise experience of 15.0 and 27.0 of mitigating and non-mitigating climate change SME Managers/CEOs, respectively, implies that most of the SMEs Managers/CEOs are experienced in the administration of SMEs. The experience garnered over the years would significantly influence their performance positively and positively impact the level of administration and revenue maximization expected of the private sector. This is similar to Croatian companies that there is a high correlation between the years of experience of a business manager and his/her performance as a manager [29]. Therefore, the knowledge acquired

through experience over time will be an added advantage in business risk management [30]. The mean enterprise size with 22 and 29 staff of mitigating and non-mitigating climate change SMEs suggests that most SMEs sampled are not large enterprises. However, the non-mitigating climate change SMEs had more staff (7) than the mitigating SMEs. In most developing countries, the labor cost is always higher due to the climate change effect. Most business enterprises need more labor to work in the factory, especially during flooding and drought. So, the non-mitigating climate change SMEs will need more labor, because they did not adopt any method to ameliorate the impact of climate change on their enterprises.

In Asian countries, there is a high correlation between access to finance and improvement in SMEs' job development, which positively impacts employment growth [31]. Unlike in Nigeria, where less than 50% of SMEs have access to credit facilities to boost their business. Although, the Managers/CEOs who accessed credit facilities from financial institutions complained that the money was not disbursed at the expected time. Hence, in most cases, the purpose of the loan is defeated.

In Table 2, the cost of raw materials accounted for the highest percentage of the Total Cost (TC) among the mitigating (36.34%) and non-mitigating climate change SMEs (35.88%). Followed by the cost of salary and wages of 12.10% and 13.07%, respectively, among the mitigating and non-mitigating climate change SMEs. The resulting tally with the assertion of [32] that the cost of raw materials, salary, and wages account for the higher percentage of the production cost in SMEs. In contrast, the percentage cost of mitigating climate change was 8.49% mitigating climate change SMEs, showing that the cost of alleviating the impact of climate alteration over the years on the business organization is substantial in developing countries.

The percentage cost of transportation was significantly higher among the non-mitigating climate change SMEs (3.76%) compared to the mitigating SMEs (3.68%). Therefore, the cost of transportation of raw materials and finished good tend to be higher due to the negative impact of climate change phenomenon such as flooding on the transportation system. The fixed cost share of the TC was higher among the non-mitigating climate change SMEs (17.89%) compared to the mitigating SMEs (11.26%), showing that the optimization of firm equipment among the non-mitigating was lower compared to the mitigating climate change SMEs. Therefore, mitigating climate change SMEs were making better use of their firm equipment than non-mitigating SMEs [14].

The Net Profit Margin Ratio (NPMR) of 32.04% and 17.83% for the mitigating and non-mitigating SMEs, respectively, shows that SMEs profit from their business enterprises. This bolsters the assertion of [2] that SMEs are profitable in Nigeria and other African countries. However, making the final deduction that the mitigating SMEs were doing better profitably than the non-mitigating SMEs will be ambiguous using the Net Income (NI) result. Therefore, to determine the efficiency and competitiveness of an organization in a perfect market, there is a need to measure the output of the working capital and quantify the operational efficiency of such an organization. Hence, the use of the Net Profit Margin Ratio (NPMR), which, according to [25], shows the true picture of an organization's profitability delivering the returns on investment of the organization in a competitive market economy over a period. The 14.21% difference in the mitigating and the non-mitigating SMEs NPMR significant difference shows the effect of not mitigating climate change on the profitability of the SMEs that are not doing anything to alleviate the impact of climate alteration over the years on the profitability of their enterprises. Therefore, they are losing 14.21% of their profit to the impact of climate change on their production process, negatively affecting their enterprise profitability. Therefore, most business organizations in developing countries are handling the impact of climate change on their business with levity. Hence, they are losing a reasonable amount annually.

Forty-five percent of the respondents agreed that floods negatively influenced them due to incessant and frequent rainfall during rainy periods. Such explained that during the rainy period, flooding is a common event. Therefore, transporting raw materials to the factory for production and finished goods to the selling point becomes very difficult. Hence, transportation cost is always very high when there is flooding. This is reflected in Table 2. The transportation cost of non-mitigating climate change SMEs was significantly higher than the mitigating SMEs. [33] confirmed that this is one of the climate change risks experienced by most African SMEs, which is in line with his findings in Sudan. The respondents said that when there is flooding, most of their staff habitually use that as a reason for coming late to work, which negatively impacts production. This scenario increases the cost of doing business in most developing counties. Thirty percent of

the respondents agreed that the extended dry season, one of the phenomena of climate alteration over the years, often leads to fire outbreaks in their enterprise. Twenty-five percent of the respondents asserted that due to extreme heat, wastage of raw materials, especially agricultural products, is very common in their organization due to high temperatures. All the above situations will affect the enterprise's profit, and the cost of production and marketing will increase. This finding confirms the findings of [34] that climate change affects businesses in various ways.

Most SMEs Managers/CEOs adopted various mitigation and adaptation methods. They have to finance these various methods from their business profit, unlike in most developed countries where the government tries to assist the SMEs to thrive. According to [35], in the United States of America (USA), government assists SMEs in mitigating climate change effects on their businesses to guide against the layoff of staff that will lead to unemployment.

The results of the multinomial logit analysis indicated that SMEs' income induced the choice of mitigation and adaptation methods employed by the SMEs Managers/CEOs. Income significantly increased the probability of the choice of artificial conditioning of the environment, provision of the drainage system, and provision of fire service department compared to the use of industrial refrigerators at 5%, 5%, and 1% level of significance, respectively. The finding is in line with the authors' assertion in [12]. They remarked that in developing countries, the extent to which most small and medium enterprises can ameliorate the negative influence of climate alteration over the years is a function of the organization's income. Organizational income is a critical factor that determines the type and choice of mitigation and adaptation method employed by SMEs to ameliorate the impact of climate alteration over the years on their enterprises. Since the relationship is positive, the higher the income of the SMEs, the higher the possibility of using artificial conditioning of the environment, provision of the drainage system, and provision of fire service unit in the organization compared to the use of industrial refrigerators. The marginal effect of income indicates that a unit increase in the income of SMEs will increase the possibility of the choice of artificial conditioning of the environment by 38.97%, provision of the drainage system by 9.38%, and provision of fire service unit in the organization by 72.91% compared to the use of industrial refrigerator by SMEs Managers/CEOs.

The enterprise experience positively and significantly influences SMEs' choice of mitigation and adaptation methods. The result revealed that enterprise experience (Years of being in business) influenced the choice of artificial conditioning of the environment, provision of the drainage system, and provision of fire service unit in the organization compared to the use of industrial refrigerators at 5%, 5% and 10% level of significance, respectively, in the study area. According to [36] in a study carried out in Malaysia, experience in business determines the right and appropriate mitigation strategies to use by SMEs Managers/CEOs to ameliorate the impact of climate alteration over the years. The use of artificial conditioning, for example, requires experience and an understanding of the system. Therefore, the more experienced the Managers/CEOs of the SMEs are in the management of SMEs, the higher the choice of artificial conditioning of the environment, provision of the drainage system, and provision of fire service unit in the organization compared to the use of industrial refrigerators. The marginal effect of Managers/CEOs' experiences shows that a unit increase in the experience of the CEOs/Managers SMEs will increase the likelihood of the choice of artificial conditioning of the environment by 21.38%, provision of the drainage system by 41.19%, and provision of fire service department by 12.71% compared to the use of industrial refrigerator by SMEs.

Access to credit would positively and significantly increase the SMEs' choice of artificial conditioning of the environment, provision of the drainage system, and provision of fire service unit in the organization as climate change mitigation strategies of their enterprises compared to the use of industrial refrigerators at 5%, 5% and 5% level of significance, respectively. Peneder rightly said that the more financially liquid through access to credit a business organization is, the easier for such an organization to mitigate any business risk [37]. Therefore, the more the SMEs can access credit, the higher the possibility of employing artificial conditioning of the environment, provision of the drainage system, and provision of fire service unit in the organization compared to the use of industrial refrigerators to ameliorate the impact of climate alteration over the years on their enterprises. The marginal effect of access to credit shows that a unit increase in access to credit by the SMEs will increase the likelihood of the choice of artificial conditioning of the environment by 3.81%, provision of the drainage system by 8.71% and provision of fire service unit in the organization by 28.27% compared to the use of industrial refrigerator by SMEs.

Enterprise size would positively and significantly influence the choice of provision of the drainage system and provision of fire service unit in the organization compared to the use of industrial refrigerators in the study area at a 5% level of significance, respectively. This supports the findings of [38] in a study carried out in Taiwan that the size of a business organization in terms of the number of employees and capital stock will determine the ability of the organization to mitigate business risk. The willingness to go the extra mile to mitigate business risk is a function of what is at stake. Therefore, the bigger an enterprise is, the higher the choice of provision of the drainage system and provision of fire service unit in the organization to ameliorate climate change risk compared to the use of industrial refrigerators in the enterprise. The marginal effect of enterprise size shows that a unit growth in the enterprise size will increase the likelihood of the choice of provision of the drainage system and provision of fire service unit in the organization by 46.73% and 59.58%, respectively, compared to the use of industrial refrigerator by the SMEs.

Enterprise type has a positive and significant influence on the methods that SMEs will employ to ameliorate the impact of climate alteration over the years on their enterprises. The result showed that enterprise type (Sole proprietor, partnership, and limited liability) influenced the choice of artificial conditioning of the environment, provision of the drainage system, and provision of fire service unit in the organization compared to the use of industrial refrigerators at 5%, 5% and 1% level of significance, respectively. This supports the assertion of [39] that type of business will influence the level of investment to mitigate business risk. Likewise, this tally with the findings of [40] in Indonesia, that the quantum of investment in the power sector of Indonesia enhances the Indonesian government's mitigation of climate variability. Most limited liability and partnership SMEs will be willing to spend more money to mitigate business risks, such as climate change's effect on their business, than sole proprietor SMEs [6].

Therefore, the study revealed that a change in enterprise type from sole proprietor to a partnership or limited liability SME would increase the probability of the choice of artificial conditioning of the environment, provision of the drainage system, and provision of fire service unit in the organization compared to the use of industrial refrigerators at 5%, 5% and 1% level of significance, respectively. The marginal effect of enterprise type shows that a change in enterprise type from sole proprietor to a partnership or limited liability SME will increase the likelihood of the choice of artificial conditioning of the environment by 20.21%, provision of the drainage system by 61.52%, and provision of fire service unit in the organization by 4.89% compared to the use of industrial refrigerator by the SMEs. Cameron posited that the transition of business organizations from sole proprietorship to a partnership or Limited Liability Company (LLC) enhances risk mitigation [41].

## 6. Conclusion and Policy Implications

The study assessed the variables influencing the choice of mitigation and adaptation methods adopted by SMEs to ameliorate the negative influence of climate alteration over the years on their enterprises. The study shows that SMEs have had one or more methods to reduce the impact of climate alteration over the years on their business organization. The following policy implications can be inferred based on the study's findings. First, the result shows that an increase in SME income will enhance their possibility of using more methods to ameliorate the impact of climate alteration over the years on their enterprises. Therefore, governments at all levels and Non-Governmental Organizations (NGOs) should assist them by creating an enabling environment that will improve their profit margin and income from their enterprises. Second, enterprise experience positively and significantly influences SMEs' choice of mitigation and adaptation methods. This implies that SMEs should be encouraged to know that the manager's experience engaged in managing the enterprise is crucial in mitigating the effect of climate change. Hence, SMEs should consider the experience of whoever will lead their enterprise at any point in time in the process of hiring.

Third, as shown in the result, access to credit would positively and significantly increase the SMEs' choice of climate change mitigation methods. So, SMEs ought to be assisted by financial organizations in Nigeria by giving them loans and monitoring them on how to manage such loans to ensure they have the capacity to ameliorate the impact of climate alteration over the years on their enterprise. Fourth, the size of an enterprise will equally influence the choice of climate change risk management methods by the SMEs in the study area, as shown in the result. Therefore, the SMEs should be guided appropriately by the agency's responsibility for risk management in Nigeria based on the size of their enterprise on the right strategies to ameliorate the



impact of climate alteration over the years on their enterprises. Finally, enterprise type positively and significantly influences SMEs' choice of mitigation and adaptation methods. Hence, SMEs can be encouraged to metamorphose into partnerships or limited liability companies to boost their ability to ameliorate the impact of climate alteration over the years on their enterprises. So, governments and NGOs can sensitize SMEs to business merger ideas. It is suggested that a study be carried out to compare the impact of climate alteration over the years on sole proprietor businesses, partnership businesses, and Limited Liability Companies (LLC). This will show empirically how each business type will be impacted by climate alteration over the years.

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### Data Availability

The data related to the outcome of this study are available upon reasonable request from the first author.

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### Author Contributions

Conceptualization: O.A.T.; Data collection: O.A.T.; Data analysis: T.T.A., & A.L.I.; Methodology: O.A.T., T.T.A., & A.L.I.; Project administration: T.T.A.; Resources: O.A.T., T.T.A., & A.L.I.; Software: A.L.I.; Supervision: O.A.T.; Validation: T.T.A.; Writing – original draft: O.A.T., T.T.A., & A.L.I.; Writing – review & editing: A.L.I.

### Conflicts of Interest

The authors have no conflict of interest to declare.

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