



Determining the Influence of Climate Change Perceptions of Fishers on Employment Opportunities in Lake Chad, Borno State, Nigeria

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Abstract

The study analyzed the influence of perceived climate change by fishers on employment using three indicators measuring various aspects of employment perceptions in the Lake Chad area. The indicators which are a scale in a questionnaire, measured weather employment opportunities in the fishing industry have (i). become more attractive, (EMP₁) (ii). increased (EMP₂) and (iii). become more rewarding (EMP₃) over the years as result climate change in the study area. These indicators were scaled from 5-1 in a questionnaire with options ranging from more attractive, increased and more rewarding to less attractive, decreased to less rewarding. The cronback's alpha measure of reliability was used to ascertain the appropriateness of the items. Then exploratory factors analysis (EFA) and confirmatory factors analysis (CFA) were also conducted on these items for internal consistency and confirmed that all the items are consistent. Separate random sample techniques were used to draw the respondents to administer questionnaire on. The results from the structural equation modeling (SEM) analyses show that the regression weight from income to employment opportunities was negatively significant. This implies that when the income level of fishers increases, their perceptions on employment in fishing decrease. Thus, their investment in fishing declines leading to decline in their fortunes in fishing business, thereby investing their incomes in other sectors to diversity risk. It was recommended that any intervention programme either public or private should target the anthropogenic (human) CGP more than the natural dimension. This is because they perceived the anthropogenic climate dimension more as a threat to their business.

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Perception
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Fishers

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1. Introduction

The fifteenth edition of the analysis of Climate Change Vulnerability Index (CCVI, 2020), revealed that less developed countries are

generally more affected than industrialized countries by the vagaries of climate. Poorest countries are hit hardest by climate change impacts because they are more vulnerable to the

damaging effects of a hazard but have lower coping capacity and may need more time to recover and rebuild. Of the 10 most affected countries and territories in the period 1999 to 2018, 7 were developing countries in the low income or lower middle income country group. According to the climate change vulnerability index, 2021, reporting from UN survey, the wealthiest of nations and richest of people produce most of the carbon emissions and the poorest are the hit hardest. For instance, according to CCVI 2021, the wealthiest one percent of the world produces twice as much carbon emission as the poorest 50 percent. Also, the wealthiest five percent of people contributed 37% of emission growth between 1990 and 2015. Yet, according to the German watch 2021 climate change vulnerability index, global warming affects developing countries the most. Eight out of the ten countries most vulnerable to extreme weather impacts in 2019 were low to lower-middle income countries. The environmental factors make them more vulnerable to extreme weather events occurring.

The Lake Chad which is shared by five riparian countries consists of some of the largest and productive fisheries in Africa (Bene et al 2007). In the 1960s, the lake covers an area of over 25,000km², the fisheries provide means of livelihoods such as employment, income and fish for food and trade to about 37 million people in the riparian countries (Ovie and Emma, 2011; Ojoina 2011). In the 1970s it was established that the Lake Chad Basin (LCB) fisheries could be harvested sustainably at a level of 180,000 tonnes annually during normal hydrological periods with good influent floods into the Lake (Ladu et al., 2012). The past ichthyological fauna of the Lake Chad and its basin were listed by Blacke et al (1964) to composed of about 140 species while Lowe-McConnell (1987), cited by Sagua (1991) reported about 176 fish species in the Chari-Logone-Lake Chad system, consists of 23 families. In terms of fisheries, the Lake Chad and its contributing rivers such as Chari and Logone,

represents the single most important inland water fisheries ecosystem in both West and Central Africa (Neiland 1998; Jolley et al., 2002, in Ovie & Emma, 2011). As a unique regional water body situated at the edge of the Saharan Desert, Lake Chad provides a lifeline to the millions of people living in the riparian countries (African Union (AU), 2014. FAO (2004) reported that nowhere else in the world is such a huge fresh water body found so far from seas and oceans and in such a hot and arid climate.

However, since the occurrence of the major droughts of 1972 – 1974 and 1982 – 1984 in the region, the fisheries resources of the LCB has been greatly affected by the huge environmental changes. Since then, the waters of the lake have continued to diminish from 25 000km² in the 1960s to 2500 – 6000km² in the 1980s/1990s (Neiland et al., 2002, in Ovie and Emma, 2011). Areas of the lake that once received a mean annual rainfall of 320mm experienced less than 210mm (AU, 2011). The huge reduction in the surface area of the lake is an obvious major impact of climate change to the lake. The adverse effects of shrinkage of the lake include reduced fish stocks, siltation, and loss of vegetation and depletion of grazing land. The droughts have also caused a considerable reduction in number of fish species in the lake. For instance, Lates and *Gymnarchus* which were dominant in the lake have completely disappeared (Sagua et al. 1991, in Ladu et al., 1999). Further shrinkage of the lake due to climate change will undermine the base of human development in the region, including in the North-East zone climate change, population explosion and resource overuse in the LCB. The implication of such an occurrence, among others, include water scarcity, insecurity, falling health standard, food insecurity, poverty and intensified migration (climate refugees) leading to resource and identity conflict within and outside the basin. The study, therefore, in light of the climatic variations, intends to determine how employment opportunities in the

fish trade value-chain in Lake Chad have been affected, using the perceptions of the fishers.

2. Methods

2.1 Sources of Data

A structured questionnaire consisting of close and open ended, multiple select and Likert Scale type questions was used to obtain primary data for this study. The use of primary data became necessary as there is a paucity of secondary data on most aspects in the developing emerging economies, more especially on micro-data (Adewale, 2010; Nordas et al., 2003). To address such data problems, survey data are the most suitable for the analysis of unobservable situations such as perceptions.

2.2 Sampling Techniques and Sample Size

Random sampling technique was used to draw sample from the fisher's population. Membership records of the respondents' union/association was used to obtain the population of fishers in the study area and drew the sample. In determining the sample size, Krejcie and Morgan table/formula (1970) was used to meet the sample requirement by Hair et al. (2010) and Kline (2011) in the study area.

Separate Random sample technique was used to draw the sample respondents as this technique gives equal chance to each respondent. Excel random number generating procedure was used to allocate random number to each member of the population. Microsoft Excel was used to obtain the sample respondents on whom the survey instrument (questionnaire) was administered. Numbers generated were matched with the numbers on the association's membership list and the questionnaires were administered on them.

After attack of Baga town by the Boko Haram insurgency, most of the fishers relocated to Maiduguri and settled at three Internally Displaced Persons (IDP) Camps of New Stadium, Ali Monguno Teachers' Village at Bye pass and Gubio road. Some of them settled at

Monguno, while few others went to Yola (upper river Benue fisheries) and Hadejia (Nguru-Gashua- Hadejia wetlands). During the survey, most of the respondents were identified at Baga motor park Maiduguri, while others were located at Yola, Monguno and Hadejia. At Monguno and Hadejia, 3 fishers each were administered questionnaires while at Yola, 4 fishers were administered questionnaires. All the sample respondents in Maiduguri were administered the questionnaires at Baga motor park fish market. After the displacement of the fish trade stakeholders at Doro-Baga, Baga Motor Park Maiduguri fish market has become their rendezvous in the state. They always come to the market so that they get information about their business.

Adequate sample size is necessary for the accuracy of statistical estimate. Different proposals have been made on the rule of thumb for minimum sample size in researches. Hair et al. (2010, 2014) and Hoe (2008) have suggested a minimum ratio of 10 cases per free predictor, while Gorsuch (1997) proposed a ratio of 5 cases for every free measured indicator (variable), but not less than 100 individuals for any analysis. Hair et al. (2006), in Niran (2016), proposed a sample size of > 200 and ≤ 400 as adequate for SEM analysis. In SEM, the agreement is that a sample size ≥ 200 is adequate to provide enough statistical power for data analysis (Kline, 2011; Hoe, 2008). Therefore, considering the criteria recommended by Hair et al. (2006), Kline (2011) and Hoe (2008), a random sample size of 277 for fishers was used for the analyses of SEM in this study.

2.3 Analytical Techniques

A group of multivariate data analysis techniques such as exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and structural equations modeling (SEM) was used to assess the model fit. This group of statistical techniques is mainly employed in estimating unobservable latent variables such as perception

(Hair et al., 2014). The family of equations involved in these techniques uses observable indicators to measure the latent constructs. Measurement models were used to specify the rules of correspondence between the two sets of variables, latent constructs and manifest variables or indicators, (Hair et al., 2010). Factor loadings were estimated to ascertain the level of association between constructs and indicators as well as the measurement errors. Validity and reliability analyses were carried out on each dimension to confirm their extent of the measure of the variables. In order to retain the appropriate number of factor needed to account for the

maximum variance in the data set. Principal Component Analysis (PCA) was employed (Hair et al, 2010).

3 Results and discussions

3.1 Reliability Test Results

In Table 1, the analyses of the internal consistency of one of the scales from the questionnaire, employment opportunity, was explored. In this study, the Cronback's alpha measure of reliability, which is the most commonly used (Kline, 2011; Coakes et al., 2009 and Adam, 2014) is adopted.

Table 1 Reliability Test of Fishers' Perceptions on Employment Opportunity items

Questionnaire Item	Mean	Standard Deviation	Overall Cronback's Alpha	Individual Items Cronback's Alpha
Attractiveness of fishing employment	4.0	0.668	0.860	0.810
Increase in fishing employment opportunity	4.54	0.656		0.812
Rewards from fishing	4.54	0.639		0.788
Number of items		3		

Source: Survey, 2022

The analysis in Table 1 shows that individual items reliability ranges from 0.79 to 0.81 i.e. ideal reliability coefficient to very good Cronback's alpha value of reliability. These coefficients were found to be less than the overall Cronback's alpha value. This implies that all the individual items are appropriate (Pallant, 2010; Coakes et al., 2009). The mean values in the table show that respondents have highest concern for all the items of employment opportunities in fishing. This is evidence from the range of mean from 4.0 to 4.54. Therefore, it means that the items are reliable, hence internal consistency is established. Moreover, the standard deviation, which is a measure of volatility, suggests that there is an internal consistency and therefore

reliability of the items in the questionnaire. The closer the standard deviation to the mean the more reliable measurement is the mean (Lind et al., 2005). The standard deviations range from 0.64 to 0.67. Even if two means are equal, the one with lower standard deviation is more reliable (Lind et al., 2005). For example, in Table 1, despite the fact that two items (rewards from fishing and increase in fishing employment opportunity) have equal mean of 4.54, however, the item with standard deviation of 0.64 (rewards from fishing) is relatively more reliable than the other item which has a standard deviation of 0.67. Judging by the composite alpha of 0.86 and individual item alpha ranging from 0.79 to 0.81, which are both above the acceptable thresholds,

all the items in Table 1 are deemed reliable and internally consistent.

3.2 Exploratory Factor Analysis (EFA) for fishers' employment opportunities

There are three items for employment opportunity used in this research. Employment opportunity is a latent construct hence, EFA had

to be performed on it. This was to ascertain the sample adequacy and other conformability requirements of each item before further analyses and subsequent interpretations. All the three items have been retained (extracted) at EFA. Each of the coefficients is greater than 0.3 (Table 1).

Table 2: Correlation Matrix for Fishers' Employment Opportunity Exploratory Factor Analysis

	Attractiveness of Fishing employment	Increase in fishing employment opportunity	Rewards from fishing
Attractiveness of Fishing employment	0.743 ^a		
Rewards from fishing	0.6508	0.747 ^a	
Overall items' measure of sample adequacy: Kaiser–Meyer–Olkin measure of sample adequacy (KMO)	0.6849	0.6809	0.716 ^a
Bertlett's test of sphericity:			
Approx. Chi-square			379.22
Degree of freedom			3
P-value			0.00

Source: Field Survey, 2022

The analyses in Table 2 (correlation matrix) represent the individual overall measures of sample adequacy (MSA). The individual items' sample adequacy measures are above the acceptable threshold of 0.5 (Hair et al., 2010). Also, the overall items' sample adequacy had

attained the cut point ($KMO > 0.6$ and Bertlett's test of sphericity of < 0.05). In the table $KMO = 0.73$ indicating that the factorability of all the individual items for employment opportunity are deemed to be sufficient.

Table 3: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.344465	78.14884	78.14884	2.344465	78.14884	78.14884
2	0.349303	11.64343	89.79227			
3	0.306232	10.20773	100			

Extraction Method: Principal Component Analysis.

Source: Field Survey, 2022

Table 4: Pattern Matrix - Fishers' Perceived Employment opportunity factors

	Perceived Employment Opportunity	Communalities
Rewards from fishing trade	0.8933	0.774851
Attractiveness of fishing trade employment	0.8803	0.771703
Increase in fish trade employment opportunity	0.8784	0.797911

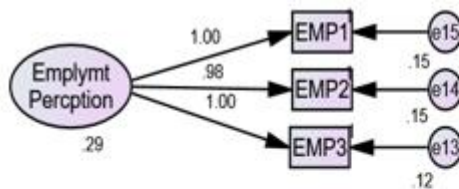
Source: Field Survey, 2022

The individual items sample adequacy coefficient ranges from 0.72 to 0.75 which is greater than the acceptable limit of 0.5. the overall measure of sample adequacy revealed of KMO of 0.73, Bartlett's Test of Sphericity with chi-square of 379.22, 3 degree of freedom at $p < 0.05$. In table 3, applying the PCA extraction method one factor was extracted as it is the only component that as eigenvalue more than unity. This single component solution explained 78% of the variance. Rotation is not necessary here since it is done to assist in interpretation where there is difficulty. The structure is already a simple one. In Table 4, the pattern matrix, all the

factors are loaded on one component i.e. perceived job opportunities. The factor loadings on these three items range from 0.88 to 0.89 and communalities ranging from 0.77 to 0.90 which is greater than the acceptable threshold of 0.3. It is therefore, deemed to have met the factorability requirement and sample adequacy.

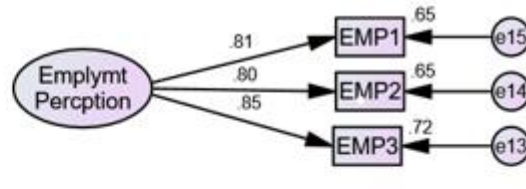
3.3 CFA for Fishers' Employment Perception

The results of the CFA for fishers' employment opportunity perceptions are presented here. There are three indicators measuring various aspects of employment perceptions of the fishers in the study area.



Model Fit Indices
 Chi-square(df) = 94 (42 df)
 ;P value(>=0.05) = 0.0000
 ;Relative Chi-square (<=3:1) = 2.54
 ;GFI (>=0.90) = 0.91
 ;TLI (>=0.9) = 0.97
 ;CFI (>=0.9) = 0.94
 ;NFI (>=0.9) = 0.92
 ;PNFI (>=0.50) = 0.56
 ;RMSEA (<=0.08) = 0.041

(a) Unstandardized



Model Fit Indices
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 ;P value(>=0.05) = 0.0000
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 ;GFI (>=0.90) = 0.91
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 ;CFI (>=0.9) = 0.94
 ;NFI (>=0.9) = 0.92
 ;PNFI (>=0.50) = 0.56
 ;RMSEA (<=0.08) = 0.041

(b) Standardized

Standardized Confirmatory Factors Analysis (CFA) For Fisher

Source: Field Survey, 2022

Figure 1 is a path diagram of a single factor employment perception for fishers in the study area. The construct has three indicators loading on it. All the three factor loadings between the construct and its indicators are above the recommended threshold of 0.5 ranging from 0.80 to 0.85. The model fit indices are far above the required minimum limits. For instance, the standardized relative $\chi^2 = 2.54$ and RMSEA = 0.041. Both are below the recent recommended values of 5 (Kline, 2005) and < 0.08 for normed χ^2 and RMSEA, respectively. Also, all the other indices, such as GFI (0.91), TLI = 0.97, CFI =

0.94 and NFI = .92 are above the minimum required of 0.9. And, PNFI = 0.58 is above its acceptable minimum value of > 0.5 . In Table 5 only the convergent validity was established as there is only one construct in the model. The AVE is 0.67 and the CR is 0.86 ($CR > AVE$). Therefore, both are above the acceptable threshold of ≥ 0.5 and ≥ 0.7 for AVE and CR estimates respectively. Thus, convergent validity for fishers' employment perception has been established.

Table 5 Convergent Validity for Fishers Employment Factor

Perceived Employment Opportunity Factor			
Items/Indicators	Factor Loading	AVE	CR
EMP1	0.81	0.673	0.860
EMP2	0.80		
EMP3	0.85		

Source: Field Survey, 2022

4. Estimated Structural Equation Model for Fishers' Employment Opportunity

Analyses and interpretations of SEM estimates on employment opportunity for fishers in the study area were presented. Both standardized and unstandardized estimates were presented but only the standardized values were used for analyses and interpretations. Also here, four issues are to be considered. These are the statistical significance, magnitude and signs of the estimated parameters as well as the overall model fit to the data. Figure 2 represents (a) the standardized estimated path coefficients and covariances for fishers in the study area. All of the exogenous variables, except experience (-0.01) have statistically significant relationships with the employment perception.

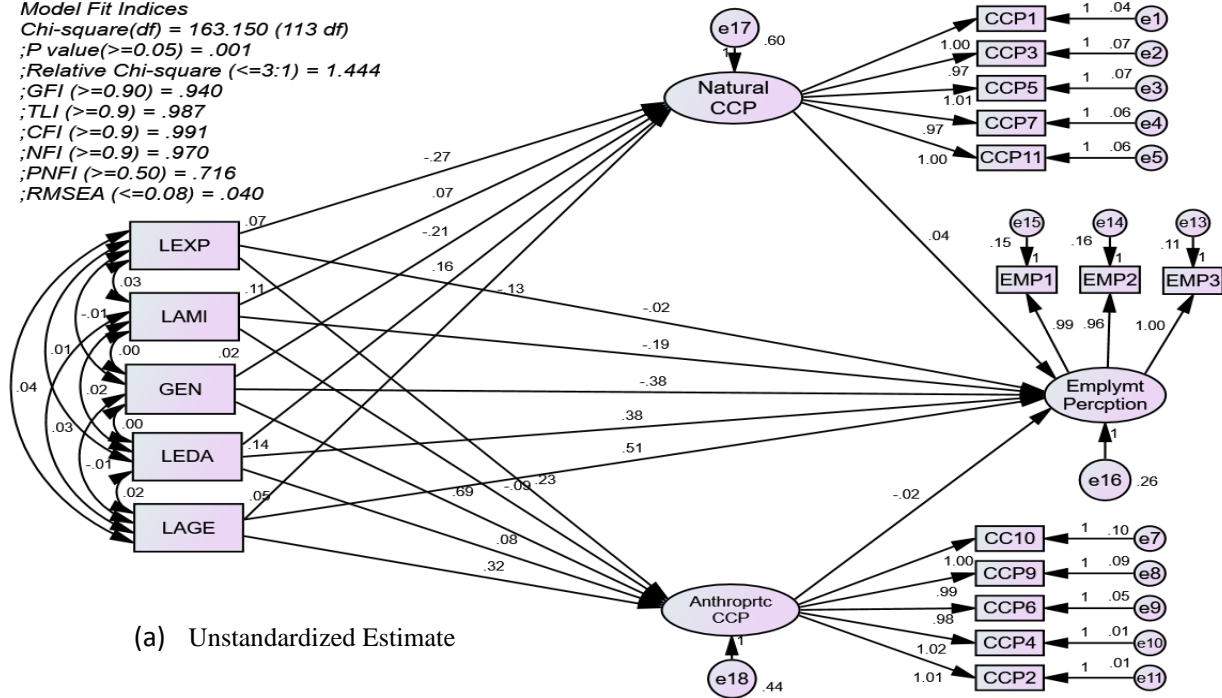
The regression weight from average monthly income to employment perception is -0.11 which implies that one standard deviation increase in income leads to 0.11 standard deviation decrease

in employment perception. This can be interpreted as when the income level of the fishers increases, their perception on employment in fishing decreases. Thus, their investment in fishing declines. As their fortunes in fishing business declines, they invest their income in other sectors to diversify risk.

The regression weight between gender and employment perception is -0.10. This implies that female fishers perceived less employment opportunities in fishing business. The path coefficient between employment perception and educational attainment is 0.26. This means that one standard deviation increase in educational attainment leads to 0.26 standard deviation increase in employment opportunities. Interpretably, it indicates that those with many years of educational attainment utilize their higher educational level to use better technology and inputs to obtain better output than their less educated peers.

Model Fit Indices

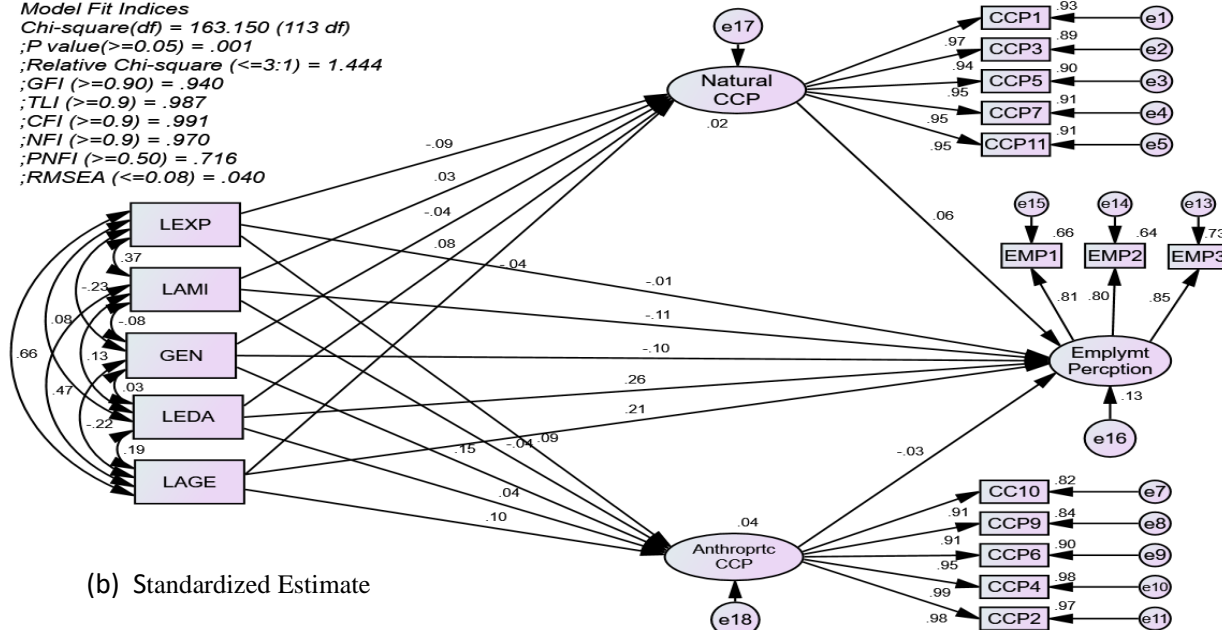
Chi-square(df) = 163.150 (113 df)
 ;P value(>=0.05) = .001
 ;Relative Chi-square (<=3:1) = 1.444
 ;GFI (>=0.90) = .940
 ;TLI (>=0.9) = .987
 ;CFI (>=0.9) = .991
 ;NFI (>=0.9) = .970
 ;PNFI (>=0.50) = .716
 ;RMSEA (<=0.08) = .040



(a) Unstandardized Estimate

Model Fit Indices

Chi-square(df) = 163.150 (113 df)
 ;P value(>=0.05) = .001
 ;Relative Chi-square (<=3:1) = 1.444
 ;GFI (>=0.90) = .940
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 ;CFI (>=0.9) = .991
 ;NFI (>=0.9) = .970
 ;PNFI (>=0.50) = .716
 ;RMSEA (<=0.08) = .040



(b) Standardized Estimate

Figure 2 Fishers' Standardized Estimate for employment opportunity
 Source: Field Survey, 2022

This result is similar to the finding of Abu Samah et al. (2019) in their study on the impact of climate change adaptation by small-scale fishers in Malaysia, reported that those with higher educational attainment have better adaptation practices than those with less educational attainment. Their findings also concurred with studies by Shaffril et al. (2015), D'Silva et al. (2012) Salik, et al (2015) and Islam and Sallu (2014). Other reasons given included their accessibility to information as well as technology literacy affords them the use of the internet to get more climate related information such as weather, impacts of climate change, response to climate change. They also reported that educated fish trade stakeholders also have more skills to diversify alternative means of livelihood and possess better risk management strategies. The regression weight between age and employment perception is 0.21, which is statistically significant at 0.01 level. This implies that one standard deviation increase in age leads to 0.21 standard deviation increase in employment perception. This can be interpreted as a fisher grows older they use their knowledge of local climate to influence their climate change perception and coping strategies. This is similar to the report by Hasan (2015) which revealed that generally, older fishers would have better knowledge of the environment and climate change as well as more concerned about the impact of climate change than the younger fishers. Hasan (2015) also added that the traditional knowledge assists fishers in fishing business to understand their local environment, trends and pattern of disaster so that they prepare suitable coping strategies. Thus, elderly fishers perceive more opportunities in fishing.

The regression weights between the exogenous variables and the natural CCP are statistically insignificant and majority are with negative sign. For instance, the path regression from experience to natural CCP is -0.09, with gender is -0.04 and with age is -0.04 while from

income to n natural CCP is 0.03 and from educational attainment to natural CCP is 0.08. Thus, the -0.09 path coefficient between experience and natural CCP implies that 10 standard deviation increase in experience of a fisher leads to 0.9 standard deviation decrease in natural CCP. Also, 10 standard deviation increase in age leads to 0.4 standard deviation decrease in natural CCP. This result is supported by the findings of Abu Samah et al. (2019) who reported that old and experienced fishers perception were negatively significantly related to climate change adaptation. Norsida et al. (2018) also reported that socio-demographic profiles of respondents were negatively related to their perception on climate change. Also, Michetti and Ghinoi (2020) reported that many studies have shown that there was no strong link between natural climate change and risk perception and experience. Furthermore, the path coefficients between the exogenous variables and the anthropogenic CCP also have different signs as in the case of the natural CCP and the variables. For example, the regression weight between experience and the anthropogenic CCP is .09, with income is -0.04, with gender is 0.15 and with education is 0.04 while with age is 0.10. Regression weight of 0.09 between anthropogenic CCP and experience and -0.09 between experience and natural CCP implies that the experienced fishers perceive more of anthropogenic than natural CCP as a threat to fishing while regression weight of 0.15 between gender and anthropogenic and -0.04 between gender and natural CCP also implies that female fishers perceive anthropogenic CCP poses more threat than natural CCP. Also, the regression weight between anthropogenic CCP and employment perception is -0.3 while with natural CCP is 0.06. This means that 10 standard deviation increase in anthropogenic and natural CCP leads to 0.03 standard deviation decrease and 0.6 standard deviation increase in employment perception respectively

The correlation coefficient among the exogenous socio-economic variables also have mixed signs and magnitudes. They are not highly correlated to suspect multicollinearity problem, not > 0.85 (Awang, 2015). The correlation coefficient between experience and age is 0.66, between income and age is 0.47. However, the correlation between gender and experience is -0.23 and between gender and age is -0.22. Also, between experience and income is 0.37, between education and age is 0.19 and between income and education is 0.13. All the model fit indices have satisfied required cutoff values. For instance, the relative Chi-square is 1.44 far below the cutoff point of ≤ 5 (Hair et al., 2010 & 2014), RMSEA = 0.04 which is below the threshold of 0.08 (Hair et al., 2010 & 2014) and PNFI is 0.716, which is greater than the required limit of ≥ 5 (Hair et al., 2014). All the fit indices that are supposed to be greater than or equal to 0.90 are above their thresholds. These indices range from 0.940 (GFI) to 0.991 (CFI). Therefore, it could be concluded that the two dimensions of climate change perceptions are associated with employment perception differently with anthropogenic CCP -0.03 while with natural CCP is 0.06. Any intervention programmes, either public or private should target the anthropogenic CCP more than the natural.

5. Conclusion

From the SEM results for employment opportunity, it was found that regression weight from income to employment perception of -0.11 implies that when the income level of the respondents increases, their perceptions on employment in fishing decrease. In order to diversify risk, they reduce investment in fishing and invest else-where such as animal husbandry or crop farming and other fishing related occupations in the area. Female fishers perceived less employment opportunities in fishing business (regression weight between gender and employment is -0.10). With a path coefficient of 0.26 between education and employment, those

with many years of educational attainment utilize their level of education to use better technology and inputs to obtain better outputs than their less educated peers. This result is similar to the findings of Abu-Samah et al. (2019), where they reported that those with higher educational attainment have better adaptation practices than those with less education attainment. Those with many years of education can also access information and technology literacy which affords them the use of the internet to get more climate related information. They also have better diversification skills and risk management strategies. The study revealed that there was a statistically significant relationship between age and employment perceptions. The study also concluded that experienced fishers and female fishers perceive anthropogenic CCP poses more threat than natural CCP. The study could not find enough statistical evidence to establish a relationship between the two dimensions of climate change perception on employment by fishers. It is, therefore, recommended that any intervention programmes, either private or public, should target the anthropogenic CCP more than the natural dimension. This is because they perceived the anthropogenic climate change dimension more as a threat to their business than the natural one.

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