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# Effects of fish sellers' (Fatoma) climate change perception on employment opportunities in fish trade value-chain in Lake Chad, Borno State, Nigeria

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**ABSTRACT:** With the reduction in the volume and the surface area of Lake Chad over the years due to extreme weather conditions, the fish output has been grossly affected. Due to this fluctuation in fish production, fishing opportunities have been reduced. Over 96% of fishing communities in Lake Chad derive about 80%-90% of their income from fishing. The study looked at how the fish sellers (Fatoma) perceived the impacts of these climate change conditions on employment and other socio-economic variables in their profession. A questionnaire was designed to obtain primary data using the membership register of their association. A sample of 222 was randomly drawn using the Krejcie and Morgan formula (1970) to meet the sample requirement for structural equation modelling (SEM) analysis. A family of multivariate data analysis techniques composed of exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and SEM was used to assess the model fit. After validity and reliability analyses, factor loadings were estimated to confirm the level of association between constructs and their indicators, as well as measurement errors. The study concluded that the perception of fish sellers on the effects of climate change on socio-economic variables is more significant in the anthropogenic climate change perception (CCP) dimension than in the natural CCP dimension. Also, fish sellers with higher income perceived employment opportunities in the fish trade despite the impacts of climate change. However, experienced fish sellers did not perceive employment opportunities in the face of climate change in the trade. It was recommended that governments and their agencies should create climate change awareness through advocacy programmes among the fish trade stakeholders in the area.

**Keywords:** Climate change, employment, fish sellers, perceptions, fish trade, Lake Chad.

JEL classification: Q22 & Q51

## INTRODUCTION

Changes in precipitation and temperature are associated with reduced fish productivity and lead to maladaptive responses such as overexploitation of the limited fish resources and habitat destruction. In West Africa, the major climate change indicators are an increase in temperature and a decrease in rainfall (Gbemavo *et al.*, 2021). Such variations in climatic conditions lead to destructive natural phenomena like flooding, droughts, pests and diseases and heat waves (Idris *et al*., 2024). Climate change is a potential threat to fisheries more than other simultaneous forces such as habitat debasement, overfishing, pollution, new species invasion, etc. (Olu *et al*., 2023). A drought-related water shortage leads to shrinkage of water bodies both in depth and width, resulting in a reduction in volume and surface area; eventually, freshwater firths experience salinity. The Sahelian droughts of 1972-1974 and 1982-1984, combined with anthropogenic streamflow modification, caused a reduction

in the extent of Lake Chad, which eventually altered the fish habitat; fisheries production experienced large fluctuations due to these environmental changes (Ojoina, 2011). The major climatic factors perceived by fish sellers in the study area that cause threats to fish trade are rainfall increase and temperature increase (Daluma and Mohammed, 2023). The fluctuations in fish production, therefore, have had a significant impact and have contributed to regional poverty. The reduction of Lake Chad has undoubtedly reduced fishing opportunities (Neiland *et al.*, 1994), biodiversity loss, wildlife depletion, changes in vegetation and the disruption of major means of livelihood in the area, such as fishing, farming and animal herding (Johnson, 2025). In the face of such undesirable conditions, fisheries stakeholders adapt livelihood diversification strategies, i.e. occupational mobility, pluri-activity, occupational multiplicity or occupational pluralism, to cope with vulnerable conditions (Salgueiro-Otero *et al*., 2022).

In the area of employment generation, FAO (2012) estimates that 660 to 820 million people globally rely on fisheries for their livelihoods. Ayisi *et al.* (2024) revealed that over 90% of fishers and ancillary or related workers in the capture fisheries are employed in the artisanal fisheries. Since it has been reported that different climatic conditions such as rainfall, temperature, drought, storm surge, etc., affect fish productivity, this would likely lead to changes in employment opportunities in the fish trade value chain. An estimate by FAO (2020) put the number of registered Nigerian fishermen who are directly engaged in the capture fisheries between 12 and 13 million. However, this estimated figure may be an underestimation of the reality in the trade. Aquatic foods provide about 15% of animal protein to over 4 billion individuals, most of whom live in poor nations (Funge-Smith and Bennett, 2019; Ayyuba *et al*., 2024).

Lake Chad Basin Fisheries employs over 100,000 fishers (both full- and part-time), and about 200,000 from allied trades such as fish processing, transportation, marketing/trade, rope/carton making, fish loading, food selling, and petty trading. Over 96% of the fishing communities in Chad Basin derive about 80%-90% of their income from fishing (Ladu, 2004). All of these are dependent on the fisheries for their livelihoods. It is therefore a huge employer of local labour, contributing to poverty alleviation and food security in the region. At the retail level, it is a major source of women's empowerment in southern Nigeria, where over 90% of the processed fish from the Lake Chad fisheries is exported on a weekly and monthly basis (Ladu *et al*., 2012). About 20% of the daily catch is retained and consumed (auto-consumption) by the fishing households (Neiland *et al*., 1994) as cited in Ladu *et al*. (2012). The environmental characteristics and performance of fisheries of the Lake Chad Basin are greatly influenced by the regional hydrological regime and the distribution of water. This study, therefore, examined the perceptions of the fish sellers (Fatoma) on the impact of climate change on employment opportunities in their profession in the Lake Chad fish trade value chain.

### Theoretical framework

This research used the vulnerability framework and protection motivation theory (PMT) to understand how fish trade stakeholders in the study area protect themselves in the face of harmful events such as climate change. The vulnerability framework has been extensively used in climate change studies to account for risk. For instance, Shah *et al*. (2020) used the vulnerability framework to study climate change in Trinidad and Tobago; Limuwa (2018) used it to evaluate the perceptions of small-scale fishers on climate change and coping strategies from Lake Malawi, among others. As for PMT, a number of studies in various fields have used it as a framework. For instance, Bagagnan *et al*. (2019) used it to explain farmers' adaptation to climate change perceptions in the Central River Region of The Gambia. Hence, this study applied these theoretical frameworks to account for climate change perceptions of fish sellers in the study area.

## METHODOLOGY

### Sources of data

A structured questionnaire was designed to obtain primary data for this study. The use of primary data became necessary due to a lack of accurate secondary data in the study area on the fish trade value chain. In most developing countries, including Nigeria, there is a paucity of data on some aspects, especially in micro-data (Adewale, 2010; Nordas *et al*., 2003). Therefore, survey data are often suitable for analysis in such a situation, as used in this study.

### Pilot testing

In the pilot test, twenty questionnaires were administered to fish sellers (Fatoma) at Baga Motor Park Fish Market, Maiduguri, by a research assistant. After recording the results, some discrepancies were discovered and corrected in the main survey. For instance, gender was included after the pilot test. Also, it was suggested that wind direction does not matter; rather, the presence of wind that disturbs fishing.

### Sampling techniques and sample size

In drawing the sample for this study, a random sampling technique was used to draw sample respondents among

the fish sellers. Membership records of the respondents' union/association were used to obtain the population of fish sellers in the study area and to draw 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, 2022) and Kline (2011, 2016) in the study area.

Random sample technique was used to draw the sample respondents as it gives equal chance to each respondent to be selected. Excel random number generating procedure was used to allocate random numbers to each member of the population as obtained from the union's membership register. Microsoft Excel was used to obtain the sample respondents on whom the questionnaire was administered. Numbers generated were matched with the numbers on the association's membership list, and the questionnaires were administered to them.

When Baga town was attacked by the Boko Haram insurgency, most of the fish sellers settled in Maiduguri at Internally Displaced Persons' (IDP) Camps. Some of them settled in Monguno town, while others went to Yola and Hadejia. During the survey, most of the respondents were identified at Baga Motor Park, Maiduguri and questionnaires were administered to them, while those located at Yola, Monguno and Hadejia were administered the questionnaires in the following order: Monguno 2, Hadejia 3 and Yola 3.

To attain the accurate statistical estimate required for SEM analysis, different minimum sample sizes have been suggested in research. Hair *et al*. (2006, 2022) 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, 2016; Hoe, 2008). Therefore, following the criteria suggested by Hair *et al*. (2006), Kline (2011) and Hoe (2008), a random sample size of 222 for fish sellers was used for the analyses in this study.

### Analytical techniques

A family of multivariate data analysis techniques consisting of exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and structural equation modelling (SEM) was used to assess the fitness of the model to the data. This family of statistical techniques is mostly used in estimating unobservable latent variables such as perception (Hair *et al*., 2014, 2022). The family of equations involved in these techniques employs observable indicators to measure the latent variables. A measurement model was used to specify the rules of correspondence between the two sets of variables, latent constructs and manifest variables or indicators (Hair *et al*., 2022). Also, factor loadings were estimated to confirm the level of association between constructs and indicators, as well as the measurement errors. Validity and reliability analyses were also carried out on each dimension to confirm whether they actually measure the latent constructs.

### Validity and reliability of scale

This research utilised construct validity, which has three components: convergent, discriminant and nomological parts. Before proceeding to SEM, these validities were examined. For reliability, Cronbach's Alpha was used to measure the internal consistency to ascertain the correlation among the items that make up the scale.

## RESULTS AND DISCUSSION

To extract the minimum factors required to account for the maximum proportion of the total variance of the data, Principal Component Analysis (PCA) was used in this study as proposed by Hair *et al.* (2022).

### Reliability test

Table 1 presents the analysis of the internal consistency of one of the scales from the questionnaire, employment opportunity. Both the aggregate (overall) Cronbach's alpha and the individual coefficients confirm the reliability of the items on employment perceptions by fish sellers (Fatoma) in the Lake Chad fish trade value chain. All three individual items have their Cronbach's alpha within the acceptable limits. However, in a five-point Likert scale, ranging from positive to negative, a mean of two plus is on the negative side. But closeness of the standard deviation to the mean, except in one item, suggests that the scores are consistent internally and were at a reliable measure.

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

The three items measuring employment opportunity were subjected to Exploratory Factor Analysis (EFA) to assess their suitability for factor extraction and to establish the adequacy of the sample for subsequent analyses. All three items were retained, with factor loadings exceeding the minimum recommended threshold of 0.30 (Table 1).

The correlation matrix (Table 2) showed inter-item correlation coefficients ranging from 0.69 to 0.81, exceeding the minimum acceptable value of 0.30. All correlations were statistically significant at the 1% level ($p < 0.01$), indicating substantial associations among the items. The individual measures of sampling adequacy also ranged from 0.69 to 0.80, exceeding the recommended threshold of 0.50. At the overall level, the Kaiser–Meyer–

**Table 1.** Reliability test for fish sellers' perceptions on employment opportunity items.

| Questionnaire Item | Mean | Standard Deviation | Overall Cronback's Alpha | Individual Items Cronback's Alpha |
|---|---|---|---|---|
| Attractiveness of fishing employment | 2.38 | 0.878 | 0.894 | 0.842 |
| Increase in fishing employment opportunity | 2.36 | 0.949 | | 0.811 |
| Rewards from fishing | 2.44 | 1.052 | | 0.896 |

**Source**: Survey questionnaire, 2020.

**Table 2.** Fish sellers' job opportunity exploratory factor analysis.

| Parameters | Attractiveness of Fish trade employment | Increase in fish trade employment opportunity | Rewards from fish trade |
|---|---|---|---|
| Attractiveness of Fish trade employment | 0.717[a] | | |
| Increase in fish trade employment opportunity | 0.81333*** | 0.686[a] | |
| Rewards from fish trade | 0.6927*** | 0.7303*** | 0.822[a] |
| Overall items' measure of sample adequacy: | | | |
| Kaiser–Meyer–Olkin measure of sampling adequacy (KMO) | | | 0.7332*** |
| Bartlett's test of sphericity: | | | |
| Approx. Chi-square | | | 418.4064 |
| Degree of freedom | | | 3 |
| P-value | | | 0.0000 |

a = Measure of sample adequacy for individual item; b = Overall measure of sample adequacy for job opportunity (**Source**: Field Survey, 2022).

**Table 3.** Eigenvalues and percentage of total variance explained.

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 2.492038 | 83.06795 | 83.06795 | | | |
| 2 | 0.324904 | 10.83012 | 93.89807 | 2.492038 | 83.06795 | 83.06795 |
| 3 | 0.183058 | 6.101927 | 100 | | | |

**Source**: Field Survey, 2022

**Table 4.** Fish sellers' perceived employment opportunity factor (Pattern Matrix).

| Parameters | Perceived Emp. Opportunity | Communalities |
|---|---|---|
| Increase in fish trade employment opportunity | 0.9326 | 0.8431 |
| Attractiveness of Fish trade employment | 0.9181 | 0.8697 |
| Rewards from fish trade | 0.8827 | 0.779 |

**Source**: Field Survey, 2022

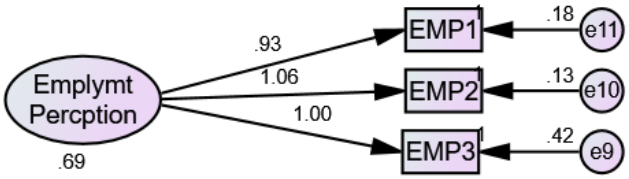
Olkin (KMO) measure of sampling adequacy was 0.73, which exceeded the recommended minimum of 0.60. In addition, Bartlett's Test of Sphericity was statistically significant, $\chi^2(3) = 418.40$, $p = 0.000$, indicating that the correlation matrix was significantly different from an identity matrix and was therefore suitable for factor analysis.

In Table 3, there is only one item with an eigenvalue of one or above. This one factor extracted (retained) has explained 83% of the variance. As there are no difficulties in interpretation, there is no need for any form of rotation to aid in interpretation. Therefore, the loadings of the extracted factor explained 83% of the variance in job opportunities.

In the pattern matrix (Table 4), all three factors loaded on one component, i.e. perceived employment opportunity,

*Model Fit Indices*
*Chi-square(df) = 94 (42 df)*
*;P value(<=0.05) = 0.0000*
*;Relative Chi-square (<=3:1) = 2.24*
*;GFI (>=0.90) = 0.93*
*;TLI (>=0.9) = 0.911*
*;CFI (>=0.9) = 0.94*
*;NFI (>=0.9) = 0.92*
*;PNFI (>=0.50) = 0.54*
*;RMSEA (<=0.08) = 0.031*

(a




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(b)

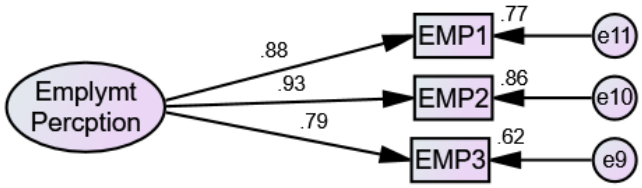



**Figure 1.** Estimate for fish sellers' perceived employment opportunity factor: **(a).** Unstandardised **(b).** Standardised (Source: Field Survey, 2022).

with factor loadings ranging from 0.88 to 0.93, greater than the acceptable unit of 0.3. The communalities of the three items are also above the threshold, ranging from 0.78 to 0.87. This implies that the factorability and sample adequacy were deemed to have been fulfilled (Hair *et al.,* 2022)

**CFA for fish sellers' employment perception**

The results of the Confirmatory Factor Analysis (CFA) assessing fish sellers' perceptions of employment opportunities are presented in this section. The construct of employment opportunity perception was measured using three indicators, each capturing a distinct aspect of the fish sellers' perceptions regarding employment opportunities in the study area. The measurement indicators and their relationships with the latent construct are presented in Figure 4. The indicators have met the sample adequacy and other requirements for retention. Figure 1 shows the path diagram with a one-factor (employment) CFA model, and its three indicators were specified. The standardised factor loadings between the employment latent construct and indicators range from

**Table 5.** Convergent validity for fish sellers' perceived employment opportunity factor.

| Items/Indicators | Factor Loading | AVE | CR |
|---|---|---|---|
| EMP1 | 0.88 | | |
| EMP2 | 0.93 | 0. 754 | 0.902 |
| EMP3 | 0.79 | | |

**Source:** Field Survey, 2022.

0.79 to 0.93, which are above the cut-off point of 0.5 (Hair *et al*. 2010). The model fit indices show that all of them are within the cut-off points. For example, the relative x is 2.24, which is below the acceptable limit of ≤3. Other indices include GFI = 0.93, TLI = 0.911, CFI = 0.94, NFI = 0.92 and PNFI = 0.54; all are above their thresholds of ≥0.90 for the first 4 indices and ≥0.50 for PNFI, respectively. RMSEA estimate is 0.031, far less than the cut-off value of <0.08.

In Table 5, the critical ratio (C.R.) values are large enough to show the statistical significance of all relationships in the model, as evidenced by the Probability Values. In Table 5, the CR = 0.90 and AVE = 0.75 (CR > AVE), which are above the critical values of 0.7 and 0.5 for the respective fit indices. This implies that convergent validity has been established since CR > AVE.

## Estimated structural equation model for fish sellers' employment opportunity

This section presents the analyses and interpretations of SEM estimates on employment opportunity for fish sellers in the study area. Both standardised and unstandardised estimates were presented; however, only the standardised values were used for analyses and interpretations. Four issues of the statistical significance, magnitude and signs of the estimated parameters, as well as the overall model fit to the data were considered.

Figure 2 represents the path diagram for fish sellers' SEM. The standardised estimates in Figure 2(a) are used for interpretation of the path coefficients and covariation among the variables in the structural model. The regression weights between the socio-economic variables and the natural CCP have different signs and magnitudes. The path coefficient between gender and natural CCP, for instance, is -0.35, implying that the female fish sellers (Fatoma) did not perceive the natural CCP as a threat to their business. This is corroborated by a similar finding by Daluma *et al*. (2024) on the perception of fishermen on climate change in the Lake Chad area. Equally important to note is that, with the regression weight of -0.42, the female fish sellers also did not see even the anthropogenic CCP as a threat. The regression path coefficient between age and anthropogenic CCP is -0.47. This implies that one standard deviation increase in age leads to a 0.47 decrease in anthropogenic CCP. This differs from the results of their fisher and fish dealer counterparts in the study area, whose perception of anthropogenic CCP increases as they grow older (Daluma *et al*., 2024; 2025). Also, the path coefficients of experience and education to anthropogenic CCP are 0.24 and 0.22, respectively. This therefore supports the hypothesis as specified in the model: years of experience and educational attainment have significant and positive effects on anthropogenic CCP. The effects of the socio-economic variables are more significant on the anthropogenic CCP than on the natural CCP, considering the magnitude of the regression weights.

The effects of the socio-economic variables on employment perception have various signs and magnitudes. For instance, the regression weight between gender and employment perception is -0.14, with experience at -0.7, age at -0.20, while income is 0.13. In the case of gender and employment perception (-0.14), female fish sellers perceived fewer employment opportunities in the fish trade in the face of climate change in the study area. Also, the path coefficient of -0.20 between age and employment perception implies that one standard deviation increase in age leads to a 0.20 standard deviation decrease in employment perception. This can be interpreted as a fish seller grows older, they perceive fewer opportunities in the fish trade business. This is contrary to the perception of fishers (0.2), whose perception of employment opportunities increases with an increase in their age (Daluma *et al*., 2024). This could be because fishers are closer to nature and take measures to cope with the impacts of climate change, while fish sellers could be less concerned with mitigating the impact of climate change; therefore, they perceive fewer opportunities in the fishing trade in the face of climate change. This is similar to the findings of Navy *et al*. (2016), where they reported that in their study area of Cambodia, out of fishers, traders and processors, only fishers were more cooperative in tackling the threat of climate change. The 0.13 path coefficient from income to employment perception implies that fish sellers with higher income perceive more employment opportunities in fish trade despite the impacts of climate change. This is also contrary to the perception of fishers with higher income (-0.11). This implies that fishers invest less in fishing, while fish sellers invest more in the fish business instead of diverting their investment to other sectors.

The exogenous variables have some level of correlation

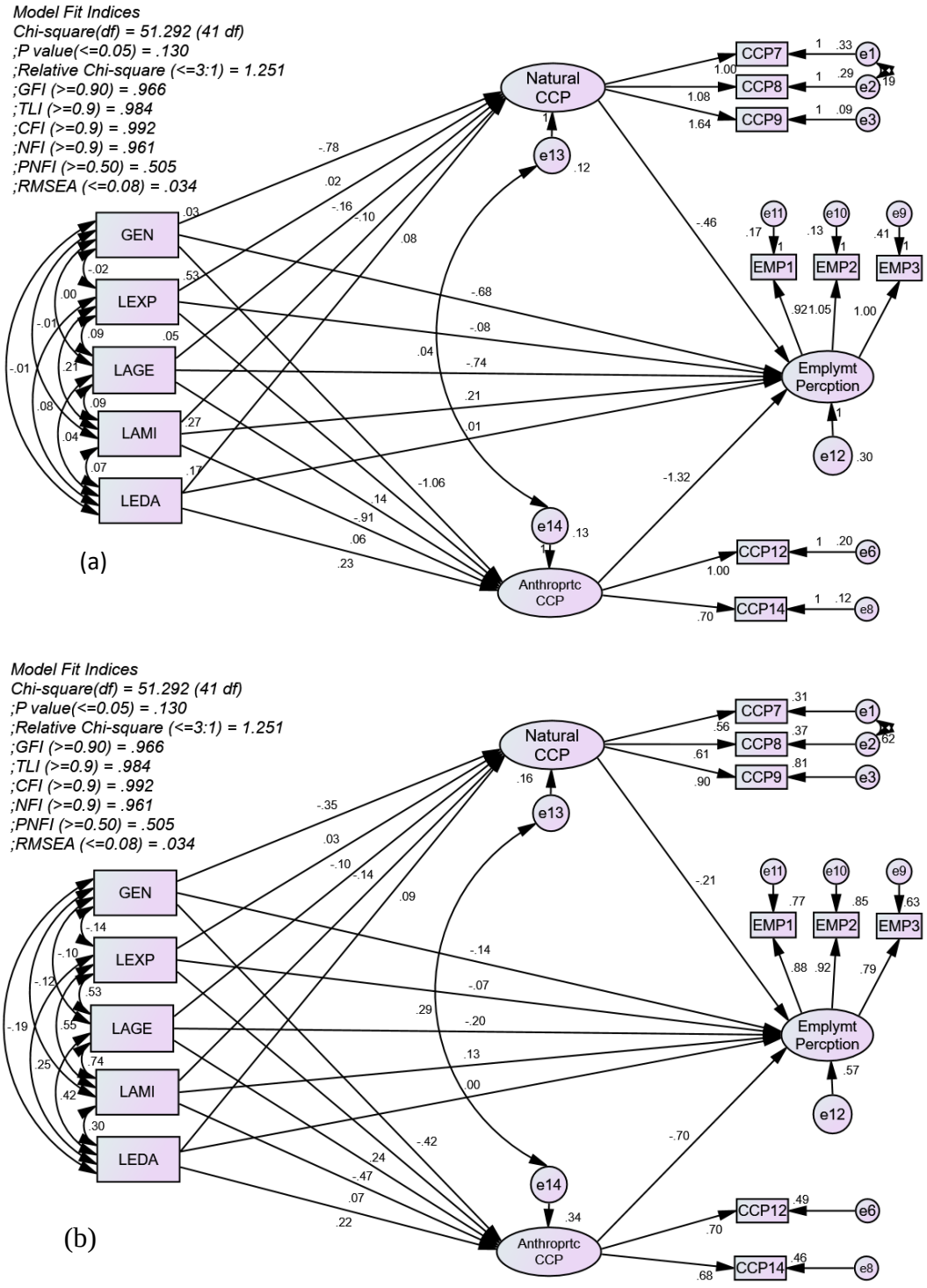



**Figure 2.** Fish sellers' estimated results for employment opportunities: **(a).** Unstandardised **(b).** Standardised (Source: Field Survey, 2022).

among them. However, these correlations are not high enough (> 0.85) to suspect a multicollinearity problem in the model (Awang, 2015). The correlations range from 0.19 (between gender and education) to 0.74 (between age and income). Also, the correlation between the error terms is 0.29. These low covariances among the exogenous variables, as well as the error terms of the endogenous variables, confirm the success of the

discriminant validity (Awang, 2015). Also, the regression weights between employment perception and natural CCP is -0.21 while with anthropogenic CCP is -0.70. This means that one standard deviation increase in natural and anthropogenic CCP, respectively, leads to a 0.2 and 0.70 standard deviation decrease in employment perception.

The model fit indices have attained the required cut-off limits. RMSEA is 0.034, and the relative Chi-square is 1.251. Both are less than the required limits of RMSEA ≤ 0.08 and CMIN/df ≤ 5 (i.e. 3:1) (Hair *et al*., 2010; 2014; 2022). All the fit indices that are supposed to be ≥0.90 have reached the required thresholds. For instance, GFI = 0.966, TLI = .984, CFI = 0.992 and NFI = 0.961, while PNFI = 0.505 (greater than its required limit of 0.50). Both the natural and human dimensions of perceived climate change risk, i.e., perceived vulnerability risk, have various degrees of effect on the employment opportunities as perceived by fish sellers in the study area.

## Conclusion

The study concluded that female fish sellers did not perceive the two dimensions of climate change as a threat to their business. It is also concluded that with an increase in age, the fish sellers' perception of anthropogenic CCP decreases. Another conclusion is that experienced fish sellers with many years of educational attainment perceived the anthropogenic CCP as a threat to their business. It is generally concluded that the effects of socio-economic variables of fish sellers are more significant on anthropogenic CCP than on the natural CCP. The study also concluded that the higher the income of a fish seller, the more they perceive employment opportunities in fish trade despite the impact of climate change. Also, female Fatoma perceived fewer employment opportunities in the face of climate change and variability. The study again concluded that, as a fish seller grows older, they perceive fewer employment opportunities in the trade. The result of the study also shows that there is no statistically significant relationship between education and employment perception. The relationship between experience and employment perception showed that experienced fish sellers did not perceive employment opportunities in the face of climate change in the fish trade. The study concluded that there were statistically significant relationships between the climate change dimensions and employment perception. It is therefore recommended that governments and their agencies create climate awareness advocacy among the fish trade stakeholders in the Lake Chad area. They should also promote positive adaptation and mitigation measures in the area.

## CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

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