June 25, 2025

DOI: 10.71113/JMSS.v2i3

Volume 2

Number 3

J M S S

JOURNAL OF MODERN SOCIAL SCIENCES

ISSN (P): 3078-4433

ISSN (E): 3078-4441

ASIA TECHNOLOGY RESEARCH INSTITUTE
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Journal of Modern Social Sciences (JMSS)
Volume 2 Issue 3 , 2025

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Virtual Water Resource Utilization Efficiency and Influencing Factors in China's Tertiary Industry: An Input-Output and Stochastic Frontier Analysis

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Abstract

This study aims to investigate the virtual water utilization efficiency and its influencing factors across 14 industries of China's tertiary industry during 2002-2020. By applying the input-output model, Shephard water distance function, and stochastic frontier analysis (SFA), this research incorporates multi-factor analysis with the total virtual water footprint as the water input indicator. Results show that the annual total virtual water footprint of the tertiary industry exhibited fluctuating changes, influenced by macroeconomic conditions, industrial structure, and water-saving policies. The overall virtual water utilization efficiency increased, though the growth rate decelerated, with significant disparities across industries: high-efficiency industries were concentrated in specific fields, while low-efficiency industries were mostly traditional service industries. Stochastic frontier analysis indicates that most estimation errors originated from the technical inefficiency term. Technical inefficiency analysis reveals that factors such as water resource endowment are significantly correlated with water-related technical inefficiency. This study provides a basis for deepening the understanding of water resource utilization in the tertiary industry and offers references for optimizing water resource management policies.

Keywords: virtual water utilization efficiency; Input-output model; Shephard energy distance function; Stochastic frontier analysis

Suggested citation: Cao, J., & Ding, W. Virtual Water Resource Utilization Efficiency and Influencing Factors in China's Tertiary Industry: An Input-Output and Stochastic Frontier Analysis. *Journal of Modern Social Sciences*, 2(3), 201–209. https://doi.org/10.71113/JMSS.v2i3.306

Introduction

Water is the source of life and plays a crucial role in economic and social development. With rapid global economic growth and continuous population expansion, water scarcity has become an increasingly severe issue, serving as a key constraint on national development (Qian et al., 2011). As a country with relatively limited water resources, China's per capita water availability is far below the global average, exacerbating water supply-demand conflicts. In this context, improving water resource utilization efficiency has emerged as a critical measure to alleviate water stress and achieve sustainable development (Sun & Zhao, 2014). Among various industries, the tertiary industry is vital for optimizing economic structures, promoting employment, and driving economic growth (Yang, 2018). In recent years, China's tertiary industry has witnessed a steady increase in its GDP share, accompanied by expanding water consumption. However, research on water resource utilization efficiency in the tertiary industry remains insufficient, failing to meet the needs of precise water management (Huang et al., 2022). Therefore, investigating the water resource utilization efficiency of the tertiary industry and its influencing factors is of significant practical importance for rational water allocation and sustainable development of the sector.

Scholars worldwide have conducted extensive research on water resource utilization efficiency. Early studies primarily employed single-factor indicators (Mo et al., 2004; Li et al., 2008), such as water consumption per unit of output, which are simple and intuitive but unable to comprehensively reflect the overall efficiency of water use. Subsequently, data envelopment analysis (DEA) gained popularity due to its advantages in handling multi-input and multi-output problems without predefined production functions. Many scholars have applied DEA and its extended models to measure and analyze water resource utilization efficiency across different regions and industries (He et al., 2017; Molinos et al., 2016; Cheng et al., 2016; Hu et al., 2018; Deng, 2019; Adler, N., Friedman, L., & Sinuany-Stern, Z. 2002). However, DEA has limitations, including its inability to account for random factors and statistical noise, as well as its lack of direct analysis of technical efficiency determinants (Chambers et al., 1998).

To address these issues, stochastic frontier analysis (SFA) based on the Shephard distance function has increasingly drawn attention (Wang & Li, 2021; Yang, 2012; Wang & Dong, 2024; Chen & Liu, 2022; Xing et al., 2018). This method not only measures efficiency and analyzes influencing factors simultaneously but also incorporates the impact of randomness on outputs, yielding more scientific and reliable results (Li & Fan, 2009). In terms of research perspectives, previous studies often focused on physical water consumption, whereas the concept of virtual water has opened new avenues for water resource research (Hoekstra & Hung, 2003). Virtual water refers to "invisible" water embedded in goods and services. Analyzing water resource efficiency from the virtual water perspective allows for comprehensive consideration of both direct and indirect water use across industries, providing a more holistic understanding of actual water utilization (Sun et al., 2025; Cai et al., 2020; Wu et al., 2022). Although some studies have adopted this perspective, research specifically targeting the tertiary industry remains underdeveloped (Zhang et al., 2010).

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.306

This study aims to fill this gap by examining China's tertiary industry. Using input-output models, the Shephard water distance function, and stochastic frontier analysis (SFA), we investigate the virtual water utilization efficiency and its determinants across 14 industries of the tertiary industry from 2002 to 2020. We construct a comprehensive analytical framework by treating total virtual water footprint as the water input indicator and integrating multiple factors, including labor, capital, technological R&D, pollution control, and subsector value added as the output. Through systematic analysis of trends in virtual water footprints, dynamic evolution of virtual water utilization efficiency, and key efficiency determinants, this research provides a scientific basis for formulating targeted water management policies and promoting efficient water use in the tertiary industry.

Methods

Input-output model construction

Compilation of the Water Resources Input - Output Table

Using the merged sectoral input - output table, the water - use data of each sector are taken as the water - related inputs and outputs to compile the water resources input - output table (Table 1). The direct consumption coefficient matrix can be calculated from the input - output table (Leontief & Ford, 1970):

$$A=\begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{pmatrix}, \text{ where } a_{ij}=\frac{x_{ij}}{X_j}$$

Virtual Water Accounting

(1) The direct water - use coefficient reflects the direct water - use intensity of sector *i*, representing the amount of water resources directly consumed by sector *i* for each unit of total output produced (Xu et al., 2002). The calculation formula is as follows:

$$w_i=\frac{W_i}{X_i}, \quad i=1,2,\cdots,n$$

By calculating the direct water - use coefficients of all sectors, we can obtain the row matrix of direct water - use coefficients:

$$DWC=[w_1,w_2,w_3,\cdots,w_n].$$

(2) The total water - use coefficient reflects the total water - use intensity of sector *i*, representing the sum of direct and indirect water consumption for each unit of total output produced by sector *i* (Xu et al., 2002). The import part needs to be excluded during the calculation:

$$B=\begin{pmatrix} a_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & a_n \end{pmatrix}, \text{ where } a_i=\frac{X_i}{IM_i+X_i}$$

By calculating the total water - use coefficients of all sectors, the row matrix of total water - use coefficients can be obtained, where DWC is the matrix of direct water - use coefficients, *I* is the identity matrix, *B* is the diagonal matrix of domestic production proportion, and *A* is the direct consumption coefficient matrix.

(3) The formula for calculating the virtual water of each sector is as follows:

$$TW=TWC\cdot TFU$$

In the formula: TWC is the row matrix of total water - use coefficients, TFU is the column matrix composed of the total final use of each sector in the input - output table, and TW is the matrix composed of the virtual water footprints consumed by each sector.

Table 1 Input-Output Table

	Intermediate Use			Final Use			Import	Total Output
	Sector 1	…	Sector n	Final Consumption Expenditure	Export	Total Final Use		
Sector 1	x_{11}	…	x_{1n}	TC_1	EX_1	TFU_1	IM_1	X_1
…	…	…	…	…	…	…	…	…
Sector n	x_{n1}	…	x_{nn}	TC_n	EX_n	TFU_n	IM_n	X_n
Value Added	V_1	…	V_n					
Total Input	X_1	…	X_n					
Water	W_1	…	W_n					

Shephard Water Resource Distance Function

Before constructing the distance function, a production technology set must first be defined. Based on the original three - factor framework (capital, labor, and personnel), two additional indicators are incorporated: technological R&D investment and pollution control investment. Thus, the input factors include capital input (K), labor (L), water resources (W), technological R&D (R), and pollution control (S), with sectoral value added as the output factor. The production technology set is expressed as:

$$(P=\{(K,L,W,R,S,Y):(K,L,W,R,S) \text{ can produce } Y\}$$

Following Zhou et al.'s construction of the Shephard energy distance function (Zhou et al., 2012), the Shephard water resource distance function is defined as:

$$D_e(K,L,W,R,S,Y)=\sup\{\alpha:(K,L,\frac{W}{\alpha},R,S) \in P(K,L,W,R,S,Y)\}$$

In the formula: *P (K, L, W, R, S, Y)* represents the possible set of outputs that can be produced under the input combination of capital (K), labor (L), water resources (W), technological R & D (R), and pollution control (S) under certain production technology conditions. The distance function D_e represents the maximum contraction ratio α of water resource input while keeping the output unchanged.

According to this definition, W/D_e is expressed as the optimal water resource input; the ratio of the optimal water resource input to the actual input is expressed as the water resource utilization efficiency *TWE*. Therefore, the formula is expressed as follows:

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.306

$$TWE = \frac{\frac{W}{D_e(K,L,W,R,S,Y)}}{W} = \frac{1}{D_e(K,L,W,R,S,Y)}$$

When $D_e(K, L, W, R, S, Y) = 1$, it means that it is currently on the production frontier, and the water resource utilization efficiency at this time is 1.

Construction of the Stochastic Frontier Model

In terms of the selection of the functional model, since the Cobb - Douglas production function has relatively more limitations and less flexibility (Battese & Broca, 1997), this paper adopts the trans - log production function in the selection of the functional form:

$$\ln D_e(K_{it}, L_{it}, W_{it}, R_{it}, S_{it}, Y_{it}) = \beta_0 + \sum_{j\in\{K,L,W,R,S,Y\}} \beta_j \ln X_{jit} + \beta_t t + \sum_{j\in\{K,L,W,R,S,Y\}} \beta_{jj} (\ln X_{jit})^2 + \beta_{tt} t^2 + \sum_{j<k,j,k\in\{K,L,W,R,S,Y\}} \beta_{jk} \ln X_{jit} \ln X_{kit} + \sum_{j\in\{K,L,W,R,S,Y\}} \beta_{jt} t \ln X_{jit} + v_{it}$$

Here, X_{jit} represents the input variable corresponding to j (for example, when j = K, X_{Kit} = K_{it}, and so on). In the formula: i represents the industry; t represents the year.

K_{it}, L_{it}, W_{it}, R_{it}, S_{it}, and Y_{it} respectively represent the fixed assets, the number of employees, the virtual water consumption, the technological R & D investment, the pollution control investment, and the added value of industry i in year t; v_{it} is the random error term, which follows the standard normal distribution; β is the parameter to be estimated. Through the deformation and derivation of the formula, the stochastic frontier function model in the standard form can be obtained:

$$\ln \frac{1}{W_{it}} = \beta_0 + \sum_{j\in\{K,L,R,S,Y\}} \beta_j \ln X_{jit} + \beta_t t + \sum_{j\in\{K,L,R,S,Y\}} \beta_{jj} (\ln X_{jit})^2 + \beta_{tt} t^2 + \sum_{j<k,j,k\in\{K,L,R,S,Y\}} \beta_{jk} \ln X_{jit} \ln X_{kit} + \sum_{j\in\{K,L,R,S,Y\}} \beta_{jt} t \ln X_{jit} + v_{it} - u_{it}$$

Here, X_{jit} represents the input variable correspond-ing to j (for example, when j = K, X_{Kit} = K_{it}, and so on). $u_{it} = lnD_e(K_{it}, L_{it}, W_{it}, R_{it}, S_{it}, Y_{it})$ re-presents the water resource inefficiency term of industry i in year t, and it follows the truncated normal distribution $N(m_{it}, \sigma_{it}^2)$; $(v_{it} - u_{it})$ represents the composite error term. Explanatory variables are introduced for the water resource inefficiency term: environmental protection investment (*EPI*), water resource endowment (*WRE*), technological development level (*TDL*), education development level (*EDL*), industrial structure (IS), urbanization process (*UP*), economic development level (*PG*), and industry endowment (*IE*). At this time, the water resource inefficiency function is:

$$m_{it} = a_0 + a_1 EPI + a_2 WRE + a_3 TDL + a_4 EDL + a_5 IS + a_6 UP + a_7 PG + a_8 IE + w_{it}$$

Among them, W_{it} is the random disturbance term of the water resource inefficiency function, and α_i is the estimated parameter. According to the setting of the technical inefficiency term by Battese and Corra (Battese & Corra, 1977), let $\gamma = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2}$, which represents the proportion of the water resource inefficiency term in the composite error term. The closer the ratio is to 1, the greater the influence proportion of the water resource inefficiency term.

Data Sources and Variable Descriptions

This study uses China's Input-Output Tables (2002, 2007, 2010, 2012, 2015, 2020) to integrate sectors into 19 industries per GB/T 4754-2017, selecting 14 tertiary sectors as decision units, Specific sector names and their codes are shown in Table 2. Panel data across 8 years explore their 2002-2020 water efficiency and influences. Water use data from China Water Resources Bulletin are determined by the "water production and supply" input proportions in Input-Output Tables. Tertiary industry water use is calculated by subtracting urban household water from total urban domestic water, reflecting public service consumption. Relevant literature informs the selection of input-output and influencing variables for efficiency analysis.

Table 2 Sectors and Their Codes

Code	Industry	Code	Industry	Code	Industry
01	Wholesale and Retail Trades	06	Real Estate Industry	11	Education
02	Transportation, Storage and Post Industry	07	Leasing and Business Services	12	Health Care and Social Work
03	Accommodation and Catering Services	08	Scientific Research and Technical Services	13	Culture, Sports and Entertainment Industry
04	Information Transmission, Software and Information Technology Services	09	Water Conservancy, Environment and Public Facilities Management Industry	14	Public Administration, Social Security and Social Organizations
05	Financial Industry	10	Resident Services, Repair and Other Services		

Input - Output Variable System

In this section, an input-output indicator system covering six dimensions is constructed to comprehensively reflect the multi-factor driving relationships of virtual water resource utilization efficiency. The input-output model is used to quantify the correlation mechanisms among variables, providing data support for subsequent efficiency calculations. Specific indicator data, their sources, and explanations are presented in Table 3.

Table 3 Data Sources and Explanations for Input-Output Variables

Variable	Indicator Definition	Data Source	Explanation
Water Resource Input	Total Virtual Water Footprint	China Statistical Yearbook and China Water Resources Bulletins	Calculated based on the input - output model
Labor Input	Number of Employees	China Statistical Yearbook	Reflects the scale of labor factors
Capital Input	Investment in Fixed Assets	China Statistical Yearbook	Reflects the accumulation of physical capital
Technological R&D	Expenditure on R&D	Industry statistical data and Science and	Represents the intensity of investment in

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.306

Input		Technology Statistical Yearbook	technological innovation
Pollution Control Input	Total Pollution Control Funds	China Environmental Statistical Yearbook	Measures the scale of environmental cost investment
Economic Output	Industry Added Value	China Statistical Yearbook	Reflects the final results of production activities

Influencing Factor Variable System

In this section, eight key socio-economic variables are selected to systematically analyze their mechanisms of action on water resource utilization efficiency. Through the construction of multi-dimensional indicators, the comprehensive impacts of factors such as regional differences, structural characteristics, and policy orientations are revealed. Specific indicator data, their sources, and explanations are presented in Table 4.

Table 4 Influencing Factor Variables: Data Sources and Explanations

Variable	Indicator Definition	Data Source	Explanation
Water Resource Endowment	Per Capita Water Resources	China Water Resources Bulletins	Reflects the constraints of natural conditions
Industrial Structure	Proportion of Tertiary Industry Output Value in GDP	China Statistical Yearbook	Reflects the degree of optimization of the economic structure
Industry Endowment	Ratio of Added Value to the Number of Employees	Industry statistical data	Determines the technology - or labor - intensive nature of the industry
Urbanization Process	Proportion of Urban Population in the Total Population	China Statistical Yearbook	Measures the stage of social development
Economic Development Level	Per Capita GDP	Provincial statistical year books	Reflects the characteristics of the economic development stage
Scientific and Technological Development	Number of Patent Applications Accepted	Website of the National Bureau of Statistics	Represents the technological innovation ability
Education Development	Number of University Graduates	Website of the National Bureau of Statistics	Reflects the accumulation of human capital
Degree of Environmental Protection Investment	Proportion of Environmental Protection Investment in GDP	China Environmental Statistical Yearbook	Reflects the intensity of investment in environmental governance

Results Analysis

Analysis of Sectoral Virtual Water Footprint Measurement Results

Based on calculations from the input-output model, the annual total virtual water footprint and its growth rate for the 14 sectors in China's tertiary industry during the period from 2002 to 2020 are presented in Figure 1, while the multi-year averages and annual growth rates of sectoral virtual water footprints are shown in Figure 2.

Figure 1 Annual Total Virtual Water Footprint and Growth Rate Trend Chart

Figure 1 reveals that the annual total virtual water footprint exhibits significant fluctuating characteristics across different years: it showed a continuous upward trend from 2002 to 2005, increasing from 759.449127 billion m³ to 821.94952 billion m³, with a growth rate of 8.23%. This period coincided with a high-speed economic expansion in China, where the average annual GDP growth rate exceeded 10%. The accelerated processes of industrialization and urbanization directly drove up water demand. A downward trend was observed from 2005 to 2010, followed by a resurgence from 2010 to 2015, and a new round of decline from 2015 to 2020.

Such cyclical fluctuations are closely linked to macroeconomic cycles, industrial structure evolution, and advancements in water resource management technologies. After 2005, the promotion of water-saving technologies and improvements in production efficiency reduced the intensity of water consumption in high-water-use sectors. With the gradual recovery of the global economy from the financial crisis in 2010, the rapid expansion of domestic service industries once again increased water demand. Since 2015, the deepening of supply-side structural reforms has shifted the industrial structure toward low-water-consumption and high-value-added sectors. The elimination of outdated production capacity and the popularization of green production technologies effectively curbed the growth of virtual water footprints.

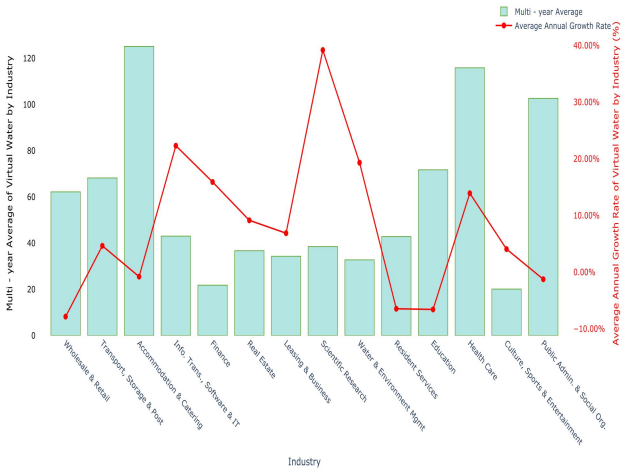

Figure 2 Trend Chart of Multi-year Average and Average Annual Growth Rate of Virtual Water

The data indicate a significant interactive relationship between water demand characteristics in different economic growth stages, improvements in production technical efficiency, and industrial structure optimization. The early high-speed growth was

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.306

accompanied by a synchronous increase in water demand, while in later stages, technological progress and industrial restructuring gradually enhanced water resource utilization efficiency, driving the total virtual water footprint into a downward trajectory.An analysis of the multi-year averages of sectoral virtual water consumption in Figure 2 shows that the accommodation and catering services, education, culture, sports and entertainment, and public administration and social organization sectors exhibit relatively high values. This is likely due to their intensive involvement in infrastructure construction and daily operational water use—such as water for catering services, daily water consumption in schools, and water for operating cultural and sports venues. In contrast, the financial industry, health care, social security, and social welfare sectors have lower multi-year average virtual water consumption, which is related to their service- and office-oriented nature with fewer physical water-consuming links.

Regarding the average annual growth rates of sectoral virtual water consumption: industries such as scientific research and technical services, information transmission, computer services, and software show relatively high growth rates. In recent years, these sectors have developed rapidly with expanding scales, and activities such as cooling for big data centers and the expansion of office spaces have increased water demand. Conversely, sectors like wholesale and retail trade, resident services and other services, and education have negative average annual growth rates. This is speculated to result from continuous optimization of water management and improvements in water use efficiency within these industries, as well as reduced water demand influenced by factors such as industrial restructuring and changing market environments.

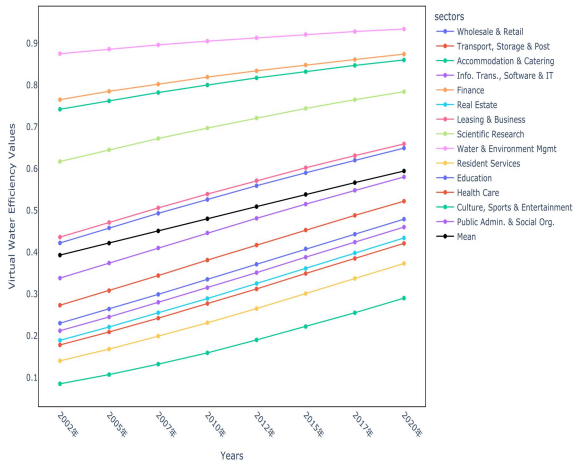

Figure 3 Line Chart of Virtual Water Resource Utilization Efficiency by Sector during 2002 - 2020

Analysis of Virtual Water Resource Utilization Efficiency Measurement Results

Using StataMP software, the virtual water resource utilization efficiency values for 14 sectors in the tertiary industry across multiple years from 2002 to 2020 were calculated, along with the multi-year averages for each sector and the annual average across all sectors, as shown in Table 5.

From 2002 to 2020, the overall virtual water resource utilization efficiency of the tertiary industry exhibited an upward trend, with the average efficiency across all sectors increasing from 0.393 to 0.594—a cumulative growth of 51.15%, as shown in fig 5. This period can be divided into two stages:

2002–2010: High-Speed Growth Period, with a compound annual growth rate (CAGR) of 2.39%. The fastest growth occurred from 2002 to 2005, reaching an annualized rate of 3.44%.

2010–2020: Slowdown Period, with the CAGR decreasing to 1.95%. The growth further moderated to 1.65% from 2017 to 2020, reflecting tech

As shown in Figure 3, the efficiency gradient exhibits distinct stratification, with a polarization between **high-efficiency sectors** (mean ≥ 0.7) and **low-efficiency sectors** (mean ≤ 0.35). High-efficiency sectors are concentrated in technology-intensive and policy-oriented fields (e.g., financial industry, environmental management), while low-efficiency sectors are mostly labor-intensive and traditional service industries (e.g., accommodation and catering, resident services).

High-efficiency sectors show stable growth:

Water Conservancy, Environment, and Public Facilities Management (efficiency value 0.934 in 2020) and the Financial Industry (0.874) consistently lead, with CAGRs of 0.45% and 0.88%, respectively. The former benefits from direct links to water resource management and rapid technological iteration, while the latter reduces physical resource dependence through digital transformation.

Mid-efficiency sectors demonstrate significant growth:

Information Transmission, Software, and In-formation Technology Services increased from 0.338 in 2002 to 0.580 in 2020—a substantial rise. As a knowledge-and-technology-intensive sector, continuous technological progress has optimized water use processes and promoted the adoption of water-saving technologies and equipment. Leasing and Business Services grew from 0.436 in 2002 to 0.659 in 2020, likely driven by improved industry standards, increased corporate focus on sustainable development, and implementation of water-saving measures.

Table 5 Table of Virtual Water Resource Utilization Efficiency by Sector during 2002–2020

Industry	Year								Mean
	2002	2005	2007	2010	2012	2015	2017	2020	
01	0.230	0.264	0.299	0.335	0.371	0.408	0.443	0.479	0.354
02	0.273	0.308	0.344	0.381	0.417	0.453	0.488	0.522	0.398
03	0.085	0.107	0.132	0.159	0.190	0.222	0.255	0.290	0.180
04	0.338	0.374	0.410	0.446	0.481	0.515	0.548	0.580	0.461
05	0.765	0.785	0.802	0.819	0.834	0.848	0.861	0.874	0.823
06	0.189	0.221	0.255	0.289	0.325	0.361	0.398	0.434	0.309
07	0.436	0.471	0.506	0.539	0.571	0.602	0.631	0.659	0.552
08	0.617	0.645	0.672	0.697	0.721	0.744	0.765	0.784	0.706
09	0.875	0.886	0.896	0.905	0.913	0.921	0.928	0.934	0.907
10	0.140	0.168	0.199	0.231	0.265	0.301	0.337	0.373	0.252
11	0.422	0.458	0.493	0.526	0.559	0.590	0.620	0.649	0.540
12	0.178	0.209	0.242	0.277	0.312	0.349	0.385	0.421	0.297
13	0.742	0.762	0.782	0.800	0.817	0.832	0.847	0.860	0.805
14	0.212	0.245	0.280	0.315	0.351	0.388	0.424	0.460	0.334
Mean	0.393	0.422	0.451	0.480	0.509	0.538	0.566	0.594	0.500

Low-efficiency sectors lag in improvement:

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.306

Accommodation and Catering Services (multi-year mean 0.180) only achieved 30.3% of the overall mean in 2020, with the gap widening annually (from 0.308 in 2002 to 0.304 in 2020). Resident Services (multi-year mean 0.252) also show slow progress. These sectors suffer from fragmented operations, limited management capacity of small and micro enterprises, and low penetration of water-saving technologies.

Stochastic Frontier Analysis

The results of the stochastic frontier analysis are presented in Table 6. From the overall model validity test, the model passes the joint significance test (Wald chi2(5)), indicating that the selected variables have overall explanatory power. The proportion of technical inefficiency variance, gamma = 0.7544984, shows that 75.45% of the error originates from the technical inefficiency term, with only 24.55% attributed to random noise.

The analysis of variable coefficients indicates that the estimated coefficient of sectoral added value in the reciprocal of virtual water consumption model is 0.4611978 and passes the significance test. This positive correlation reflects the promoting effect of industrial structure upgrading or technological intensification on water resource utilization efficiency. The estimated coefficient of labor input is -0.4588328, significantly negative, indicating that an increase in labor input significantly raises the scale of water resource input. The capital input variable did not pass the significance test,showing its impact on water resource input is statistically insignificant. The estimated coefficient of technological R&D investment is 0.4795237 (at the 5% significance level), suggesting that increased R&D investment significantly reduces dependence on fresh water by promoting the innovation and application of water-saving technologies and improving the recycling efficiency of water resources. The estimated coefficient of pollution control investment is 0.3691577 (at the 1% significance level), reflecting that increased environmental governance investment encourages industries to strengthen water resource protection and rational use—through measures such as reducing wastewater discharge and improving water quality—thereby significantly decreasing water resource input. Additionally, the inefficiency decay rate (eta = 0.099) shows that technical inefficiency decreases at an annual rate of 9.9%, meaning the efficiency gap between industries narrows gradually over time. However, the pace of improvement remains slow, necessitating stronger policy intervention to accelerate efficiency enhancement.

Table 6 Stochastic Frontier Model Regression Results

Variable	Coefficient	Std. Error	z	P>|z|
_cons	9.14949	2.309758	3.96	0.000
Sectoral Added Value	0.4611978	0.1242231	3.71	0.000
Labor Input	-0.4588328	0.1128231	-4.07	0.000
Capital Input	-0.0382183	0.0714376	-0.53	0.593
Technological R&D Input	0.4795237	0.2298477	2.09	0.037
Pollution Control Input	0.3691577	0.1279462	2.89	0.004
/eta	0.0989736	0.0247375	4.00	0.000
gamma	0.7544984	0.1493111		
Log likelihood	-23.944448			
Wald chi2(5)	63.11			

Analysis of the Technical Inefficiency Surface

The technical inefficiency term of virtual water consumption is analyzed using a fixed-effects model, with results presented in Table 7. The model's within-group R^2 is 0.7638, indicating strong explanatory power of independent variables for intra-industry efficiency fluctuations. However, the overall R^2 is low (0.2242), primarily because the fixed-effects model strips out time-invariant individual heterogeneity (rho = 0.943). The significance and direction of core variables highlight that environmental protection investment, technological innovation, and industrial structure upgrading are key dynamic factors driving efficiency improvements. Below is a detailed analysis of how each variable influences the technical inefficiency term of water resources:

Water Resource Endowment ($\beta = -2.2268$, $p < 0.01$) confirms the promoting effect of resource abundance on water-saving technological innovation by reducing technical inefficiency. Abundant water resources provide a tolerance space for industrial technology trials, facilitating experimental improvements in water use efficiency.

Industrial Structure ($\beta = -7.9037$, $p < 0.01$) exhibits the most pronounced negative effect: a 1% increase in the tertiary industry's share reduces the technical inefficiency term by 7.90%. This verifies the structural contribution of low-water-consumption industries to efficiency enhancement, as a higher proportion of tertiary sectors aligns with more water-efficient production patterns.

Technological Development ($\beta = -3.2746$, $p < 0.01$) and **Education Level** ($\beta = -0.8513$, $p < 0.01$) show significant negative correlations, reflecting the roles of technological innovation in process improvement and human capital in management optimization, respectively. Technological progress drives the adoption of water-saving technologies, while educated labor enhances operational efficiency through better resource management.

Environmental Protection Investment ($\beta = -0.8149$, $p < 0.01$) demonstrates a direct marginal effect: increased investment in environmental governance improves water resource utilization efficiency by upgrading sewage treatment facilities and promoting water-saving technologies, thereby reducing waste and enhancing reuse.

Notably, the positive effects of **urbanization process ($\beta = 14.8615$, $p < 0.01$)** and **economic development level ($\beta = 3.2532$, $p < 0.01$)** reveal a dual-pressure mechanism. Urbanization intensifies water supply-demand imbalances through population concentration, while economic growth outpaces efficiency improvements, leading to increased inefficient water consumption. **Industry endowment ($\beta = 0.1680$, $p = 0.160$)** lacks statistical significance, likely due to the complex relationship between technical intensity and water use efficiency in the sampled industries or limitations in data observation dimensions, which may obscure clear associations.

Table 7 Technical Inefficiency Term Regression Results

Variable	**Coefficient**	**Std. Error**	**t**	**P>|t|**
Water Resource Endowment	-2.226846	0.6982126	-3.19	0.007
Industrial Structure	-7.903651	2.324279	-3.40	0.005
Industry Endowment	0.1679892	0.1126267	1.49	0.160
Urbanization Process	14.86153	4.516941	3.29	0.006
Economic Development	3.25316	0.9615347	3.38	0.005

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.306

Scientific and Technological Development	-3.27464	0.9695216	-3.38	0.005
Education Development	-0.8513252	0.2509342	-3.39	0.005
Degree of Environmental Protection Investment	-0.8149081	0.2438856	-3.34	0.005
rho	0.94295681			
Overall R - squared	0.2242			
Within R - squared	0.7638			

Conclusion

This study employs an input-output model to measure the virtual water footprint of 14 sectors in China's tertiary industry from 2002 to 2020, and uses the Shephard water footprint distance function and a stochastic frontier model to conduct an in-depth exploration of virtual water resource utilization efficiency and its influencing factors. The following conclusions are drawn:

Sectoral Virtual Water Footprint Measurement

From 2002 to 2020, the total annual virtual water footprint of the tertiary industry exhibited fluctuating trends, primarily associated with macroeconomic conditions, industrial structure adjustments, and the implementation of water-saving measures. At the sectoral level, accommodation and catering services, education, and other sectors had relatively high multi-year average virtual water consumption, while the financial industry, health care, and social work sectors had lower values. Sectors such as scientific research and technical services showed relatively high average annual growth rates in virtual water consumption, whereas sectors like wholesale and retail trade experienced negative growth.

Virtual Water Resource Utilization Efficiency Measurement

Over 2002–2020, the overall virtual water resource utilization efficiency of the tertiary industry showed an upward trend, though the growth rate gradually slowed, reflecting diminishing marginal returns and a narrowing scope for technological improvements. A distinct efficiency gradient emerged: high-efficiency sectors, concentrated in technology-intensive and policy-oriented fields, demonstrated stable growth; mid-efficiency sectors showed significant efficiency improvements; low-efficiency sectors, mostly labor-intensive and traditional service industries, lagged in progress.

Stochastic Frontier Analysis

The model passed the joint significance test, confirming the overall explanatory power of the selected variables. Most of the error was attributed to the technical inefficiency term. Sectoral added value was positively correlated with virtual water consumption, promoting water resource utilization efficiency; increased labor input led to higher water resource input; capital input had no significant impact on water resource input; increased technological R&D and pollution control investments significantly reduced water resource input. Technical inefficiency decreased at an annual rate of 9.9%, but the pace of improvement remained slow.

Technical Inefficiency Surface Analysis

Results from the fixed-effects model indicated strong explanatory power of independent variables for intra-industry efficiency fluctuations. Improvements in water resource endowment, industrial structure, technological development, education level, and environmental protection investment significantly reduced the technical inefficiency term of water resources. Conversely, urbanization and economic development were associated with increased technical inefficiency, while industry endowment had no significant effect, likely due to complex correlations or data limitations.

Based on the research findings, the following recommendations are proposed to further improve virtual water resource utilization efficiency in the tertiary industry:

Optimize Industrial Structure for Low-Water-Consumption Transitions

Continue to adjust the industrial structure toward low-water-consumption and high-efficiency sectors by accelerating the transformation and upgrading of water-intensive traditional service industries. Encourage the development of technology-intensive and knowledge-intensive service sectors with low water consumption, thereby facilitating structural optimization and enhancing overall water resource utilization efficiency.

Increase Investment in Water-Saving Technology Innovation and Adoption

All sectors should prioritize research and development (R&D) investments to drive the innovation and application of water-saving technologies. Sectors with high average annual growth rates in virtual water consumption should particularly focus on developing and adopting advanced water-saving technologies and equipment to improve water recycling efficiency and reduce reliance on fresh water resources.

Strengthen Education and Environmental Awareness for Sustainable Practices

Enhance educational levels and environmental consciousness by strengthening specialized education in water resource management at universities, cultivating professionals with water-saving awareness and management capabilities. Through targeted education and advocacy, raise environmental awareness among the public and enterprises, prompting active adoption of water-saving measures to improve utilization efficiency.

Expand Environmental Protection Investment for Infrastructure and Technology Upgrades

Governments and enterprises should increase investments in environmental protection projects, including sewage treatment and water resource recycling, to modernize water treatment facilities and promote the adoption of water-saving technologies and equipment. Incentivize enterprises to implement environmentally friendly and efficient production processes, thereby reducing water waste and technical inefficiencies.

Balance Urbanization, Economic Growth, and Water Resource Management

Address the challenges of urbanization and economic development by strengthening water resource management and supply system construction. Rationalize urban water planning, promote the use of water-saving appliances and infrastructure, and enhance urban water utilization efficiency. During economic growth, prioritize improvements in water resource efficiency to avoid excessive consumption and waste, ensuring coordinated development between economic progress and water resource protection.

These recommendations align with the study's empirical insights, aiming to provide actionable strategies for achieving sustainable water resource use in the tertiary industry through structural optimization, technological innovation, human capital development, and policy intervention.

Acknowledgments

The authors thank the editor and anonymous reviewers for their helpful comments and valuable suggestions.

Funding

Not applicable.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Statements and Declarations

Statements and Declarations
No funding was received for conducting this study. The present study has no relevant financial or non-financial interests to disclose.

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Author Contributions

Not applicable.

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JOURNAL OF MODERN SOCIAL SCIENCES Volume 2 Issue 3 , 2025, 210-214
ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.298

Homeland and Ancestor - Social Identity and National Consciousness of Malaysia Chinese

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Abstract

This article discusses how the Chinese who have lived in Malaysia for generations treat their national identity, citizenship, social identity, and explore the various differences between Malaysian Chinese and Chinese in China. Especially the new thoughts differences, and similarities that those Malaysian Chinese who choose to "return" to China to live have developed after coming into contact with Chinese society and culture. Through an interview with a Malaysian Chinese living in Iwu, Chekiang Province, and a systematic analysis of existing academic materials, this article will discuss those differences, including how the identity of "overseas Chinese" differ from "ethnic Chinese", how Chinese living in a multi-ethnic country like Malaysia is different from a single-ethnic country like China, and how the Chinese dialect influences and inherits Chinese national consciousness.

Keywords: Chinese Dialect, Malaysia Chinese, Social Identity, Nation-State, National Consciousness

Suggested citation: Qin, X. (2025). Homeland and Ancestor - Social Identity and National Consciousness of Malaysia Chinese. *Journal of Modern Social Sciences*, 2(3), 210–214. https://doi.org/10.71113/JMSS.v2i3.298

Introduction

Malaysian Chinese have a long history. As early as the 15th century, after Zheng He's voyages to the West (鄭和下西洋) organized by the Emperor of the Ming Dynasty of China, a large number of coastal residents of China, forced by their livelihoods or in search of more wealth, left their hometowns, sailed to sea, and settled in various locations in Southeast Asia, including today's Philippines, Malaysia, Indonesia, Thailand, and Singapore. As the British began to colonize Southeast Asia and the Qing Dynasty in China faced internal and external troubles in the late 19th century, more Chinese chose to "Ke Hoan(過番, go aboard)" and come to British colonies to work, mine minerals or serve on plantations. They mainly come from Fukien, Taiwan, and Canton Province in southern China, speak different languages: Hokkien, Cantonese, Teochew or Hakka, and are divided into different Chinese communities based on their mother tongue. After the independence of Malaysia and Singapore, the status and influence of the Chinese in the local area continued to change, and eventually became an indispensable and important part of the multi-ethnic country of Malaysia (Lee, 2009a).

Malaysian Chinese, as an ethnic entity, have always been the focus of social research due to their special status. In Malaysia, they are one of the many ethnic groups, but they belong to the same nation as the majority of China's population. Therefore, their relationship, identity, and cultural belonging with their motherland Malaysia, and China's Chinese is an issue worth exploring. In recent years, with the rapid development of China's economy, many Malaysian Chinese have "returned to their roots" and either chosen to settle in China or come to their ancestral hometowns to look for family relatives. As members of the broad "same nation", the differences between China's Chinese and Malaysian Chinese constitute a new research topic.

As an important basis for the research and conclusions of this article, we interviewed Mr. Anderson, who currently lives in Iwu, Chekiang Province. He is a young entrepreneur from Kuantan City, Malaysia. He came to Chekiang Province with his China wife several years ago to settle and run a business. His great-grandfather left hometown - Putian, Fukien Province, China - before World War II and settled in Malaysia, making him a typical Malaysian Chinese who can be used as a research subject. Through interviews with him and combined with academic materials, this article will comprehensively analyze the situation and differences of Malaysian Chinese in the following three topics: the use of Chinese dialects by Malaysian Chinese; the cognitive and social differences between the multi-ethnic country of Malaysia and the single-ethnic-dominated country of China; and the interaction and connection between the dual identities of Malaysian Chinese as "Chinese" and Malaysian citizens;

The Heritage of Home Voice: Daily Use of Chinese Dialects by Malaysian Chinese

The two provinces of Canton and Fukien, due to their geographical location on the southern coast of China and close to Southeast Asia, have become important source areas for overseas Chinese since the Age of Discovery. In addition, in the century after the Opium War, most of the port cities that were forcibly opened or occupied by Western colonists were in these two provinces: such as Chinchew, Canton City, and Hong Kong. Therefore, these two provinces have become an important source of immigrants, and the population with these two provinces as their ancestral home accounts for the vast majority of the Chinese population in Malaysia. Also brought with them by the immigrants were their dialects: Foochow (福州話), Hokkien (閩南話), Teochow (潮州話), Hakka (客家話), Hailam(海南話) and Cantonese (廣州話) which make up the "6 major sub ethnic groups" of Malaysian Chinese. Among them, the Hokkien and Cantonese-speaking groups are the largest and have the most extensive influence (Wang, 2016). Nowadays, on the streets of Kuala Lumpur or Penang, one can communicate freely using Hokkien or Cantonese without any language barriers. Unlike China, in Malaysia, people form communities based on Chinese dialects. People whose mother tongue is the same dialect have better

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.298

feelings for each other and have closer communication (Puah & Ting, 2014). With the widespread popularization of Mandarin, such obvious distinctions basically no longer appear in mainland China.

A Study on the Importance of Dialects Among Malaysian Chinese: For Culture Heritage

In her work, Brenda J. Allen emphasized the importance of differences, pointing out that even within the same or similar ethnic groups, specific differences within them should be valued, (2010, Pg 5) which is fully reflected on Malaysian Chinese. As mentioned earlier, among the Malaysian Chinese, dialects have great significance in cultural and social life. People who speak the same dialect and can communicate with each other in their mother tongue usually have ancestors from the same region of China and share a common regional culture, way of thinking, and clan heritage, so they are more likely to accept each other and work together. In the early days of Chinese immigration, immigrants faced an unfamiliar land, hostile indigenous people, and colonial governments. They had no choice but to help each other in order to finally take root in their new homeland. As a result, dialects became an important symbol for dividing groups, not only symbolizing the origin of the ethnic group but also an important communication tool (Ng & Chan, 2017). On the other hand, Lee's research (2009b) shows that in Malaysia, the most important indicator of whether a person is Chinese is whether he or she can speak “Sinophone”, which means any dialect of Chinese in Malaysia.

Language are important tool for Malaysian Chinese to maintain their ethnic uniqueness. This is determined by the history and environment experienced by the Chinese in Malaysia. Since Malaysia's independence from British colonial rule, the United Malays National Organization has been in control of the Malaysian government and has continued to promote the nationalist policy of "Malay supremacy". In 1969, the fierce conflict between the Malays and ethnic minorities eventually triggered the "13 May Incident", resulting in bloody conflicts. In 1970, the government implemented the "National Culture Policy" and in 1971 promulgated the "New Economic Policy", which was essentially a policy to provide more development space for the Malays and plan to assimilate other ethnic groups into Malays culturally (Matondang, 2016). Under the increasing pressure of Malay nationalism, the Chinese are seeking to inherit and protect their own language and culture, maintain their independence, and oppose any assimilation. Therefore, Malaysian Chinese regard language as an important cultural carrier and rebellious spirit, and have formed a unique language and cultural consciousness.

Reflection of Difference Between Malaysia Chinese and China Chinese in Language: Example From Interview

During the interview, Anderson mentioned that his great-grandfather was from Putian, Fukian Province, and came to Malaysia with his fellow villagers to start a business and settle down during the wave of migration to Southeast Asia . In daily life, his family mostly speaks Hokkian, and the Chinese community where he lives in Kuantan also mainly speaks Hokkian. Although the local Chinese school he attended taught mainly Mandarin, he learned Hokkian from his family. He also mentioned that he learned Cantonese when he was a university student in Kuala Lumpur, so he has a good command of the three main Chinese dialects in Malaysia. Anderson’s description also fully reflects the regional specificity of dialect boundaries: Hokkian is spoken in many Chinese communities in Kuantan, while Cantonese is spoken in Kuala Lumpur. In China, people are more likely to be divided by administrative boundaries, such as provinces, or other cultural characteristics, and as the government's efforts to promote Mandarin continue to deepen, more and more young people no longer speak their hometown dialects, people often define whether a person is Chinese based on appearance, looks and origin rather than language. Anderson also mentioned that he found that in China, even in dialect areas, people will first use Mandarin instead of their own dialect to communicate with others, which is completely opposite in Malaysia . All of these constitute important differences in language among Malaysian Chinese, makes it an important observation point in differential research.

Collision Between Multi-Ethnic State and Nation-State: The Main Differences In The Status and Role of Chinese In China and Malaysia

Malaysia is obviously a multi-ethnic country. According to a statistic from Worldatlas (Sawe, 2019), among the various ethnic groups in Malaysia, Malays account for 50.1% of the population, Chinese account for 22.6%, other indigenous people account for 11.8%, and Indians account for 6.7%. These data show the diversity and complexity of Malaysia's ethnic composition. Although the Malays are often regarded as the majority of the country, they only make up half of the country's population and are far from meeting the standards of a nation-state. On the contrary, among China’s 56 ethnic groups, the Han nationality accounts for more than 91% of the population, and the vast majority of other ethnic minorities do not exceed 1% (University of Minnesota Human Rights Library, 2014). This establishes the Han nationality as the dominant ethnic group in China, also with Chinese government intends to unite the entire country's population under one definition using the supra-ethnic concept of "ZhongHua MinZu (中華民族, Nation of China)” (Zhang, 1997), all of those making China an in fact “nation-state.” In these two completely different societies, the situations, challenges, and national cognition faced by Chinese people are also completely different. Specifically, in Malaysia, the Chinese not only face the issue of multi-ethnic coexistence but also face challenges regarding cultural independence under the nationalist policies of the Malays in power.

Coexistence and Integration of Chinese and Other Ethnic Groups In Multi-ethnic Context

As the absolute subject of the country, in China, "Chinese" is almost synonymous with "China". In most cases, Chinese people regard the country as the complete property of their nation and do not need to deal with ethnic relations issues within their own country. In Malaysia, the number of Chinese is neither as small as in the United States and Australia to be considered a specific "immigrant group", nor as large as in China. As an important part of the Malaysian nation, the Chinese need to think about and practice not only their own society and lifestyle but also the will of the entire country. In this regard, the study by Ong et al. (2020) explored the "Enduring Values of Ethnic" of the Malaysian state to maintain ethnic harmony, that is, the government balances the needs and interests of each ethnic group and maintains social stability through ethnic consultation and overall planning. As the second largest ethnic group, Chinese society is inevitably closely related to these issues. This national environment also leads to different self-perceptions of Malaysian Chinese and Chinese. Anderson said in an interview that he would consider the Chinese to be "part of the many ethnic groups in Malaysia" and not much different from other ethnic groups , which further reflects the unique thinking and status of Malaysian Chinese in the multi-ethnic narrative.

With the continued existence of the Chinese community in Malaysia and the continuous formation of a multi-ethnic society, the cultures of various ethnic groups will inevitably blend and change. The cultural customs and ways of thinking of Malaysian Chinese have also changed due to the integration between ethnic groups. In his book (2010, pg 70), Allen mentioned the

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.298

phenomenon of racial integration and racial transformation in the United States when arguing for Race Matter. This challenged traditional racial concepts and proved that race is not fixed and unchanging, but fluid, and so is national culture. Among the Chinese in Malaysia, one can see rice dumplings filled with Indian curry fillings, and Peranakan cuisine, which is a fusion of Chinese and Malay eating habits (Zhang, 2024a). Finally, in terms of thinking, Malaysian Chinese, in a multi-ethnic environment, have formed a mindset that pays more attention to individual habits and differences. As Anderson mentioned in an interview, when he came to China, he felt uncomfortable with the Chinese people's unified fast-paced way of doing things and living, because in Malaysia, people are not required to do things at the same pace and efficiency, but are more likely to follow their own wishes.

Under Malay Nationalism, Challenge of Malaysian Chinese to Maintain National Cultural Independence

In sociology, race is often considered a product of "social construction," a man-made concept that serves a purpose, and therefore naturally requires proper maintenance and constant construction to maintain (Allen, 2010). Such concepts are reflected in the long-standing rivalry and complex relationship between the Malays and the Chinese in Malaysia. The inheritance and emphasis on traditional culture, customs, and language by Malaysian Chinese fundamentally stems from the Malay government's decades-long "Ketuanan Melayu" (Malay Hegemony) policy. From Malaya's independence in 1957 to the national election in 2018, the United Malays National Organisation has been in power in Malaysia for 61 years and has always pursued the ideology of Malay supremacy. The National Culture Policy (NCP) mentioned above, promulgated in 1971, is a concentrated embodiment of this idea. The NCP aims to establish a broad "Malaysian nation" in which all ethnic groups are integrated into the Malays, speak the Malay language, and accept Islamic traditions (Matondang, 2016). At the same time, "Malay Privilege" is ubiquitous in society, and Malays can use their privileges to "make life easier; it is easier to get around, to get what one wants, and to be treated acceptably." As Allen described (2010, pg 15).

Under such circumstances, to uphold their cultural heritage and national uniqueness, Malaysian Chinese have to attach great importance to their own cultural traditions and try their best to avoid the fate of assimilation. They attach great importance to the inheritance of language, clan rituals, and traditional festival celebrations, and insist on opening Chinese schools despite government pressure in order to gain independent education. At the end of our interview, Anderson pointed out that he believed the main difference between Malaysia and China was the religious atmosphere. In Malaysia, Islamic traditions and lifestyles are everywhere, and even non-Muslims have to follow them . This further reflects the challenges faced by Malaysian Chinese in maintaining their own independent culture. With modernization and the emergence of new subcultures, Chinese people living in China are experiencing a rapid process of accepting new things and improving or abandoning old cultures. But in Malaysia, the challenges brought by the multi-ethnic society make it impossible for them to update so quickly, and they can only protect and pass on their own culture as much as possible.

Chinese Race or Malaysian Citizen: Social Identity and Roots Seeking Vision of Chinese Malaysians

The uniqueness of the social identity of the Chinese in Malaysia lies in the fact that they are the majority ethnic group of one country (China) but settled in another country. This gives them a complex social identity and self-perception: they are both citizens of Malaysia and members of the Malaysian nation, and they are also Chinese, a group of people with the same roots as the majority ethnic group in China (Tan, 1997). Many Malaysian Chinese are sharing Anderson's idea: in their daily lives, they are just one of Malaysia's multi-ethnic groups and ordinary Malaysian citizens. However, when they see China making some construction achievements or further increasing its influence internationally, they also feel proud and realize that they are Chinese like those who have made great achievements . For China, these compatriots are both distant and close: they are minority, but they have the same faces and speak the same language. In recent years, with the development of transportation and Internet, many Malaysian Chinese have returned to Canton and Fukien Province - where their ancestors left - to find their roots, or to find kin with the same clan and same family name. For them, this is not just a search for roots, but also an attempt to find the true source of their own social identity.

The Evolution and Status of Social Identity For Malaysian Chinese

The identity of Malaysian Chinese has undergone a long evolution over history, and there are obvious generational differences. Early Chinese immigrants often considered themselves to be "Huaqiao (華僑, Oversea Chinese)", that is, Chinese people temporarily living in a foreign country. They often formed hometown associations, were concerned about China, and had the idea of "returning to one's roots". During World War II, overseas Chinese contributed a lot of property and strength to the war against Japan (Zhang, 2024b). After these overseas Chinese passed away, their hometowns were often written on their tombstones. But with the birth of the second and third generations of Chinese immigrants, the identity of "Huaqiao" gradually changed to "Huayi (華裔, Ethical Chinese)". They no longer consider themselves to belong to China, but to the country where they were born and live. However, their cultural identity has been preserved with the continuation of Chinese education (Lee, 2009), forming the unique Malaysian Chinese community today.

The increase in social mobility and inter-ethnic exchanges also affect the national identity of Malaysian Chinese. A study of Chinese people in Foochow pointed out that the social circles of the previous generation of Chinese were mostly relatively closed and limited to the Chinese community. However, the new generation of young people have the opportunity to come into contact with people from more ethnic groups and have a more open attitude towards their identity, and their unique identification with "Chinese" has weakened (Ting & Ting, 2020). Ong and Troyer's research (2022) also pointed out that in Chinese families, young people often communicate with their elders in dialects, but mostly use Mandarin with their peers because they have wider interpersonal relationships and more opportunities to come into contact with different communities and different ethnic groups, so they need to use a more common language of communication. Identity maintains a delicate balance and changes between "Chinese" and "Malaysian citizen".

Searching For Roots: New Thinking and Understanding of Cultural Identity

With the development of the Internet and the increasing mobility of people, people have more and more means to obtain information. For many Malaysian Chinese, this has brought them an opportunity that may be rare for several generations: returning to their ancestral hometowns in China, or finding distant relatives of the same family living in China. As mentioned earlier, the ancestors of the Chinese in Malaysia mostly came from the provinces of Canton and Fukien. These two southern Chinese Reigns have a strong sense of family and hometown and attach particular importance to the connection between family members and the worship of ancestors, as well as the editing and preservation of family trees. Such cultural customs

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.298

are also preserved by the Chinese in Malaysia today (Lim, 2007), and this is also one of their motivations for searching for their roots. Through social platforms such as Rednote, many Malaysian Chinese are able to communicate directly with Chinese people living in their ancestral hometowns and obtain accurate information about their ancestral hometowns: whether it is the place names on the tombstones of family ancestors or the brief descriptions of elders, they can all become clues and become a bridge to communicate between the Chinese in the two places. Many people eventually succeeded in finding or visiting their ancestral hometowns, fulfilling the regret of their elders who wanted to go but could not; others met relatives from the same family, with the same surname, who had the same ancestor several generations ago. Their social identity as "Chinese" has become more concrete through such behavior, and their ancestral home has also changed from an empty place name to a scene that can be seen with their own eyes.

Conclusion

In conclusion, this essay shows that among Malaysian Chinese, Chinese dialects serve as vital cultural anchors. In Malaysian cities like Kuala Lumpur and Penang, people routinely converse in Hokkien, Cantonese or other dialects within their communities, forging bonds based on shared regional heritage. This contrasts sharply with China today, where Mandarin's dominance has rendered such dialect-based groupings obsolete; Speaking any Malaysian Chinese dialect ("Sinophone") is itself a key marker of Chinese identity , meaning language choice reflects and reinforces ethnic solidarity. The essay's second theme contrasts Malaysia's plural nation-state with China's Han-centered model. Under Malaysia's Malay-Muslim majority and nationalist policies, Chinese Malaysians feel compelled to protect their own language and traditions as symbols of heritage. In mainland China, by contrast, the expectation is to assimilate into a single national culture. Anderson's narrative exemplifies this dual reality: he lives as an ordinary Malaysian citizen but also feels "proud" of China's achievements, showing himself as part of the broader Chinese "same nation". Finally, these factors produce a layered identity. Earlier immigrants identified as Huaqiao (Overseas Chinese) with enduring ties to China, whereas later generations increasingly see themselves as Malaysian citizens of Chinese descent. Chinese-language schools and clan associations continue to transmit heritage, so that being both Malaysian and Chinese remains a lived reality.

Reflecting on these findings, our perspective which inspired by Anderson's interview brings the themes into focus. Anderson's own experience highlights the negotiation of identities: in Kuantan, his family speaks Hokkien at home, he learned Cantonese at university, and Mandarin in school. He explicitly points out that Malaysia's Islamic cultural context is a defining difference from China , which helps explain why Malaysian Chinese must consciously preserve their customs. These personal insights validate the essay's claims: language and ancestral rituals become acts of cultural assertion. As mentioned, Malaysian Chinese have even come to view their language and customs as a form of "rebellion" against assimilation . In sum, Anderson's narrative confirms that the symbolic and conflict idea of "homeland and ancestor" profoundly shapes Malaysian Chinese identity in everyday life.

Looking ahead, there are several avenues for future research. The essay itself documents a shift from Huaqiao to Huayi identities over generations, indicating that longitudinal studies of younger Chinese Malaysians could illuminate how heritage and nationalism evolve. The rise of digital diaspora networks is another promising area: Social platforms enable Malaysian Chinese to trace ancestry and reconnect with relatives in China, so studying online community-building could reveal new forms of transnational identity. Comparative research with other overseas Chinese communities (For example, in Indonesia or the West) would also be fruitful, to see which patterns of language loyalty or homeland sentiment are unique to Malaysia. By following these lines of inquiry, future work can deepen our understanding of how Malaysian Chinese - and overseas Chinese more broadly - reconcile their dual heritage in an increasingly interconnected world.

Acknowledgments

The authors thank the editor and anonymous reviewers for their helpful comments and valuable suggestions.

Funding

Not applicable.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Statements and Declarations

Statements and Declarations
No funding was received for conducting this study. The present study has no relevant financial or non-financial interests to disclose.

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Author Contributions

Not applicable.

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ATRI PRESS

Journal of Modern Social Sciences

Volume 2 Issue 3 , 2025

ISSN: 3078-4433 | eISSN: 3078-4441

Managing land use disputes in mining areas in Sub-Saharan Africa

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Abstract

Mineral extraction, one of the major and important economic activities in Sub-Saharan Africa, lies at the centre of land use disputes in the region. This paper examines the induced mining land use disputes in Obuasi, Ghana, in Sub-Sahara Africa, considering stakeholder perspectives. A mixed-method approach was used, combining qualitative and quantitative research methods in data collection and analysis. Data was collected through the administration of questionnaires and structured interviews involving 92 respondents. Thematic analysis and statistical analysis were performed to provide a comprehensive understanding of the issues. It was found that mining land use disputes in Obuasi are rooted in unequal benefit sharing, unfair compensation processes, and land access modes that prioritize mining companies over landowners. It also had to do with the weak implementation and enforcement of existing regulatory frameworks. This resulted from the low awareness among landowners and the government's inaction in holding powerful actors accountable, which led to limited effectiveness in the prevention and management of mining land use disputes. Targeted interventions include creating regular stakeholder forums, setting up open grievance reporting systems, and practicing transparent compensation mechanisms with independent valuation.

Keywords

Land Dispute, Mining Areas, Landowners, Obuasi, Sub-Saharan Africa

Suggested citation: Sarpong, E., Dinye, R. D., & Sarpong, C. K. (2025). Managing land use disputes in mining areas in Sub-Saharan Africa. *Journal of Modern Social Sciences*, 2(3), 215–225. https://doi.org/10.71113/JMSS.v2i3.188

Introduction

Land disputes are among the greatest challenges in governance, and they traverse societies everywhere on the globe. They come about because of limited land and population growth (Iswantoro, 2021). They occur as a result of competing claims, boundary disagreements, survey errors, and differences in land use objectives (Krawchenko & Tomaney, 2023). Land disputes range from border disagreements between neighbors to complicated multiparty conflicts. Land inheritance disputes are quite frequent in Sub-Saharan Africa. Bugri (2008) reported that community's conflict over public land use and management, making the issue complex. Economic value, appreciation worth, and productivity of land are all vital to people, society, and states. This importance contributes to rising conflict over land, particularly among emerging economies where the management of land collapses due to incongruous administration strategies (Boafo-Anang et al., 2021).

Sub-Saharan African mining clashes with indigenous land use, which is controversial. Large-scale operations clash with local land rights, setting up a dilemma between economic progress and social justice (Hilson, 2019). Artisanal and small-scale mining (ASM) complicates matters, as it offers livelihoods but might lack legal and environmental protections. Hirons (2014) notes that there are disputes wherever ASM operators and large mining firms lay claim to the same mineral fields.

Several communities still do not receive fair compensation for land acquisition and traditional access to resources amidst policy changes (Lange, 2011). Traditional leaders have a central role in negotiating between the communities and mining companies but are undermined by the level of sophistication that characterizes modern mining activities (Nyame and Grant, 2014). Mining activities cause environmental degradation through soil and water pollution, deforestation, and landscape changes, adding to these disputes (Kitula, 2016). Land conflicts in Ghana hamper socioeconomic development and cause instability. Boundary and property disputes are exacerbated by weak resolution (Wehrmann, 2008). 80% of the land is traditionally owned, and state laws are slowly integrated into the system (Akrofi, 2013).

Obuasi district in the Ashanti region of Ghana has been highly impacted by mining activities on land use patterns (Okoh, 2014). Before mining, the area was mainly cocoa farms and subsistence agriculture (Ofosu-Mensah, 2012). Surface mining has sparked competition with traditional agriculture, which has led to conflict among companies and locals. Resettled farmers are given inadequate compensation and resettlement packages, which create

feelings of injustice and economic uncertainty (Owusu-Koranteng, 2008).

Poverty and unemployment drive members of communities to engage in illegal small-scale mining on lands meant for legal mining. This leads to frequent conflicts between communities and mining companies, sometimes resulting in violence and loss of lives and property (WACAM, 2008). Despite studies in Obuasi on the impact of mining on land use and community viability, there exists a key research gap on land use conflicts in mining communities, particularly in terms of stakeholder consultation and governance. Despite World Bank assistance, land administration in Ghana is beset by inefficiency, inaccuracy of information, and poor coordination. Ghana's multiculturalism, which was an asset, complicates the management of land conflicts due to competing cultural perceptions and practices (Osei-Bagyina, 2012 & Okoh, 2014).

This paper sought to identify not only the issues but also the management of mining land use disputes in Obuasi, in the Ashanti Region, Ghana. The purpose of the study was to find answers to the following questions: (i) What are the root causes of mining land use disputes in the town of Obuasi; (ii) What is the relationship between stakeholders (primary, secondary, and key) involved in mining land use disputes and their roles; and (iii) how are existing regulatory frameworks on mining land use able to effective address and prevent land use disputes?

Literature Review

The dependency theory, developed in the mid-20th century, provides explanations of the relationships between industrialized and developing nations that are highly relevant to mining land use conflicts. The theory describes the flow of resources from 'periphery' (developing) countries to 'core' (industrialized) countries, generating poverty cycles. The periphery in mining contexts are local communities, and the government agencies and mining corporations are the core. Harris (2024) elucidates that the majority of former colonies hold the colonial history responsible for economic troubles, which had endowed them with scant capital and reliance on foreign firms, typically disadvantaged local populations in mining disputes with multinational corporations. Conflicts arise due to conflicting priorities: mining companies are determined to extract resources and local people utilize land for agriculture and culture. Local people incur severe negative externalities like pollution and health risks without an equivalent economic gain. The majority of large mines employ experienced external recruits with minimal contribution towards local development (Garvin et al., 2009). Mining affects communities via market (employment, enterprise) and fiscal (taxes, royalties) channels. Although these could be in favor of communities, the mining operators normally appropriate the largest share of benefits (Chuhan-Pole and Dabalen, 2017).

Conflict theory, which has its foundations in Marxist theory, analyses power struggle over limited resources. In the context of mining, it demonstrates the complex interaction among mining companies, host communities, and states. The theory focuses on how social inequality and economic interests shape conflict. Large powerful mining companies are often pitted against marginalized host communities, leading to exclusion and discrimination in decision-making. Ecological issues such as deforestation, biodiversity loss, water contamination, and erosion increase conflict (Dikgwatlhe and Mulenga, 2023). Government policymaking can be utilized to instigate conflicts through discriminative policies or end them using fair practices (Chuhan-Pole and Dabalen, 2017). Control of resources lies at the core of the conflict, with powerful groups attempting to gain control of quality resources against weaker groups that are reliant on them.

The stakeholder theory, formulated by Freeman (1984), offers a framework for understanding mining conflicts by considering the interests of all the stakeholders. It involves stakeholder identification, assessment of their legitimacy and power, and formulation of engagement processes. Stakeholders include local communities affected by mining, mining companies, government regulators, environmental NGOs advocating for rights, and investors seeking returns. Stakeholder salience prioritizes them based on importance, power, and urgency. The local communities have customary claims to land but are typically not as strong as governments and mining companies (Mitchell et al., 1997). Strengthening the local communities by involving them in consultations and providing them with legal representation is the key to resolving conflicts. Interdependence is a two-way street; thus, the well-being of every stakeholder is interconnected; as such, good community relations are essential for long-term mining company survival.

Corporate Social Responsibility (CSR) generates stakeholder trust. Mining firms can invest in local development to offset their negative impacts and render themselves more reputable. Effective CSR aligns the goals of a business with societal and environmental aspirations, such as engaging stakeholders in planning and implementation (Que et al., 2019). The United Nations Declaration on the Rights of Indigenous Peoples emphasizes that indigenous peoples must give free, prior, and informed consent before mining can take place (United Nations, 2007). This is aligned with stakeholder theory's principle of inclusion and respect for the interests of all stakeholders.

These theories describe the land use conflict in the mining industry. Dependency theory demonstrates economic inequalities and resource exploitation, while conflict theory illustrates conflict and power inequalities. Stakeholder theory offers conflict resolution and interest management instruments. Appropriate resolution entails the resolution of economic dependencies and power imbalances, as well as effective decision-making with all stakeholders in resolving their rights and interests.

Legal frameworks are crucial in resolving Ghana's mining land disputes and promoting sustainable development. The Minerals and Mining Act 2006 (Act 703) regulates mineral rights, licensing, and corporate duties. Mining companies are required to acquire licenses from the Ministry of Lands and Natural Resources, conduct environmental assessments, engage communities, employ residents, and fulfill financial obligations. The key regulatory bodies are the Environmental Protection Agency (EPA), which gives environmental regulations, and the Minerals Commission, created by Act 450 (1993), which regulates the sector and offers advisory services on policy. Mining companies are also mandated to advance local development in their operational areas through health, education, and infrastructure projects under the Mining Community Development Scheme (Minerals and Mining Act, 2006 (Act 703)).

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.188

Good institutions and good instruments are necessary for good regulatory systems in developing countries (World Bank, 2002). Conflicts regarding mining land can be solved once the stakeholders are aware of their roles. The interrelationship of the factors that influence mining land disputes in Obuasi, including stakeholder roles, economic dependencies, and regulatory mechanisms, as seen in Figure 1, is presented in this study.

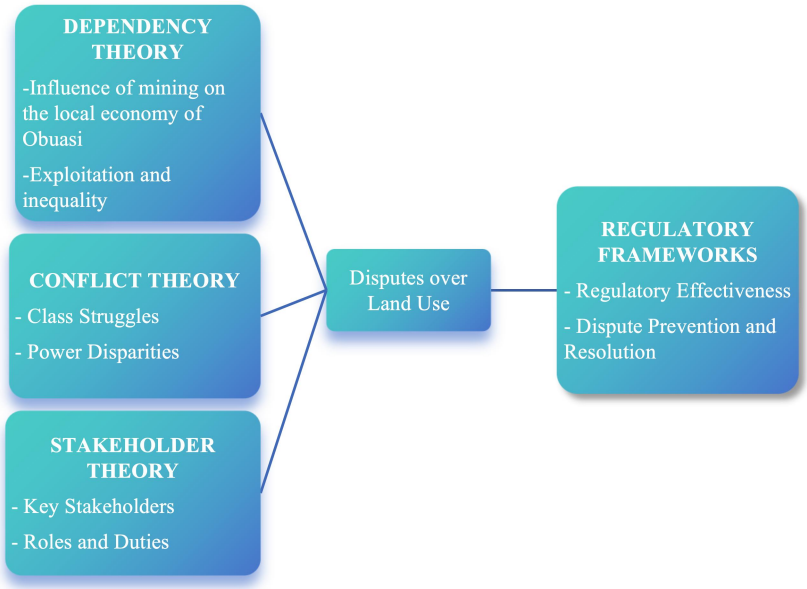

Figure 1: Conceptual Framework

Source: Authors' construct

Methodology

Obuasi is a mining town and administrative capital of the Obuasi Municipal in the Ashanti Region with a population of 104,297 comprising 51,885 males and 52,412 females (Obuasi Municipal Assembly, 2024). The Obuasi Municipality lies between latitudes 5 º35N and 5 º65N, and longitudes 6º35'W and 6º90'W. It covers a total land area of 162.4 square km. It is situated in the South-Western part of the Ashanti Region. The Municipality is located 64 km from Kumasi and bounded by Akrofoum District to the south, Obuasi East District to the east, Amansie Central to the west, and Adansi North District to the north. It has hilly terrain, with most of its hills rising over 500 meters, and consists of thirty-two communities. Obuasi is the largest town in the municipality, where we have the Obuasi Gold Mine, currently Anglo Gold Ashanti (Obuasi Municipal Assembly, 2022). The majority of people live there and practice farming amidst the rich mineral resources, and the youth are engaged in illegal small-scale mining, galamsey (Obuasi Municipal Assembly, 2024).

The study employed a mixed-method approach which combines the qualitative and quantitative research methods. This approach is especially beneficial because it balances the drawbacks of quantitative and qualitative research while utilizing their advantages. While qualitative research focuses on comprehending complicated, contextual, and frequently subjective human experiences, quantitative research is frequently connected with numerical facts, objectivity, and generalizability. Notwithstanding its advantages, the mixed-method approach is not without its drawbacks. The complexity of this methodology necessitates thorough planning and proficiency in both qualitative and quantitative research paradigms to successfully merge diverse data types (Creswell & Plano Clark, 2018). Moreover, the process can be labor-intensive and demanding in terms of resources, given the need to gather, examine, and elucidate substantial datasets from various origins (Bryman, 2015).

Sampling allows for data to be evaluated in a study by selecting a representation of an entire population (Radhakrishnan, 2014). Sampling can be done using probability sampling techniques or non-probability sampling techniques. Probability sampling techniques ensure that every member of the population has a known and equal probability of being selected, thereby enhancing the representativeness of the sample concerning the entire population. These techniques encompass simple random sampling, systematic sampling, stratified sampling, and cluster sampling (Taherdoost, 2016). Non-probability sampling techniques, conversely, do not afford all individuals an equal likelihood of selection, potentially resulting in biased samples but facilitating practical data collection when probability sampling is not feasible. These techniques include convenience sampling, purposive sampling, quota sampling, and snowball sampling (Etikan & Alkassim, 2016).

Among the sampling techniques, non-probability sampling was considered more suitable for this study. To get different points of view on land use dispute management related to mining at Obuasi, snowball sampling was employed in the data collection process. The snowball sampling uses referrals from current or well-known participants to gather other participants required for research. The samples are chosen with the specific intent of being able to provide other participants to achieve the study's objectives (Leedy & Ormrod, 2016). Through the snowball techniques, views were sought from primary, secondary, and key stakeholders who have directly or indirectly played a part in mining land use disputes at

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.188

Obuasi. Their inclusion was because they have a first-hand understanding of land use disputes at Obuasi. Landowners, members of traditional councils (Akokere, New Edubiase, and Dompoase Traditional Councils), government authorities, youth/environmental/advocacy groups, and staff/management of mining companies were the targeted populations.

Records obtained from local government authorities showed that an average of 600 land permits have been issued between 2018 and 2023. To determine the sample size needed for this study, a confidence level of 95% and a margin of error of 0.1 was used. The equation for determining the sample size (Yamane, 1973) was:

$n = \frac{N}{1+(e)^2}$ Where n is the sample size, N is the population size, and e is the margin of error.

$n = \frac{600}{1+(0.1)^2}$ $n = 80$

Therefore, the sample size for landowners in this study was 80 respondents. These respondents' part was used to gather the quantitative responses needed for the study. In addition to quantitative responses from the landowners, qualitative responses are sought from members of traditional councils, government authorities, youth/environmental/advocacy groups, and staff/management of mining companies. Three (3) respondents each were sampled from the targeted population.

Primary and secondary data were sourced to complement each other in this study. The secondary data included information from research articles, policies, reports, regulations, and books that offer information on mining land use disputes in Obuasi. Primary sources offered direct and raw on-field knowledge, and secondary sources aided in the analysis of findings and summaries that complemented the viewpoints gathered through primary sources (Leedy & Ormrod, 2016). The primary data were the responses directly gathered from the sampled population through questionnaires, interviews, and field observations. The complementary use of primary and secondary data sources aided in validating and cross-referencing research findings with each other the elements of the conceptual framework used in this study. Additionally, the questionnaires employed in this study were to elicit quantitative/numerical information from study participants, with interviews and field observations used to elicit in-depth discussions on the theories (dependency, conflict, and stakeholder), mining land use disputes, and regulatory frameworks with stakeholders who are involved in these disputes. Questionnaires and interviews aid the research in comparing and contrasting responses to the same questions, enabling an effective data analysis method (Leedy & Ormrod, 2016).

Quantitative data gathered through questionnaires were sorted into a spreadsheet for statistical functions to be performed in Microsoft Excel 2016. Also, this aided in the visual and tabular display of results obtained. The statistical functions provided valuable insights for summaries on mean, standard deviation, and frequency distributions of data obtained from respondents, as well as explored the effectiveness of existing regulatory frameworks in addressing and preventing mining land use disputes. Qualitative data obtained through interviews were transcribed for relevant themes to be identified. Based on recognized trends in the data, the data were categorized into useful codes by determining the relationships in the dataset, using NVivo 12 software. They enabled the data to be understood at a deeper level by representing a cognitive advance, distilling the essence of the facts, and providing a means to discern more profound details on the causes of disputes, the relationship between stakeholders, and the impact of conflicts on society.

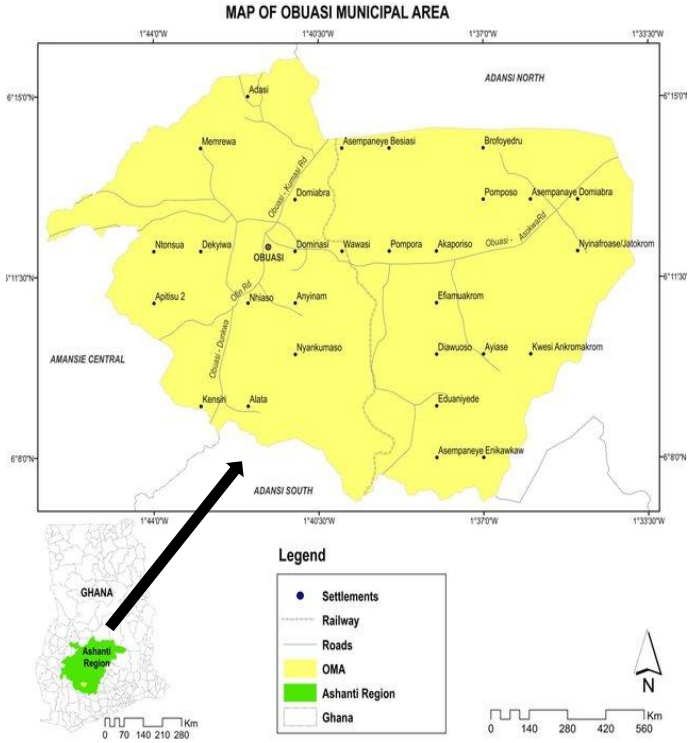

Figure 2: Map of the Study Area

Source: Abdulai, 2015

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.188

Results and Discussion

Demographic Characteristics

This study surveyed 80 landowners in Obuasi, Ghana, who are directly affected by land use regulations. The population is relatively young, with 72.5% under 40 years old: 38.75% aged 18-29, 33.75% aged 30-39, and smaller percentages in older groups. Education levels are high, with 66.25% having post-secondary education and 33.75% completing basic education. Most respondents (54) are indigenous, while 16 are non-indigenous, and 10 are native non-residents. The predominance of young, educated locals suggests a strong awareness of land regulations. These demographics provide key insights for resource allocation, land policies, and development programs in Obuasi.

Land Ownership

Land is an important development resource that sustains livelihoods in agriculture, construction, and mining. Table 1 shows land ownership characteristics, such as mode of acquisition and customary council ownership. Most of the landowners possessed the land recently: 38 respondents (nearly half) owned it for 1-5 years, 14 for less than one year, 16 for 6-10 years, and 13 for more than a decade. Strong demand for land suggests economic development or urbanization. Acquisitions cover purchases (67.5%), followed by inheritance (27.5%), while gifts (3.75%) and barter (1.25%) are uncommon, suggestive of a monetized land market. Land is controlled by three traditional councils: Akokerri (42.5%), Dompoase (36.25%), and New Edubiase (21.25%), with the most important being Akokerri. Acquired lands are put to diverse uses, chiefly construction, cultivation of crops, and animal rearing, depicting mixed economic activities in Obuasi.

Table 1: Characteristics Of Respondents Showing the Years and Mode of Land Acquisition and The Traditional Council in Charge.

Characteristic	Frequency (n)	Percentage (%)
Years of Land Acquisition		
Less than a year	14	17.5
1 - 5 years	38	47.5
6 - 10 years	16	20
More than 10 years	12	15
Total	**80**	**100%**
Mode of Land Acquisition		
Through barter	1	1.25
Through gift	3	3.75
Through inheritance	22	27.5
Through purchase	54	67.5
Total	**80**	**100%**
Traditional Council in charge of land		
Akokere	34	42.5
Dompoase	29	36.25
New Edubiase	17	21.25
Total	**80**	**100%**

Source: Authors' Construct.

Root Causes of Mining-related Disputes

It is imperative to understand mining land use conflicts in terms of their underlying causes in order to devise appropriate solutions. Knowing the causes enables the tackling of the root cause instead of symptoms. As indicated in Table 2, the respondents cited main causes of mining land use conflicts in Obuasi. The most prominent cause, cited by 31 respondents, was land access modes. Compensation procedures (21 respondents) and benefit sharing (19 respondents) were also of great concern. Six participants named the stakeholder engagement model, and three named the social investment model. These results call for specific interventions to rectify land access, compensation, and benefit-sharing arrangements in Obuasi.

Table 2: Count Of Respondents Identifying the Most Significant Causes of Mining Land Use Disputes in Obuasi.

Causes of Mining Land Use Disputes	Count of Respondents
Benefit sharing	19
Compensation processes	21
Land access modes	31
Social investment approach	3
Stakeholder engagement framework	6
Total	**80**

Source: Authors' Construct.

Accessibility of land is crucial for construction, agriculture, and business, enabling economic growth and social stability (Yekple et al., 2024). Access to land in Ghana is controlled by cultural, legal, and economic systems, with a mix of formal and informal systems.

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.188

The Land Act 2020 (Act 1036) was enacted to revolutionize land administration, requiring all acquisitions to be registered with the Land Commission to ensure transparency and minimize conflicts. Customary lands, which constitute over 80% of Ghana's land (Bugri & Yuonayel, 2015), are governed by the Act, which demands fairness and accountability. These are not always implemented in practice. Pointing out an experience witnessed, one respondent narrated:

"Sometimes, the landowners are not completely involved in some land decisions; like, there will be conversations going on between the traditional authorities and the mining companies. Then, later we will be informed about the decisions they've made which will require some landowners to give up their lands with some form of compensation. The [mining] firms are able to gain and access the land quicker than us individuals who will have to go through a lot of long processes."

Another respondent stated:

"There has been a case where a piece of land that was already sold to an individual was sold again to a mining company. The landowner was not happy with it at all."

These traditional leaders tend to readily offer mining firms easy access to land due to expected economic benefits, sidelining the landowners in decision-making. This lack of consultation creates mistrust and resentment. Landowners cherish their rights and survival means, but traditional leaders favor long-term alliances or community development. Landowners, traditional leaders, and mining firms harbor tensions. Disputes also arise among families with communal land interests since other members may unilaterally sell or lease land for mining, particularly for small-scale mining. A respondent stated:

"An individual gives out the land for money without involving the other family members who have equal rights over the land."

Act 1036 specifies that customary lands are held together by a stool, skin, clan, or family and demands group permission to utilize or sell the land. When individuals take unilateral actions in disregard of the rights of others, they contravene customary arrangements, which generate mistrust and conflicts. Members who are excluded may feel disenfranchised or exploited, which results in intra-family conflicts and conflicts with buyers of the land. Another significant conflict arises from compensation processes. Equitable compensation guarantees those who are losing land use rights to mining are dealt with justly, either through money or substitute land, under agreed terms (Kidido et al., 2015). One landowner said concerning compensation processes:

"One mining company has made it clear that all lands underground belong to them and that they acquired it from the chief. After mining or when they want to mine, they engage the chief directly. Meanwhile, someone was already farming on that land, and the person was putting the land to good use. A large part of the compensation for the land goes to the chief, while the one who was farming gets something small or nothing."

This statement was corroborated by a member of Akokerri Traditional Council:

"I have encountered land use disputes between the mining company and local landowners. This is often due to unclear boundaries, lack of consultation with the community, and inadequate compensation."

Where active farmers are not consulted and offered minimal or no compensation, their livelihood and investment are disregarded, and this generates conflicts. Giving priority to chiefs or heads of stools, clans, or families for compensation negotiations overlooks the rights of landowners who survive on the land. Mining firms evade wider consultations, consulting only traditional leaders, which undermines trust and triggers conflicts. The uneven power dynamic, with mining companies taking over suboptimal resources underground, additionally pushes farmers away, intensifying grievances.

Besides access to land and compensation, benefit sharing is another main source of conflicts. Benefit sharing is the equitable distribution of profits, opportunities, or advantages from land resources among all involved stakeholders (O'Faircheallaigh, 2015). Proper benefit-sharing ensures social equity, respects local aspirations, and provides a sustainable land-use policy. In the real world, however, equitable distribution cannot always be ensured, thus leading to more grievances and tensions among traditional authorities, mining companies, and land users. One respondent noted:

"Lack of clear communication and engagement between mining companies and local communities. This then leads to misunderstandings and disagreements over land use and the benefits that should be shared with the community."

Unclear communication of land ownership, use rights, and agreements between mining firms and local authorities usually leads to confusion. Allocation of economic benefits, jobs, or infrastructure in a biased way leaves some groups out or underpaid. Failure to engage community members in negotiations breeds resentment and social tension. Mining firms deal primarily with customary leaders or government representatives, leaving local stakeholders feeling excluded. Conflicts over who gains from mining activities promote fragmentation, driven by confusing or unmet benefit-sharing agreements. These types of conflicts over land access, compensation, and benefit sharing are consistent with dependency theory, where landowners are dependent on the discretion of more powerful actors, and therefore economic dependency continues.

Compensation does not usually economically empower landowners but makes them depend on mining revenues or insufficient support. Conflict theory is present in land use conflicts, and it is concerned with power imbalances. Mining companies negotiate straight with traditional leaders to the disadvantage of landowners driving class conflicts in Obuasi's land management system. Unequal benefit sharing and unfair compensation benefit powerful actors, such as mining companies and traditional leaders, against landowners. This marginalization fuels the tensions and conflicts since the owners and people of the land believe that their interests are secondary to state and corporate interests.

Stakeholders Identification and Roles

Stakeholders are central to community development, promoting social equity, cohesion, and economic development through partnership (Costumado & Chemane, 2024; Hori, 2020; O'Hara et al., 2023). The identification of stakeholders in mining land use conflicts is key to successful resolution. Landowners in Obuasi cited traditional leaders (35 respondents), such as chiefs and councils, as the most influential. The other main stakeholders included the community members and landowners (21), mining firms (14), the government (8), and civil society organizations (2), as shown in Table 3.

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Table 3: The Most Influential Stakeholders in Mining Land Use Disputes

Influential Stakeholders	Count of Respondents
Government	8
Landowners	21
Mining companies	14
CSOs	2
Traditional leaders	35
Total	**80**

Source: Field Survey, 2024

In-depth interviews of the traditional councils, government authorities, and industry representatives yielded qualitative data. Through these interviews, the major themes were developed with focus on the need for synergistic efforts of the stakeholders towards conflict resolution and sustainable community building. One of the local government representatives named them as:

"Illegal miners, AngloGold Ashanti, Obuasi East District Assembly, Obuasi Municipal Assembly, traditional authorities, and the communities where AngloGold Ashanti has concessions."

One mining firm representative mentioned:

"Traditional authorities, Environmental Protection Agency, Minerals Commission, Obuasi East District Assembly, and AngloGold Ashanti."

One other member of New Edubiase Traditional Council listed:

"Traditional authorities, mining company, local communities, the government, and civil society organizations."

A respondent who is a landowner noted:

"The traditional authorities are the custodians of these lands. They are capable of preventing many land disputes by ensuring due land process and giving the appropriate land out to the right individuals or groups."

The most significant stakeholders are those individuals, institutions, or groups with an interest in decisions or projects. They are actively involved in planning and implementation, and their actions significantly impact results. Local stakeholders involve government institutions, business leaders, traditional leaders, civil society organizations (CSOs), and local individuals. Their participation draws in resources, knowledge, and legitimacy, fostering livelihoods, environmental security, and successful program results.

In Obuasi, traditional leaders were the most prominent stakeholders, and their importance in land use and conflict resolution was evident. Traditional leaders are custodians of the communal and ancestral lands and regulate land allocation to ensure adherence to protocols and resolve conflicts to promote fairness and transparency. Theirs is the role to safeguard land use rights for present and future generations. They also prevent land access conflicts through management of land processes, providing credibility and trust in agreements to other stakeholders, developers, or investors.

The locals and landowners are influential land-use decision actors. Landowners view land as cultural heritage and ancestral, not economic assets. Their involvement ensures fair compensation, clear land boundaries, and minimal resistance to development. Omitting or treating them unjustly creates tensions, which delay the projects. Landowners also contribute to economic growth by farming or property ownership. Some of them engage in illegal small-scale mining whenever access is compromised, fostering environmental degradation and conflicts.

Mining corporations are also major stakeholders. While they bring jobs and infrastructure to the economy of a local community, their operations have the effect of displacing people and interfering with living areas. Conflict is created when firms fail to engage landowners or provide adequate compensation. Environmental destruction heightens conflict when environmental practices are not prioritized. Mining firms can reduce conflict by carrying out corporate social responsibility (CSR) activities, engaging stakeholders in a transparent manner, and providing equitable compensation.

One of the major stakeholders of land use in mining is the national and local governments. It is vested with the role of formulating and implementing policies on land allocation, ownership, and environmental protection. Institutions such as the Minerals Commission, Environmental Protection Agency (EPA), and Lands Commission offer regulatory oversight and arbitrate when there are disputes. Good governance will reduce conflict in mining communities. Yet, poor enforcement, corruption, or placing economic gain over community well-being can exacerbate tensions. Communities become disenfranchised when the state prioritizes royalties and taxes over local concerns, undermining trust and increasing land use disputes.

Literature emphasizes the roles played by different actors in managing such conflicts. Government, mining firms, and communities, along with the EPA, Minerals Commission, and NGOs, are identified by Okoh (2014) and Famiyeh (2017) as major actors. Traditional leaders possess land protocols, while owners demand justice. Mining firms balance economic and environmental accountabilities. The actions of every actor contribute to managing mining land use conflicts, indicating the complexity in managing such conflicts.

Existing Regulatory Frameworks

Regulatory frameworks ensure fairness in land use, but 82% of respondents in Obuasi were unaware of existing frameworks for mining land use disputes. Despite many having post-secondary education, only 14% were aware, mentioning the EPA Act 1994 and the Minerals and Mining Act 2006. This highlights a gap in public knowledge.

The named regulatory frameworks by the survey respondents were corroborated by an official of the Obuasi Municipal Assembly:

"Currently, we have the Minerals and Mining Act 2006, and its amendment in 2015, the EPA Act 1994 (Act 490), and the Land Act 2020 (Act 1036). There are also Alternative Dispute Resolution (ADR) Mechanisms in place."

A member of the Dompoase Traditional Council stated:

"There are EPA guidelines, local customary laws, and the Land Act 2020 used to manage mining land use and any disputes that may arise from it."

The Minerals and Mining Act, 2006 (Act 703) is the main law governing mining in Ghana, bringing together the previous legislations into a single umbrella law. The Act seeks to balance the state, community, and investor interests and is concerned with dispute resolution, compensation for land use, and control of mining. The Act vests powers in the President to suspend mineral rights and compulsorily acquire land in the public interest of

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.188

mining. Licenses and permits are subject to stringent conditions, such as Environmental Impact Assessments (EIAs) and reclamation obligations to enforce environmental and safety standards. This is meant to guarantee sustainability, reduce environmental degradation, and optimize economic returns in the form of taxes and royalties.

Redress for impacted communities is a strong feature of Act 703. The Act forces fair compensation for resettlement, loss of property, and loss of land use, considering land value, loss of livelihood, and cultural importance. Yet, valuation and beneficiary disputes continue to occur. The Act promotes Alternative Dispute Resolution (ADR) like negotiation and mediation to reduce expensive litigation. Regardless of these attempts, enforcement and stakeholder buy-in continue to be problematic.

The foundation of environmental regulation in Ghana is the EPA Act 1994 (Act 490), which creates the Environmental Protection Agency (EPA) to oversee environmental elements in mining. The EPA requires mining firms to secure environmental permits through the submission of Environmental Impact Assessments (EIAs), which describe risks and mitigants. The agency also has pollution controls that ensure that water, air, and land are not contaminated. In resolving environmental disputes, the EPA encourages communication and mediation between parties. Public hearings within the EIA process provide affected communities an opportunity to express concerns and influence decisions, fostering transparency and trust.

Alternative Dispute Resolution (ADR) mechanisms are critical in resolving stakeholder disputes, particularly where litigation is not possible. Some of the mechanisms used include arbitration, mediation, negotiation, and community dialogue. Arbitration provides legally binding decisions, while mediation procures mutually acceptable solutions using a neutral third party (Amoa-Abban, 2017). Mediation and negotiation, especially in land disputes, encourage compromise and establish relationships (Ibrahim et al., 2022).

Although regulatory mechanisms are in place, weaknesses in enforcement render them ineffective and increase the length of disputes. Respondents were also requested to rank the effectiveness of regulatory mechanisms in solving and managing mining land use conflicts, as indicated in Table 4.

Table 4: Rate of effectiveness of regulatory frameworks

Rate of effectiveness	Count of respondents (n)	Percentage of respondents (%)
Neutral	31	38.75
Somewhat effective	26	32.5
Somewhat ineffective	10	12.5
Very effective	6	7.5
Very ineffective	7	8.75
Total	**80**	**100%**

Source: Field Survey, 2024

The interviewees rated their perception of government intervention in mining land use conflicts. As seen from Table 5, most rated the frameworks as neutral, revealing low awareness and weak application. Although a minority perceived them as effective, the majority were not aware, an implication of regulatory authorities' and CSOs' failure to sensitize the masses. This lack of awareness perpetuates power imbalances, in which powerful actors take advantage of uninformed landowners who at best gain only meager compensation for land loss.

Table 5: The Current Level of Government's Intervention in Mining Land Use Disputes

Perception of the current level of government intervention	Count of respondents (n)	Percentage (%)
Adequate	34	42.5
Insufficient	37	46.25
None	6	7.5
Too much	3	3.75
Total	**80**	**100%**

Source: Field Survey, 2024

The respondents were not satisfied with the government's handling of mineral land disputes, particularly in land compensation and environmental restitution issues. The majority stated that the government was not doing enough, leading to heightened mistrust and intractable conflicts. These findings reflect Hilson's (2002) and Cobbinah et al.'s (2020) research, which link poor dispute management to inadequate government intervention. The lack of strong integration of customary land issues also worsens coordination challenges. There needs to be more government intervention and more coordination with the local communities to allow trust establishment and conflict management.

Summary and Conclusion

This research provides a new analysis of the mining land use disputes in Obuasi through the interplay between systemic, institutional, and relational factors. The study presents surprising findings, particularly the lack of correlation between the level of education and regulatory awareness among landowners. Despite their post-secondary levels of education, most landowners lacked an understanding of important frameworks like the Land Act 2020 and the Mining and Minerals Act 2015.

The revelation of the role of traditional leaders in generating disputes is very important. While they are viewed as custodians of the land, their actions or inactions contribute to conflicts and point out their challenges in balancing external and community interests. The study effectively employs theories of dependency, conflict, and

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.188

stakeholders in analyzing power dynamics and struggles over resource allocation.

It brings together quantitative and qualitative approaches, and the research methodology, though at times challenging to integrate, provides broad insights. The identified key issues in the study include unequal benefit-sharing, unfair compensation, and land access prioritization of mining companies. These findings align with global patterns in resource-rich regions, where powerful entities often benefit at local communities' expense. While the theoretical framework effectively identifies power imbalances as a central issue, it struggles to propose solutions where powerful stakeholders resist change, highlighting areas requiring further attention in mining community relations.

This research provides a perspective on mining land use disputes in Obuasi by examining the complex interplay of systemic, institutional, and relational factors: The disconnect between education levels and regulatory awareness among landowners. Despite many having post-secondary education, there remains a significant gap in understanding crucial frameworks like the Land Act 2020 and the Mining and Minerals Act 2015.

The role of traditional leaders in dispute generation was revealed. While traditionally viewed as land custodians, their actions or inactions often contribute to conflicts, highlighting the challenges they face in balancing external and community interests. The study effectively employs dependency, conflict, and stakeholder theories to analyse power dynamics, resource allocation struggles, and stakeholder engagement practices.

The study identifies key issues including unequal benefit-sharing, unfair compensation, and the prioritization of mining companies' land access needs. These findings align with global patterns in resource-rich regions, where powerful entities often benefit at the expense of local communities. While the theoretical framework effectively identifies power imbalances as a central issue, it struggles to propose solutions in contexts where powerful stakeholders resist change. This research contributes to understanding these complex dynamics while highlighting areas requiring further attention in mining community relations.

The land-use conflict at Obuasi requires far-reaching solutions that create a better framework that is more workable and equitable among different stakeholders concerned. Key suggestions to practitioners and policy thinkers revolve around the enhancement of stakeholder participation and transparency: regular forums including government agencies, mining companies, traditional authorities, landowners, and community members will go a long way in ensuring less powerful actors' positions in decision-making processes. The tensions can also be reduced and the landowners treated fairly by making grievance reporting channels accessible, and fair compensation mechanisms are put in place, authenticated by independent reviews. Land use management necessitates the strict application of regulatory frameworks, which is often characterized by severe sanctions in cases of non-observance for the sake of sanity. Complex legal frameworks should be simplified and communicated through various media to ensure better understanding among rural communities.

Public agencies and CSOs should focus on education and engagement campaigns to ensure that stakeholders understand and benefit from the regulations already in place. Further, strengthening the ADR mechanisms and their integration into the regulatory framework can better streamline dispute resolution, reduce dependence on litigation, and ensure greater harmony in relationships among stakeholders. Future research should dwell on the marginalized group's implications of mining land use conflicts, assessments of public participatory processes in terms of performance, and enforcement barriers. There is also the need for study to determine modern technologies such as Geographic Information Systems that have the potential to increase openness about land transactions and resolve disputes. These actions will help the country move into an inclusive approach and efficient management of its mining land-use challenges.

Acknowledgments

The authors thank the respondents, editor and anonymous reviewers for their helpful comments and valuable suggestions.

Funding

Not applicable.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Statements and Declarations

No funding was received for conducting this study. The present study has no relevant financial or non-financial interests to disclose.

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Author Contributions

This work was carried out in collaboration among all authors. This project was conducted jointly by the authors. The authors reviewed and agreed to the final manuscript. All authors read and approved the final manuscript.

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ATRI PRESS

Journal of Modern Social Sciences

Volume 2 Issue 3 , 2025

ISSN: 3078-4433 | eISSN: 3078-4441

Reading Anxiety in First and Second Language Acquisition: A Comprehensive Literature review

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Abstract

Reading anxiety, a domain-specific form of affective disturbance, disrupts comprehension and hinders literacy development in both first (L1) and second/foreign (L2/FL) language contexts. This review synthesizes empirical and theoretical work to examine its conceptualization, prevalence, cognitive and affective correlates, educational consequences, and intervention strategies. Findings confirm that reading anxiety is distinct from general academic anxiety and is consistently associated with poorer reading performance, reduced motivation, and negative self-perceptions. Cognitive factors and affective influences shape its intensity and impact. A range of pedagogical interventions have demonstrated efficacy in reducing anxiety and improving outcomes. Yet, limitations in measurement tools, research design, and population diversity remain. The review highlights differences between L1 and L2 reading anxiety and calls for integrative theoretical models and longitudinal, multimethod research. Addressing reading anxiety is critical for fostering confident, capable readers across linguistic and educational settings.

Keywords

Reading anxiety; First language (L1) reading; Second language(L2/FL)acquisition;

Suggested citation: Liu, Q. (2025). Understanding Reading Anxiety in First and Second Language Acquisition: A Comprehensive Literature Review. *Journal of Modern Social Sciences*, 2(3), 226–233. https://doi.org/10.71113/JMSS.v2i3.329

Introduction

Reading anxiety refers to the unpleasant feelings of worry or distress that learners experience when engaging in reading activities, particularly in a non-native language. It has been characterized as a situational, domain-specific form of anxiety or "specific phobia" triggered by reading tasks. While the broader construct of foreign language anxiety (FLA) encompasses general apprehension in language learning contexts (Horwitz, 1986), reading anxiety is specific to the act of reading. Saito, Garza, and Horwitz (1999) introduced the concept of foreign language reading anxiety (FLRA) and developed the Foreign Language Reading Anxiety Scale (FLRAS). They found that FL reading anxiety shared only about 41% of its variance with overall FLA, suggesting it is a related but distinct phenomenon in L2 contexts. Although much research has focused on L2 reading anxiety, recent scholarship has emphasized that anxiety can also occur when reading in one's first language (L1), especially among students with reading difficulties. Piccolo et al. (2017) note a dearth of studies on L1 reading anxiety, even though reading anxiety in L1 may contribute to understanding reading disabilities.

Reading anxiety is pedagogically important because it can create a vicious cycle: anxious readers may avoid practice, fall behind in skill development, and experience further anxiety. This review examines the state of knowledge about reading anxiety in L1 and L2, synthesizing findings on its definitions, prevalence, underlying cognitive and affective correlates, and consequences. We also critically assess methodological issues in the research and review intervention studies designed to alleviate reading anxiety. Finally, we compare reading anxiety across L1 and L2 contexts, noting both shared features and key differences, with the aim of informing educators and researchers about how to identify and support anxious readers.

1. What is Reading Anxiety?

1.1 Conceptualizing Reading Anxiety

Reading anxiety has been conceptualized in several ways. Early work by Horwitz, Horwitz, and Cope (1986) defined foreign language anxiety broadly as "a distinct complex of self-perceptions, beliefs, and feelings related to language learning" (Figure1.1). Within that framework, Saito et al. (1999) specifically introduced Foreign Language Reading Anxiety (FLRA) as a construct

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.329

associated with the act of reading in a FL. They described FL reading anxiety as learners' emotional and physiological reactions, including nervousness and tension, triggered when reading text in a non-native language. In a large study of learners of Spanish, Russian, and Japanese, Saito and colleagues developed the FLRAS questionnaire and found that FL reading anxiety is correlated with but distinct from general FLA. They reported a correlation of r = .64 between general language anxiety and reading-specific anxiety, meaning only 41% shared variance and 59% unique (Saito et al., 1999). This indicates that many factors contribute to reading anxiety that are not captured by general FLA.

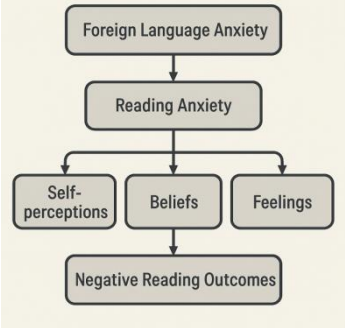

Figure1.1

The situational, phobic quality of reading anxiety is emphasized in later definitions. Piccolo et al. (2017) describe reading anxiety as "an unpleasant emotional reaction experienced by students when reading; it is a specific phobia, situational type". In other words, students may be generally confident, but reading a text, especially a difficult or unfamiliar one, triggers acute anxiety. Zhou (2015/2017) similarly defines FL reading anxiety as the worry or fear learners feel during a reading passage in the target language. This state-specific anxiety can manifest physically, like increasing heart rate, sweating, cognitively, like mind going blank, and emotionally, like frustration and panic, as discussed by Azizi et al. (2024) in their review of medical students' reading anxiety.

Researchers typically operationalize reading anxiety via self-report scales. The FLRAS by Saito et al. (1999) is widely used for L2 contexts, items probe worry about difficult vocabulary, culture, etc., and Horwitz's Foreign Language Classroom Anxiety Scale (FLCAS) includes a subscale on reading. Edwards et al. (2023) note that there is a need for reliable, reading-specific measures in L1 contexts as well. They developed a 10-item Reading Anxiety Scale for college students and found it to be distinct from general anxiety, which is higher correlation with reading fluency than math. Thus, the literature treats reading anxiety as a measurable construct separate from overall academic anxiety.

Conceptually, reading anxiety intersects with but is not identical to related constructs. It is linked to cognitive load, language skills, and affective factors, like motivation and self-efficacy. Critically, Piccolo et al. (2017) point out the importance of distinguishing reading anxiety from reading disabilities: anxious reading may hinder decoding and comprehension, but it can also co-occur with or stem from underlying dyslexia or learning problems. In sum, reading anxiety is best understood as a situational anxiety phenomenon tied to the specific challenge of reading text, whether in L1 or L2.

1.2 Prevalence and Patterns of Reading Anxiety

Empirical studies consistently report that reading anxiety is a common experience among language learners, often at moderate levels. Exact prevalence rates vary by context and measures. In FL/EFL settings, survey studies often find the majority of students experiencing at least some reading anxiety. For example, Dang (2024) found that 68.5% of Vietnamese university EFL learners reported moderate levels of English reading anxiety, with only a minority at very high or very low extremes. Similarly, Zhou (2015) observed that Chinese learners of Chinese as a foreign language generally reported a medium level of reading anxiety, with intermediate-level students experiencing lower anxiety than beginners. These findings suggest that while most students feel some apprehension, very high anxiety is less common.

In L1 contexts, prevalence data are scarce, but research indicates elevated anxiety among specific populations. Edwards et al. (2023) found that even native-English college students showed measurable differences in reading anxiety on their new scale. Importantly, students with diagnosed reading-related learning disabilities reported significantly higher reading anxiety than peers without such disabilities. This suggests that reading anxiety in L1, while not widely studied, can be substantial for struggling readers. Piccolo et al. (2017) emphasize that understanding L1 reading anxiety is crucial for addressing reading disabilities, yet empirical data remain limited. Overall, reading anxiety appears relatively prevalent among learners of all backgrounds; a key question is what cognitive, linguistic, and situational factors predict its level.

Several background factors have been linked to differences in reading anxiety. Gender findings are mixed, though Chen et al. (2014) reported that instructor-supported collaborative annotation reduced anxiety particularly among male middle-school learners. Age and education level matter: Azizi et al. (2024) compared first-year medical students in online versus face-to-face English courses and found that those in traditional classrooms exhibited higher mean reading anxiety than those in an online, collaborative platform. This could reflect changing learning environments or generational differences in attitude toward technology. Course context is also relevant: for instance, Oh (1992) discovered that anxiety levels varied significantly with different reading test formats (cloze vs. think-aloud) for Korean university freshmen.

2. Factors influencing reading anxiety

2.1 Cognitive Correlates

Cognitive factors are strongly associated with individual differences in reading anxiety. One key correlate is language proficiency and skill level. Unsurprisingly, stronger readers tend to feel less anxious: higher vocabulary knowledge, decoding ability, and fluency often correlate with lower anxiety (e.g. Sellers, 2000; Shi & Liu, 2006, as reviewed in Zhou, 2015). Zhou (2015) reports that learners with higher English proficiency and reading comprehension scores tend to report lower FL reading anxiety. Alamer and Lee's (2021) longitudinal study found that higher L2 achievement at an earlier time predicted lower later anxiety, whereas the reverse was not supported. Thus, competence and confidence in reading can buffer anxiety, and deficits can exacerbate it.

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.329

Relatedly, working memory capacity has been identified as a cognitive correlate. Reading in a L2 imposes high processing demands, so learners with limited working memory may become anxious when texts are hard. Chow, Mo, and Dong (2021) tested a model of how working memory and reading anxiety jointly affect L2 reading comprehension. They found that both verbal working memory and reading anxiety were unique predictors of comprehension performance. Specifically, higher working memory aided comprehension, but higher reading anxiety hindered it. Moreover, reading anxiety partially mediated the effect of working memory: learners with lower working memory tended to feel more anxious while reading, which in turn impaired comprehension. This suggests a dual pathway by which cognition and affect interact: processing resources can trigger anxiety, and anxiety itself can consume cognitive resources, creating a vicious cycle.

First-language literacy and cognitive skills also play a role. Sparks and Alamer (2023) found that strong L1 reading achievement and metalinguistic knowledge predicted lower L2 reading anxiety two years later. In their structural model, L1 reading skills influenced L2 reading anxiety both directly and indirectly (via L2 aptitude and L2 achievement). This highlights a cognitive transfer effect: students who are good readers in their native language bring stronger meta-cognitive strategies and phonological/orthographic processing skills that help them decode L2 texts more easily, reducing anxiety. Conversely, poor L1 reading skills, which often reflecting learning disabilities, make L2 reading much more threatening, elevating anxiety.

Task characteristics also influence cognitive load and thus anxiety. Saito et al. (1999) hypothesized that unfamiliar scripts and complex grammar increase FLRA. Indeed, Zhou's review notes that students reading Japanese with an unfamiliar non-Roman script were more anxious than those reading languages with more familiar orthographies. The nature of reading tasks, including skimming vs. careful comprehension, vocabulary difficulty, time pressure, likely alters cognitive demand. For instance, Oh (1992) found that cloze tests and think-aloud protocols evoked higher anxiety in L2 readers than simpler multiple-choice tests. These findings imply that educators should consider cognitive complexity when designing reading assessments to avoid unnecessarily provoking anxiety.

In sum, cognitive correlates of reading anxiety include the learner's existing reading skills in L1 and L2, working memory capacity, and task difficulty. High skill and capacity tend to mitigate anxiety, whereas demanding tasks and unfamiliar scripts amplify it.

2.2 Affective Correlates

Alongside cognitive factors, affective and motivational variables are closely linked with reading anxiety. Learner motivation and attitudes toward reading are powerful correlates. Chow, Chiu, and Wong (2018) examined predictors of EFL reading anxiety among Chinese undergraduates and found that learners' motivation, both intrinsic and integrative, significantly predicted their anxiety levels. In particular, students who reported higher motivation for learning English experienced lower reading anxiety, even after accounting for proficiency. Learning strategies influenced anxiety mainly indirectly: motivated learners used more effective reading strategies, which in turn improved performance and reduced anxiety. This highlights that an internal drive to read, like interest and valuing English, can buffer anxiety by fostering engagement and persistence when challenges arise.

Self-efficacy and self-concept about reading ability also correlate with reading anxiety. Learners who believe they can succeed in reading tasks tend to feel less anxious. For example, Edwards et al. (2023) found that higher reading anxiety was associated with lower reading self-concept and enjoyment. Students who perceived themselves as poor readers reported more anxiety. In turn, low self-confidence can create a self-fulfilling prophecy: anxious students avoid practice and become weaker, validating their self-doubt. Conversely, interventions that boost students' confidence, including mastery experiences and scaffolding, often alleviate anxiety.

General language anxiety and personality factors contribute as well. Learners with high trait anxiety or general communication apprehension are more prone to reading anxiety. The FLRAS studies suggest that individuals who are anxious in FL classrooms also tend to be anxious when reading (the .64 correlation in Saito et al., 1999). However, some of the remaining unique variance suggests that domain-specific dispositions matter, some students may be anxious in speaking but relatively calm reading. Personality traits like neuroticism have been linked to higher FL anxieties (Abu-Rabia et al., 2014), which likely extends to reading.

Other affective correlates include classroom environment and teacher behavior. Zhou (2015) notes that learners who reported poorer classroom climates, for instance, more pressure or embarrassment when reading aloud, tended to have higher reading anxiety. Social aspects – fear of negative evaluation, peer comparison, or lack of support – can heighten anxiety during reading tasks, especially in a second language. Azizi et al. (2024) suggested that online or flipped classroom designs, which provide peer collaboration and anonymity, might lower reading anxiety compared to face-to-face lectures. This implies that affective correlates are not only internal but also situational: a supportive learning environment, positive feedback, and low-stakes practice can reduce anxiety.

In sum, students' feelings about reading – their motivation, confidence, and classroom experiences – significantly shape their reading anxiety. These affective factors interact with cognitive ones: a motivated, self-assured learner may overcome challenging texts, while a fearful, unconfident learner may feel overwhelmed. Understanding these correlates suggests holistic approaches to addressing reading anxiety by nurturing positive attitudes and a supportive environment, in addition to skill-building.

3. Consequences of Reading Anxiety

A central concern is how reading anxiety affects learning outcomes. By and large, research indicates that higher reading anxiety is associated with poorer comprehension and performance. Zhou (2015) reports that numerous studies have found significant negative correlations between FL reading anxiety and reading achievement. In one example, moderate negative correlations were observed between Chinese learners' reading anxiety and both elementary- and intermediate-level comprehension scores. Shi and Liu (2006) similarly found that ESL students with high FL reading anxiety scored lower on reading comprehension tests. These findings align with cognitive theory: anxiety consumes working

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.329

memory resources through worry (Eysenck et al., 2007), leaving fewer resources for understanding text. Moreover, anxious students often read more slowly and skip sections, hindering comprehension (Abu-Rabia, 2004).

Empirical studies using regression models confirm this negative impact. Liu and Dong (2023) conducted a longitudinal study of Chinese university English majors and found that their foreign language reading anxiety, measured at three points in a semester, was significantly negatively correlated with simultaneous reading test scores. Their analyses showed that FL reading anxiety was a significant predictor of students' reading performance at the same time point, even after controlling for background variables. However, reading anxiety at one time did not predict later performance, nor did past performance predict later anxiety, suggesting the effect is immediate rather than lasting over long delays. Al-Obaydi, Rahul, and Pikhart (2024) similarly reported that students in an oral-reading intervention group had lower reading anxiety and higher comprehension scores than a control group. Notably, they found a strong negative correlation between reading comprehension and anxiety measures, indicating that improvements in comprehension coincided with anxiety reduction.

However, some researchers caution that the anxiety-performance relationship may be more complex. Argaman and Abu-Rabia (2002) found significant relationships between language anxiety and both reading and writing skills among Hebrew speakers learning English. Interestingly, they hypothesized that because writing is a communicative skill it would be more affected by anxiety than reading. Contrary to this, they observed anxiety linked to reading too, and suggested an alternative interpretation: rather than anxiety causing poor performance, it may often be a consequence of failure or frustration in language tasks. In other words, struggling readers become anxious because of their difficulties, not solely vice versa. This view is echoed in the broader language anxiety literature that anxiety and achievement likely influence each other bidirectionally. An exception noted by Zhou (2015) is a finding by Joo and Damron (2015), who reported a moderate positive correlation between reading anxiety and comprehension among second-year students. They speculated that moderate anxiety might sometimes enhance focus, an "arousal" effect, or that more proficient students may worry more due to higher expectations. This anomaly aside, the consensus is that high reading anxiety generally undermines comprehension. Consequences extend beyond immediate test scores: anxious readers often avoid reading practice, choose easier texts, and enjoy reading less over time. Anxiety can also reduce willingness to participate in reading activities, affecting motivation and further weakening skills.

In L1 contexts, similar patterns emerge: children with reading difficulties not only have lower achievement but also higher anxiety (Hendren et al., 2018; as cited in [54]). Edwards et al. (2023) found that university students with learning disabilities had higher reading anxiety, suggesting that anxiety may both stem from and worsen reading problems even in L1. Ultimately, the consequences of reading anxiety are negative for learning: it directly impairs comprehension and indirectly hinders progress by reducing practice and confidence.

4. Methodological Considerations

4.1 Reading Anxiety Scale

The literature on reading anxiety has grown but also has methodological limitations that should caution interpretation. A common issue is measurement heterogeneity. Many studies borrow instruments from FL anxiety research, but these may vary in focus. The FLRAS (Saito et al., 1999) is standard for L2 reading, but different researchers have modified it or created ad hoc surveys. In L1 contexts, there is no widely used scale (Edwards et al., 2023 developed one specifically for college students). Some studies use general FLA scales (FLCAS) and extract reading items, which may conflate anxiety sources. Piccolo et al. (2017) highlight the need for more consistent use of validated reading-specific scales. Differences in instruments can make it hard to compare findings across studies or aggregate data in meta-analyses.

4.2 Research Design

Another limitation is research design. Much of the evidence is correlational and cross-sectional, which identifies associations but not causality. Few studies track reading anxiety over time or test interventions with control groups. Notable exceptions include Liu and Dong's (2023) longitudinal design and Sparks and Alamer's (2023) cross-lagged panel analysis. These sophisticated designs reveal temporal dynamics and indirect effects, like L1 achievement predicting later L2 anxiety. However, most studies rely on a single survey session, limiting insight into how reading anxiety develops or responds to change. The scarcity of experimental designs is apparent: only a handful of classroom studies (Lo et al., 2021; Al-Obaydi et al., 2024) manipulate teaching methods and measure anxiety pre/post.

4.3 Representativeness of the sample

Sample representativeness is another issue. Many studies sample university or high-school students studying English as a foreign language, often in East Asia. This limits generalizability to younger learners, other language pairs, or less formal settings. Few studies investigate L1 reading anxiety in children or diverse populations. Cultural factors may influence anxiety,like face-saving concerns, but cross-cultural comparisons are rare. Similarly, sample sizes vary widely; some promising findings may stem from small or convenience samples.

4.4 Operational definitions

Operational definitions also vary. Some researchers distinguish trait versus state reading anxiety (Chow et al., 2021), or anxiety during silent vs. oral reading (Al-Obaydi et al., 2024). Others do not specify and treat reading anxiety as a general tendency. This complicates synthesis, as an "anxiety" measure may tap momentary dread on a test or chronic avoidance of reading. Future research would benefit from clearly defining whether reading anxiety is conceptualized as a trait-like predisposition or a situational state and measuring accordingly.Finally, many studies conflate reading anxiety with related constructs. For example, "classroom anxiety" and "reading anxiety" often overlap in questionnaires, making it unclear what proportion of anxiety is specifically about reading versus general FL worry. Careful experimental manipulation, like Oh's 1992 work on different test formats, is needed to isolate

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.329

reading-specific factors. Despite these limitations, the accumulated research provides valuable insights; but readers should interpret correlational findings with caution and advocate for stronger methodologies in future work.

5. Intervention Strategies

A central goal of reading anxiety research is to identify ways to alleviate it. Encouragingly, a variety of instructional interventions have been shown to reduce reading anxiety and improve outcomes. These interventions fall into several categories:

5.1 Strategy Training

Teaching students explicit reading strategies, including skimming, scanning, inferencing, can empower them and thus reduce anxiety. For instance, Fathi and Shirazizadeh (2020) applied an L2 reading strategy instruction program to Iranian EFL learners and found that it significantly improved reading comprehension and reduced reading anxiety while not improving self-efficacy. (cf. Capan & Pektas, 2013). Dang (2024) provides further evidence: Vietnamese EFL students who frequently used reading strategies reported significantly lower anxiety. In that study, learners with lower anxiety used Problem-Solving Strategies, like predicting, summarizing, more regularly, and a negative correlation was observed between strategy use and anxiety. In practice, this suggests that equipping learners with metacognitive strategies and practice can make reading tasks feel more manageable and reduce the sense of helplessness that fuels anxiety. There is a example that can be used in real English classes, Example: Fathi et al. (2020) implemented a listening strategy framework with Iranian EFL learners, leading to improved comprehension and reduced anxiety. （Figure5.1） Operational Steps:

Initial Assessment: Use a reading strategy inventory to gauge learners' baseline use. Modeling: Demonstrate strategies such as predicting, summarizing, and questioning through think-alouds. Guided Practice: Students apply strategies to short passages with teacher scaffolding. Independent Application: Encourage students to use strategies on longer texts. Reflection: Facilitate group discussion on which strategies reduce anxiety and why.

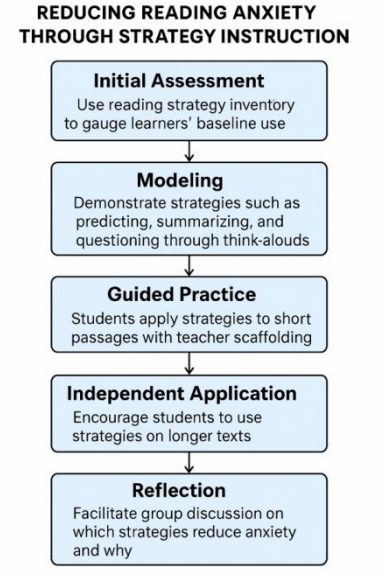

Figure5.1

5.2 Collaborative & Supported Reading

Chen et al. (2014) developed a predictive model (PRAPM) to identify when learners are experiencing reading anxiety by tracking their digital annotation behaviors. They used a Collaborative Digital Reading Annotation System (CDRAS) in which students annotated texts together. When combined with online instructor support, this collaborative approach significantly lowered reading anxiety, especially for male learners and improved comprehension. The idea is that social reading and real-time feedback can reduce isolation and fear of misunderstanding. Similarly, Azizi et al. (2024) found that medical students in an online, collaborative English reading course had lower anxiety than those in traditional lecture-based classes, indicating that a peer-supported environment can buffer anxiety. In general, interventions that make reading more interactive, peer discussion, group work and provide timely teacher reassurance can demystify texts and build confidence. Digital collaborative annotation has been utilized to foster active reading and peer support. For Example , Chen et al. (2014) employed a Collaborative Digital Reading Annotation System (CDRAS) with an AI-based PRAPM to predict and reduce anxiety. Operational Steps:

Digital Text Distribution: Share reading materials through annotation platforms. Collaborative Annotation: Students tag difficult segments, raise questions, and comment on peers' inputs. Instructor Feedback: Teachers monitor annotations and provide targeted responses. AI Monitoring: Use PRAPM to identify patterns and alert instructors to anxiety-prone students. Finally , Post-Reading Discussion: Review key insights and clarify misunderstood points.

5.3 Psychosocial Approaches

Other studies have addressed the anxiety indirectly by altering the learning context. For example, Lo, Lu, and Cheng (2021) implemented a "Reader's Theater" (RT) intervention, where students performed scripted dialogues from reading passages. High school EFL students reported that this drama-based approach not only improved reading comprehension but also reduced their English learning anxiety. RT likely lowers anxiety by making reading a playful, collaborative performance rather than a solitary academic task; even though students felt some pressure during improvisational stages, overall it gave them a sense of achievement. Gok, Bozoglan, and Bozoglan (2021) integrated a flipped classroom into an advanced reading course and found that pre-service teachers in the flipped group showed significant decreases in both foreign language classroom anxiety and reading anxiety. The flipped model, which means students engage with texts or videos at home, then practice together in class, may reduce anxiety by giving students more control over pacing and reducing in-class pressure.Operational Steps:

Pre-Class Materials: Assign video lectures or annotated readings. Interactive Quizzes: Require completion before class to ensure preparedness. In-Class Tasks: Facilitate group discussions, problem-solving, or comprehension games. Teacher Facilitation: Offer real-time support and clarification during class. Follow-Up Review: Assign reflection activities on anxiety levels and comprehension gains.

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.329

5.4 Oral Reading and Repeated Exposure

Incorporating oral reading exercises can also alleviate anxiety. Al-Obaydi et al. (2024) had EFL learners in Iraq read aloud regularly during online sessions. They observed that after six months of daily oral reading, the intervention group not only outperformed controls on comprehension tests but also experienced lower reading and classroom anxiety. The data showed that as comprehension scores rose, anxiety scores fell. The act of successfully reading aloud and receiving constructive feedback appears to build confidence. Teacher observations in that study highlighted that frequent oral reading in a supportive online environment improved rapport and motivation. Thus, repeated, guided reading practice can desensitize students to their fears and normalize reading difficulties. For instance , Al-Obaydi et al. (2024) showed that regular online oral reading improved scores and reduced anxiety. （Figure5.2） Operational Steps:

Routine Integration: Include oral reading as a consistent class activity. Safe Environment: Foster a judgment-free setting through peer encouragement. Use of Technology: Leverage tools like voice recorders or online conferencing. Feedback Loop: Provide constructive, non-evaluative feedback. Progress Tracking: Monitor growth in fluency and reductions in expressed anxiety.

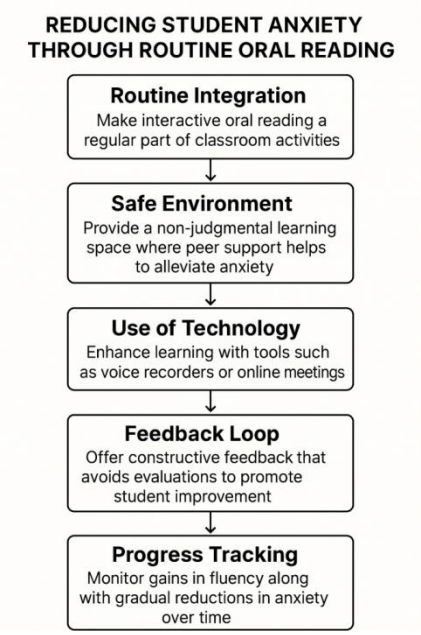

Figure5.2

5.5 Metacognitive Support

Although not always labeled as “interventions,” providing metacognitive support, including teaching students to recognize anxiety symptoms, set goals, and self-monitor, can help. For instance, Dang (2024) recommended teaching coping strategies after noting the link between strategy use and anxiety. The idea is that if students understand why they feel anxious and have techniques, such as deep breathing, positive self-talk, or breaking tasks into smaller steps, they may become less overwhelmed. Shifting attribution, helping students see anxiety as normal and manageable, could also mitigate its effects, as could creating a classroom culture where mistakes are viewed as learning opportunities.

Overall, the intervention literature suggests that multifaceted approaches are most effective. Combining strategy training with a supportive learning environment, and gradually increasing text difficulty, can address both the skills gap and the emotional response. Importantly, interventions often produce the greatest anxiety reduction when they improve actual comprehension simultaneously, thus eliminating the source of worry. Many of the cited studies implemented quasi-experiments or mixed methods designs, like questionnaires plus interviews, which is encouraging compared to purely correlational research. However, most interventions have been short-term or context-specific, so more research is needed on long-term and diverse implementations.

6. Reading Anxiety in First and Second Language Contexts

An explicit comparison between L1 and L2 reading anxiety reveals both commonalities and divergences. On one hand, the core features, lik fear of decoding difficulties, test anxiety, are similar. Both first-language and foreign-language readers can feel anxious when encountering unfamiliar words, complex grammar, or challenging content. The physiological and emotional reactions, including sweaty palms, racing thoughts, are fundamentally the same. Edwards et al. (2023) demonstrate that college students reading in their native language still exhibit a measurable dimension of reading anxiety that correlates with reading fluency and self-concept. Similarly, Piccolo et al. (2017) argue that reading anxiety should be acknowledged as a facet of reading disability in L1 contexts. In this sense, reading anxiety is not exclusively an L2 phenomenon but a generic response to demanding literacy tasks.

However, the sources of reading anxiety often differ between L1 and L2. For L2 readers, anxiety frequently stems from linguistic uncertainty: not knowing vocabulary or syntax produces stress. Saito et al. (1999) noted that unfamiliar scripts and cultural content in FL texts are potent sources of anxiety. Zhou (2015) found Japanese learners anxious primarily due to their lack of familiarity with kanji characters. In contrast, L1 readers typically have less concern about basic decoding or meaning since the language is familiar, and anxiety in L1 is more likely tied to reading competence. For instance, children with dyslexia experience anxiety related to their struggles (Hendren et al., 2018), and Edwards et al. (2023) found that even adult L1 readers with learning disabilities felt elevated anxiety. Thus, L1 reading anxiety often coexists with or signals underlying learning disorders, whereas L2 reading anxiety can often be attributed to linguistic and cultural unfamiliarity.

The prevalence and intensity also tend to differ. Most studies indicate that L2 reading anxiety is quite common and can be a significant barrier for many learners, as seen by the moderate levels reported in EFL populations. L1 reading anxiety is less prevalent overall in the general population, but among individuals with reading problems it can be severe. Piccolo et al. (2017) lament the lack of research on L1 reading anxiety, but their review suggests it is especially relevant for early readers who fear reading failure. In bilingual situations, one might even find some learners who have high L1 reading anxiety due to a reading difficulty but lower

ISSN (P): 3078-4433 | ISSN (O): 3078-4441 Doi:10.71113/JMSS.v2i3.329

anxiety when reading a second language if, for example, the L2 was learned through context or if they have high motivation for the L2.

Comparisons between L1 and L2 reading anxiety are also reflected in educational implications. Sparks and Alamer's (2023) mediation model indicates that strengthening L1 reading achievement can reduce future L2 reading anxiety. This implies that supporting native-language literacy may have spillover benefits for foreign-language learning. Conversely, L2-focused interventions must account for students' L1 reading profiles. Argaman and Abu-Rabia (2002) found that Hebrew-speaking students had similar anxiety toward English reading and writing as toward their L1 language tasks, suggesting personal dispositions, like perfectionism or fear of failure, may transfer across languages.

In short, L1 and L2 reading anxiety share the basic phenomenon of text-induced distress, but they arise from different constellations of cognitive and emotional factors. The L2 literature (Saito, Zhou, Dang, etc.) emphasizes language proficiency and cultural distance, while the L1 literature (Piccolo, Edwards) focuses on literacy skills and disabilities. The available evidence suggests that interventions should be tailored accordingly: foreign language educators should focus on language support and strategy use, whereas L1 educators should identify and assist struggling readers to prevent anxiety.

Conclusion

Reading anxiety is a significant affective construct in language education, with proven impacts on learning. This review has shown that reading anxiety is well-defined as a situational, phobic reaction to reading tasks, occurring in both first- and second-language contexts. Empirical research indicates that it is widespread among language learners, generally at moderate intensity. It correlates negatively with comprehension and performance, and positively with traits like poor self-concept and low motivation. Yet, reading anxiety is also amenable to change: classroom interventions that improve skills and foster supportive environments can lower anxiety and improve outcomes.

Comparatively, L2 reading anxiety arises largely from linguistic challenges, whereas L1 reading anxiety often signals fundamental reading difficulties. Understanding this distinction is crucial for educators: reducing L2 reading anxiety may involve easing linguistic demands and building strategy use, while reducing L1 reading anxiety may require direct reading remediation and confidence-building. Sparks and Alamer (2023) suggest that strengthening L1 literacy can have downstream effects on L2 anxiety, implying a holistic approach to language education.

Methodologically, future research should move beyond cross-sectional surveys. Longitudinal and experimental studies (like those of Liu & Dong and Al-Obaydi et al.) provide more compelling evidence of causality. More work is needed on measurement in L1 contexts, on younger learners, and on varied linguistic settings. Research should also clarify the interplay between anxiety and achievement – for example, does anxiety reduction mediate gains from reading interventions, or vice versa?

For practitioners, the key takeaway is that recognizing and addressing reading anxiety is vital. Instructors should assess anxiety levels, using appropriate scales, and implement strategies training, supportive pedagogy, and frequent low-stakes reading practice to build learner confidence. Emphasizing comprehension rather than speed, encouraging peer collaboration, and addressing students' attitudes can create a classroom climate that minimizes fear. As Saito et al. (1999) and subsequent researchers have shown, reading anxiety is not an immutable trait but a response that can be alleviated. With careful instructional design and attention to learners' emotional states, educators can help anxious readers overcome barriers and become more proficient and confident readers in both their first and second languages.

Acknowledgments

Thank you to the scholars who have put forward valuable ideas for this research, as well as to the editors and reviewers for their work and valuable opinions.

Funding

This study was no funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the author.

Statements and Declarations

No funding was received for conducting this study. The present study has no relevant financial or non-financial interests to disclose.

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No funding was received for conducting this study. The present study has no relevant financial or non-financial interests to disclose.

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JOURNAL OF MODERN SOCIAL SCIENCES

Bimonthly

Started in 2024

Vol. 2, No. 3 (Sum No. 5)

June, 2025

Submission https://atripress.org/index.php/JMSS

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Asia Technology Research Institute

June, 2025