Neutrosophic Methodological Foundations of Marketing Research in the Rural Labor Market

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Abstract

This article introduces a neutrosophic methodological framework for conducting personnel marketing research in the rural labor market of Uzbekistan. Given the inherent uncertainty and indeterminacy in labor market dynamics, the study applies neutrosophic logic to enhance the reliability of marketing data regarding labor demand and supply. The research outlines the interrelated stages of personnel marketing analysis, incorporating neutrosophic sets to better identify discrepancies between labor demand and supply, the scale and causes of rural unemployment, and the structural needs for new professions. Key areas of focus include problem identification, goal formulation, data collection and analysis, forecasting labor market trends, and developing targeted interventions to mitigate unemployment and improve workforce qualifications. Additionally, the study proposes strategic marketing initiatives for rural employment assistance centers, integrating neutrosophic decision-making models to optimize labor market strategies. By adopting neutrosophic approaches, the study provides a robust, uncertainty-aware methodology for balancing labor market proportions and formulating evidence-based policies to enhance rural employment opportunities.

Keywords: Rural labor market; Neutrosophic approach; Rural labor market; Labor demand; Labor supply; Personnel marketing research; Comprehensive marketing models; Stages of personnel marketing research; Informal employment; Labor market forecasting; Uncertainty analysis

1. introduction

Current statistical data do not fully reflect the demand and supply in the rural labor market. As a result, there is no reliable methodology for assessing job positions. Consequently, it remains challenging to determine the volume and causes of the discrepancies between labor demand and supply.

The regulation and provision of rational employment for the rural population, based on market mechanisms, are carried out through constant analysis of labor demand and supply using highly reliable information. Solving these problems based on personnel marketing research yields positive results.

The problems of utilizing marketing research have been addressed by many domestic and foreign scholars [1,2,3,4,5,6]. The well-known American economist F. Kotler offers a comprehensive definition: “Marketing research is the systematic determination of the scope of data necessary in connection with the marketing situation faced by the firm, their collection, analysis, and report on the results” [5, p. 181]. This definition is most widely used in trade transactions and material-technical supply. However, there is relatively little marketing research conducted on labor demand and supply [7,8].

In market-developed countries, marketing research is widely used in studying the demand and supply of goods. In Uzbekistan, marketing has been established as a separate science and is effectively applied in the analysis of goods markets, securities, investments, and scientific developments. However, personnel marketing research is practically seldom used in studying the main elements of the rural labor market [9,10]. Therefore, it is advisable to develop methodological foundations for conducting personnel marketing research to study the main components of the rural labor market, especially in labor-surplus regions where unemployment is most prevalent.

2. Materials and method

Personnel marketing not only examines the current and future state of labor demand and supply but also serves as the primary mechanism for regulating employment. Through this mechanism, necessary information about the rural labor market is collected and analyzed, and the volume and list of new professions, as well as the main directions for their qualification improvement and retraining, are determined. The main goal of personnel marketing research is to determine the optimal proportion between labor demand and supply. This has significant socio-economic importance in ensuring rational employment of the rural population and reducing unemployment [11-14].

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Personnel marketing research in rural employment centers in Uzbekistan is conducted in several ways. Small and medium-sized employment centers can request local educational or research institutions' faculty or researchers to plan and conduct such research, or they can hire specialized organizations for this purpose. In large employment centers, it is advisable to conduct personnel marketing research through newly established departments dedicated to this direction. These departments can range from one to several dozen employees, depending on the scale and complexity of collecting and analyzing marketing information [15-17]. The heads of such departments report directly to the deputy director of the employment center for marketing. The department staff includes research program developers, statisticians, sociologists, psychologists, digital technology specialists, and others, who use a bank of statistical methods and economic-mathematical models to conduct a systematic analysis of personnel marketing information at the employment centers (see Figure 1).

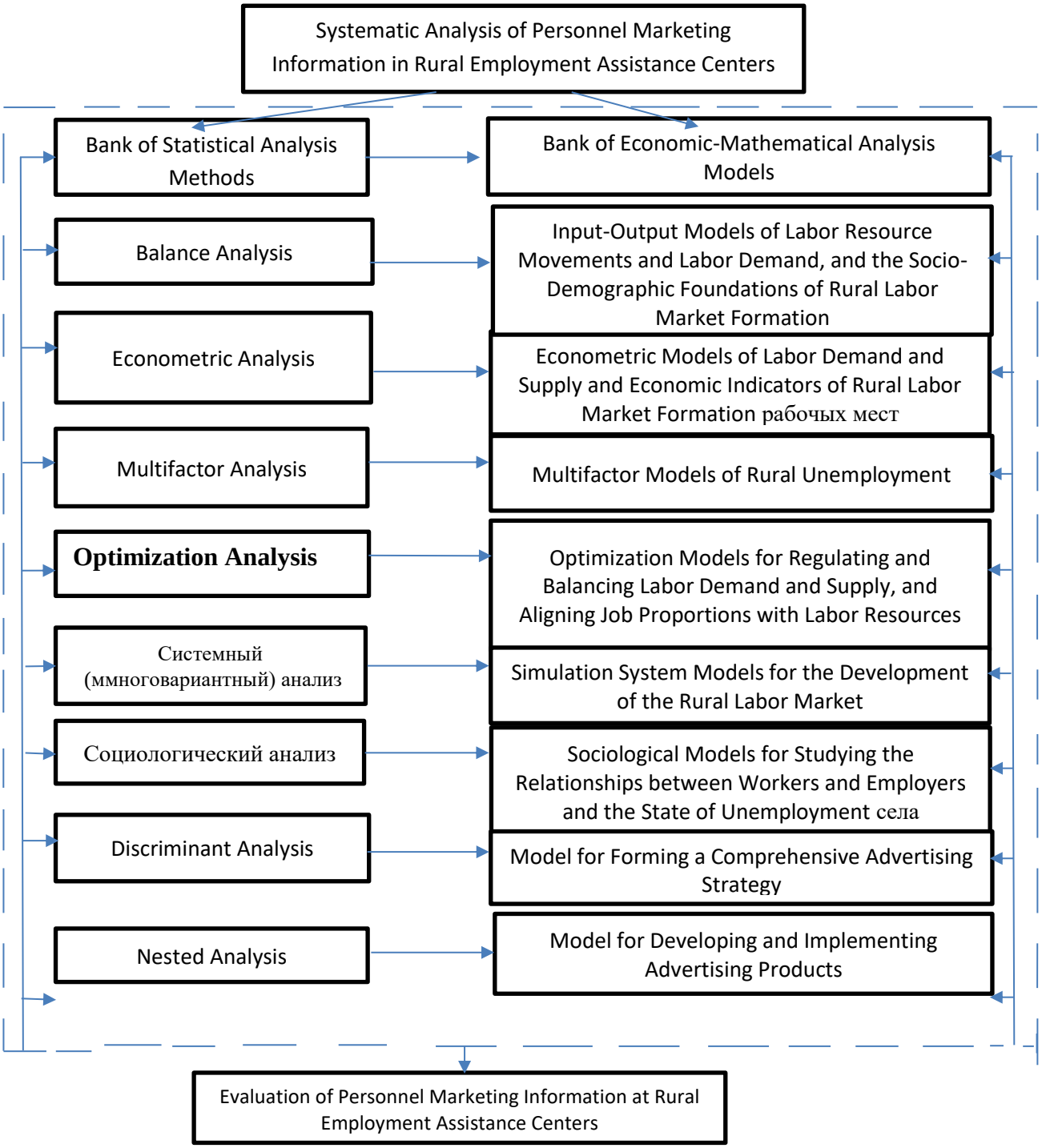

Figure 1. Systematic Analysis of Personnel Marketing Information at Rural Employment Assistance Centers

a. Introduction of Neutrosophic Logic in Labor Market Analysis

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The rural labor market is characterized by **uncertainties**, **incomplete information**, and **ambiguous employment trends**. Traditional statistical and econometric models may struggle to accommodate **indeterminacy** in labor demand, supply, and informal employment structures. **Neutrosophic sets** provide a robust way to model these uncertainties.

A **neutrosophic variable** in the labor market can be defined as:

$L = (T, I, F)$

Where:

- **T (Truth Membership Degree)** – The extent to which a given labor market policy or marketing strategy effectively meets the labor demand.
- **I (Indeterminacy Degree)** – The uncertainty surrounding employment statistics due to informal labor, seasonal work, and unreliable data.
- **F (Falsity Membership Degree)** – The extent to which the available labor market data contradicts actual employment conditions.

b. Neutrosophic Regression Model for Labor Market Estimation

A neutrosophic regression model can be proposed to analyze the relationship between labor demand *LD*, labor supply *LS*, and other socio-economic indicators:

$LD_i = \alpha+\beta_1 LS_i+\beta_2 W_i+\beta_3 ED_i+\beta_4 I_i+\epsilon_i$

Where:

- LD_i = Labor Demand in rural region iii
- LS_i = Labor Supply in rural region iii
- W_i = Wage levels in the rural labor market
- ED_i = Education and skill level of workers
- I_i = Indeterminacy component due to informal employment, modeled as a **neutrosophic variable**.
- ϵ_i = Error term

The **neutrosophic approach** allows each coefficient (β_i) to be expressed as a **triple set**:

$\beta_i = (\beta_i T, \beta_i I, \beta_i F)$

where:

- $\beta_i T$ represents the **true effect** of the factor on labor demand.
- $\beta_i I$ represents the **indeterminate effect**, accounting for **policy changes**, **informal work**, and **data inconsistencies**.
- $\beta_i F$ represents the **false effect**, considering data biases and errors in statistical reporting.

c. Neutrosophic Decision-Making in Rural Employment Policies

When policymakers design employment assistance programs, they face uncertainty in **estimating actual rural unemployment levels**. A **Neutrosophic Multi-Criteria Decision-Making (N-MCDM) Model** can be used to prioritize rural labor policies:

Define a **Neutrosophic Decision Matrix**:

$D = [(T_1, I_1, F_1) (T_2, I_2, F_2) \dots (T_n, I_n, F_n)]$

Where each column represents a **policy option**, and the triplet values correspond to:

- T_n: Success probability of the policy.
- I_n : Uncertainty in implementation (e.g., funding gaps, seasonal fluctuations).

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- F_n : Risk of failure due to external economic factors.

Using the **Neutrosophic Weighted Aggregated Sum Product Assessment (N-WASPAS)** method, policymakers can rank policy options by calculating:

$N_i = \lambda S_i + (1-\lambda) P_i$

where:

- S_i is the **neutrosophic sum method** score.
- P_i is the **neutrosophic product method** score.
- λ is the decision-maker's preference weight.

d. Neutrosophic Clustering for Informal Employment Estimation

Traditional employment data often **underestimate informal workers**. A **Neutrosophic K-Means Clustering** approach can be used to categorize **rural workers** into three groups:

1. **Officially employed workers (High T, Low I, Low F)**:
   - Workers in **formal** employment programs.
2. **Uncertain employment workers (Moderate T, High I, Moderate F)**:
   - Workers in **seasonal** or **part-time** jobs with fluctuating demand.
3. **Hidden unemployed workers (Low T, High I, High F)**:
   - Informal workers who are **underemployed** or **not reported** in labor statistics.

The **clustering function** is formulated as:

$$\arg\min \sum_{i=1}^{k} \sum_{j=1}^{n} \|LDj, LSj, Ij - Ci\| 2$$

where C_i represents the **neutrosophic centroids** of labor market clusters.

e. Simulation-Based Forecasting of Rural Labor Trends

Using a **Neutrosophic Monte Carlo Simulation**, we can estimate **future labor market trends** under uncertainty.

Define:

$L_t = f(LD_t, LS_t, W_t, ED_t) + \epsilon_t$

where ϵ_t follows a **Neutrosophic Normal Distribution**:

$\epsilon_t \sim N(T, I, F)$

Monte Carlo simulations generate **thousands of future scenarios**, adjusting for **uncertainties in workforce participation, informal sector growth, and policy effectiveness**.

To obtain reliable marketing information about labor demand and supply, it is necessary to conduct personnel marketing research through interconnected stages (see Figure 2).

1. Identification of Problems and Formulation of Goals for Personnel Marketing Research at Rural Employment Assistance Centers

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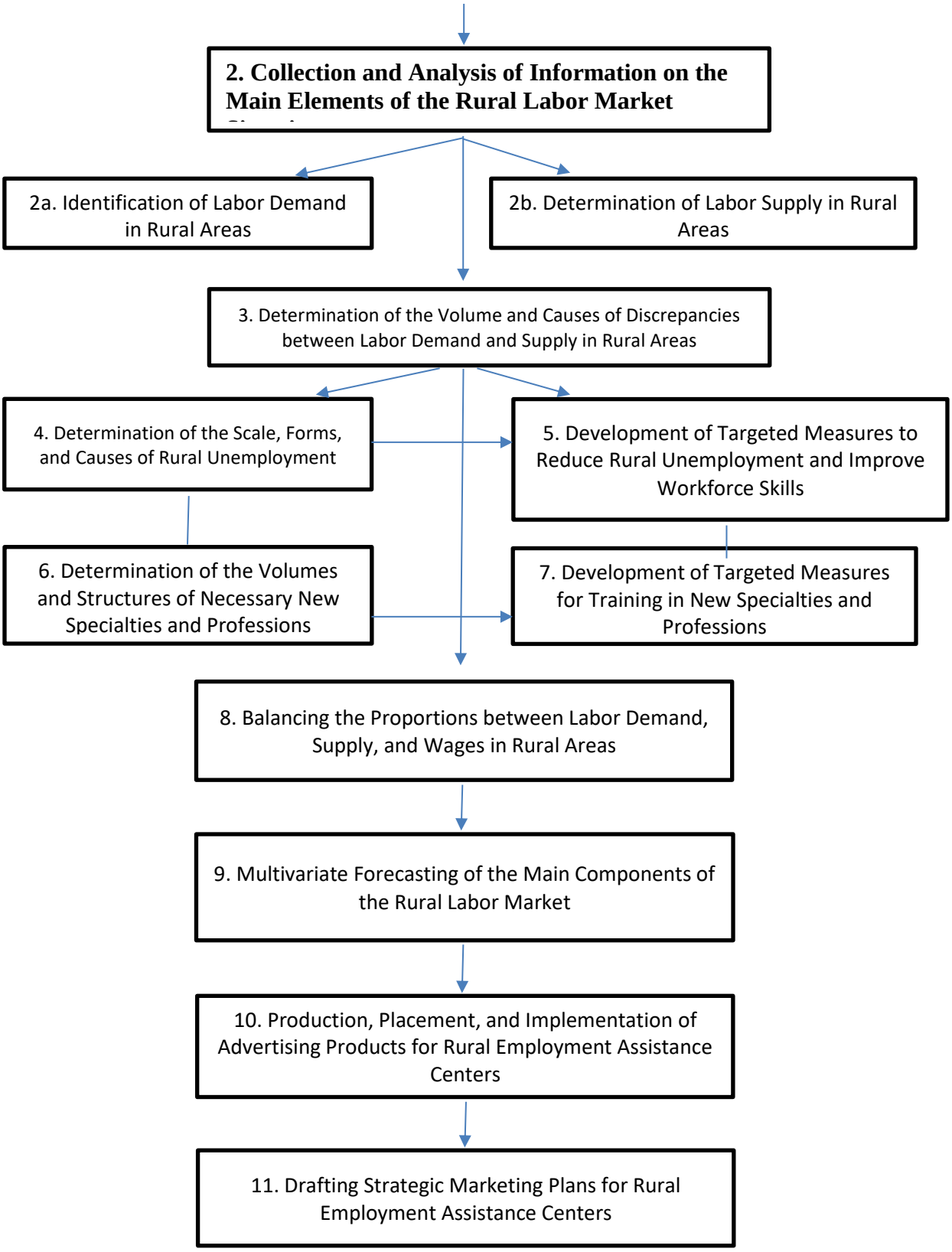

Figure 2. Stages of Personnel Marketing Research at Rural Employment Assistance Centers.

In the initial phase, problems are identified, and objectives are formulated for personnel marketing research. A complex and challenging issue in this research is finding reliable information about the demand and supply of the workforce. Significant problems include satisfying the demand for labor in the job market and reducing the number of people not engaged in public production, i.e., minimizing the unmet portion of workforce supply in terms of selling their labor

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capacity. The goal of the research is to develop strategic measures to harmonize the proportions between demand, supply, and labor price in the rural labor market.

In the second phase of personnel marketing research, information on the state of the main elements of the rural labor market is collected and analyzed. The researcher can gather secondary or primary information or both simultaneously. Secondary information is obtained from internal and external sources.

Internal sources include annual reports of enterprises, results of personnel marketing research, reports from employment assistance services, consumer-advertising reviews, and others. External sources consist of data from statistical collections on rural economy sectors and labor, international labor organizations, labor statistics, periodical publications, scientific research, and specialized marketing organizations. This also includes information obtained from job fairs, exhibitions, conferences, and meetings on employment and the labor market.

If secondary data do not provide sufficient information to achieve the research objectives, primary data must be collected through so-called field personnel marketing research. The following methods are used in this process: sociological surveys; individual or group interviews; observation and recording of employer (entrepreneur) behavior; expert evaluations.

In the process of systematic analysis of the collected information on the state of rural labor markets in labor-surplus regions, the following quantitative methods of personnel marketing research are applied:

- Multifactorial methods (primarily factor and cluster analysis) are used to justify marketing decisions based on numerous interconnected variables. For example, determining the volume of labor demand depending on supply, price, labor competitiveness, and the number of available and newly created jobs, the scale of advertising, and its costs, and other elements of the marketing mix.
- Regression and correlation methods are used to establish relationships between groups of variables that describe marketing activities in rural employment centers.
- Simulation methods are employed when the variables influencing the labor market situation (e.g., describing the competition for rural labor utilization) cannot be addressed through analytical solutions;
- Methods of statistical decision theory (game theory, queueing theory, stochastic programming) are used for the stochastic description of employers' responses to changes in the rural labor market situation;
- Deterministic operations research methods (primarily linear and nonlinear programming) are applied when there are many interrelated variables and an optimal solution must be found, such as options for the rational employment of labor resources considering the reduction of unemployment in rural areas;
- Hybrid methods, combining deterministic and probabilistic approaches, are primarily used to investigate issues of rural labor distribution and redistribution;
- The program-target method represents a set of tools for economic-mathematical analysis and forecasting, sociological surveys, and expert assessments used in the development of targeted current and future measures for labor marketing activities at rural employment assistance centers.

The aforementioned groups of quantitative methods in labor market research do not exhaust their full diversity; more than 60 methods can be used in marketing research. Using the aforementioned methods, the scales of demand, supply, and prices for rural labor are determined at this stage of the marketing research.

At the third stage of labor market research, the causes and scale of the discrepancy between the supply and demand of workers in the rural labor market are studied. Balance, econometric, and sociological methods of analysis and expert assessment are most commonly used here.

At the fourth stage of labor market research, the scale and causes of hidden, seasonal, technological, functional, structural, and other forms of rural unemployment are determined, and key factors delaying the employment of the able-bodied unemployed population are identified.

At the fifth stage of labor market research, a set of targeted measures is developed to reduce rural unemployment and improve professional training and retraining.

At the sixth stage of labor market research, the volumes and structures of new specializations and professions are determined based on the needs of local and foreign employers producing competitive agricultural products and providing services.

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At the seventh stage of labor market research, a set of targeted measures is developed for the training of new specializations and professions in connection with the restoration and development of new forms of ownership, particularly the formation of farms, joint ventures, corporations, and many others that previously did not operate in rural areas.

At the eighth stage, which is the decisive moment of labor market research, quantitative and qualitative alignment of the proportions between supply, demand, and the price of labor is carried out, based on the results obtained in previous stages. It is advisable to apply the program-target method to study the rural labor market situation at this stage.

At the ninth stage of labor market research, using simulation and optimization models, multi-scenario forecasting of the main elements and components of the formation and development of rural job and labor markets is carried out. Additionally, optimal development options for the micro and macro marketing environment of the employment service during the forecast period are determined.

At the tenth stage of labor market research, advertising activities are developed and implemented through an advertising agency established at rural employment assistance centers. The agency operates four divisions: a creative department, responsible for the development and production of advertisements; a media department, responsible for selecting advertising media and placing advertisements; a research department, studying the characteristics and needs of rural labor markets and job markets; and a commercial department, engaged in the agency's commercial activities based on labor agreements for the buying and selling of rural labor.

At the eleventh stage of labor market research, strategic marketing plans for rural employment assistance centers are drawn up using all the information obtained in the previous stages.

Thus, labor market research facilitates the collection and evaluation of information on labor supply and demand, which serves as a database for the implementation of a comprehensive set of models addressing the researched issue.

3. Results

Because of testing the proposed methodological foundations for labor market research, forecast indicators of new demand and supply for rural labor in the Republic of Uzbekistan have been calculated up to 2025. This increase is attributed to the expansion of job creation in agricultural clusters, cooperatives, farms, and household plots, as well as the enhancement of employment among the rural working-age population.

The effective organization of agricultural clusters and cooperatives will have a direct positive impact on increasing the demand for labor in the agricultural sector of the economy in the future, while reducing its supply.

In 2023, the demand for labor in the agricultural sector stands at 96,887 people. According to our calculations, the demand for labor in this sector is expected to increase in the near future. By 2026, the demand for labor in agriculture is projected to reach 112,713 people (see Table 1).

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Table 1. Forecast of Labor Demand and Supply in Agricultural Clusters, Cooperatives, and Other Sectors of the Rural Economy of the Republic of Uzbekistan

No.	Name of the Agricultural Sector	Indicators and units of measurement	**2023 y (report)**	Forecast period			Change in 2026 compared to 2023	
				2024 y	**2025 y**	**2026 y**	**+ ; -**	**%**
I.	Total for the Agricultural Sector, including:	Demand for labor, persons	96887	104798	107435	112713	+15826	116,3
		Supply of labor, persons	112442	122483	125830	132525	+20083	117,9
1.1.	Regarding agricultural clusters, the following categories are included:	Demand for labor, persons	71025	79980	82965	88940	+17915	125,2
		Supply of labor, persons	77513	93536	98877	109563	+32050	141,3
1.1.1.	Cotton and textile	Demand for labor, persons	35673	42739	45095	47450	+11777	133,0
		Supply of labor, persons	41400	49905	52740	55575	+14175	134,2
1.1.2.	Grain farming	Demand for labor, persons	3043	3266	3341	3415	+372	112,2
		Supply of labor, persons	3500	3690	3753	3816	+316	109,0
1.1.3.	Livestock farming	Demand for labor, persons	10374	11413	11759	12552	+2178	121,0
		Supply of labor, persons	12041	13340	13773	14639	+2598	121,6
1.1.4.	Fruit and vegetable production	Demand for labor, persons	16607	18532	19173	20556	+3949	123,8
		Supply of labor, persons	19275	21662	22457	24048	+4773	124,8
1.1.5.	Sericulture	Demand for labor, persons	1826	2158	2269	2490	+664	136,4
		Supply of labor, persons	2121	2524	2659	2928	+807	138,0
1.1.6.	Fishing	Demand for labor, persons	1196	1221	1229	1245	+49	104,1

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		Supply of labor, persons	1388	1426	1439	1464	+76	105,5
1.1.7.	Agrotourism	Demand for labor, persons	831	949	988	1067	+236	128,4
		Supply of labor, persons	964	1110	1158	1255	+291	130,2
1.1.8.	Medicinal plants	Demand for labor, persons	568	630	650	712	+144	125,4
		Supply of labor, persons	620	713	744	837	+217	135,0
1.2.	Agricultural cooperatives	Demand for labor, persons	4811	5106	5204	5302	+491	110,2
		Supply of labor, persons	5292	5617	5725	5942	+650	112,3
1.3.	Farms, private and subsidiary households	Demand for labor, persons	24192	26081	26711	27971	+3779	115,6
		Supply of labor, persons	25701	28586	29547	31470	+5769	122,4
II.	Non-agricultural sectors	Demand for labor, persons	196118	227996	238622	259874	+63756	132,5
		Supply of labor, persons	238718	279611	293242	320504	+81786	134,3
In rural areas – total		Demand for labor, persons	293006	332796	346060	372587	+79581	127,2
		Supply of labor, persons	353989	413413	433221	453029	+99040	128,0

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The proportion of clusters in the structure of the forming demand for labor in agriculture is high, and the volume of new labor demand is projected to increase from 71,025 (2023) to 88,940 individuals (2026). During this period, the demand for labor in agricultural cooperatives is expected to rise from 4,811 to 5,302, while the demand for labor in private farms, family farms, and other agricultural enterprises is anticipated to grow from 24,192 to 27,971 individuals.

In the forecast period, the demand for labor in the non-agricultural sector is projected to increase from 196,118 (2023) to 259,874 individuals (2026).

The results of labor market research indicate that the increase in new labor demand in Uzbekistan's agricultural sector leads to an increase in the supply of unemployed rural working-age population. According to our calculations, the labor supply in the agricultural sector in 2023 amounts to 112,442 individuals. This figure is expected to reach 132,525 individuals by 2026, with an average annual growth rate of 8.9%, compared to a 7.2% growth rate in new labor demand.

Thus, in the near future, the growth rate of new labor supply is projected to outpace the growth rate of labor demand. This trend directly influences the slow reduction in informal employment among the rural working-age population in the Republic of Uzbekistan (see Table 2).

Table 2. Forecast of Informal Employment in Rural Areas of the Republic of Uzbekistan, in thousands of people

№	Indicator Names	**2023y. (report)**	Forecast Period			In 2026 compared to 2023, %
			2024 y.	**2025 y.**	**2026 y.**	
1	Total Number of Employed in Rural Areas,	10238,1	10864,8	11082,1	11303,7	110,4
1.1	Including: In the Informal Sector	6337,4	5943,0	5884,6	5753,6	90,8
1.1.1	Share of the Informal Sector, %	61,2	54,7	53,1	50,9	x

Table 2 shows that the number of employed in rural areas was 10,238.1 thousand people in 2023, and this figure is expected to reach 11,303.7 thousand people by 2026. Due to the special attention given to the organization of new jobs in agricultural clusters and cooperatives, as well as private farms, there has been a decrease in the number of informal employment by 583.8 thousand people.

In particular, in 2023, 61.2% of the working-age population in rural areas were employed in the informal sector, and this figure is expected to decrease to 50.9% by 2026.

4. Discussion

The effectiveness of this methodology cannot be evaluated through the classical approach of comparing costs and outcomes. It is more appropriate to assess the methodology's impact by analyzing the dynamic ratio between labor demand and supply, highlighting the influence of the implemented measures.

The proposed methodology is suitable for application in the rural labor markets of labor-surplus rural regions in our republic and other Central Asian countries. In the rural areas of the Republic of Uzbekistan, there is a significant disproportion between labor demand and supply. Consequently, more than 10% of the working-age population is unemployed, with 10-15% of them considered poor. Based on the results of labor market research in rural areas, the following key measures should be developed [18, 19]:

Creation of new jobs in clusters, cooperatives, and farms aimed at agricultural production, considering the specifics of crop cultivation and livestock production.

Organization of new jobs in processing industries, construction, household services, and other sectors of the rural economy where local and foreign investments are not as costly compared to other types of labor activities.

Development of family entrepreneurship in agricultural production areas, where low-cost jobs can be organized to achieve high labor income.

Expansion of employment opportunities in small businesses and private entrepreneurship by providing various forms of financial and economic support, including tax benefits.

Creation of conditions for internal migration of the rural working-age population by attracting regional financing entities.

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Increase in the volume of organized labor export to specific foreign employers, especially in agriculture, based on labor contracts that comply with international labor law standards.

Enhancement of the efficiency of both state employment services and private structures involved in job placement for the unemployed through organizational and economic measures.

Development of a strategy to ensure rational employment of the rural working-age population based on comprehensive labor market research.

By implementing these measures, the methodology aims to address the imbalance between labor supply and demand in rural areas, ultimately reducing informal employment and improving the overall economic conditions for rural populations.

5. Conclusion

Thus, the proposed **neutrosophic-enhanced methodology** provides a structured approach for identifying specific measures to implement **effective solutions** in reducing labor supply imbalances and increasing labor demand under conditions of **uncertainty and indeterminacy**. By incorporating **neutrosophic logic**, labor market fluctuations, informal employment structures, and economic unpredictability are accounted for through **truth (T), indeterminacy (I), and falsity (F) measures**.

This approach facilitates the establishment of an **optimal equilibrium** between labor supply and demand, ensuring a **rational employment distribution** that adapts to the **real-world complexities** of rural labor markets in **Central Asia**. The inclusion of **neutrosophic forecasting models** allows policymakers to design **more flexible and adaptive employment strategies**, mitigating rural **unemployment risks** while fostering a sustainable labor ecosystem.

By leveraging **neutrosophic decision-making frameworks** such as **N-WASPAS and Monte Carlo simulations**, policymakers can assess employment trends with **higher accuracy**, integrating **green job growth, informal sector inclusion, and labor market dynamics** into long-term strategic planning. Ultimately, this **data-driven, uncertainty-aware methodology** enhances the **resilience and adaptability** of rural labor markets, contributing to **socio-economic stability** and **sustainable workforce development** in the region.

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