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Research Article

PREDICTING SERVICE GAPS IN INDONESIAN MIGRANT WORKER PROTECTION USING ARTIFICIAL INTELLIGENCE AND THE CIPPO EVALUATION MODEL

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Abstract

Indonesian migrant workers continue to face various challenges throughout the migration cycle, including high placement costs, limited access to information, exploitation, legal problems, and inadequate reintegration services upon returning home. This study aimed to evaluate the effectiveness of Indonesian migrant worker protection services using the Context, Input, Process, Product, and Outcome (CIPPO) evaluation model and to develop an artificial intelligence-based prediction model for identifying service gaps. This study employed a qualitative evaluative approach using the CIPPO framework. Data were collected from 57 informants comprising government officials, prospective migrant workers, migrant workers abroad, and returned migrant workers through in-depth interviews, observations, and document analysis. The evaluation revealed that the Context dimension achieved 40.43%, Input 77.92%, Process 100%, Product 59%, and Outcome only 11.1%. The findings indicate that although program implementation was administratively effective, its impact on improving protection services remained limited. The artificial intelligence models successfully predicted service deficiencies and identified critical areas requiring policy intervention. Integrating artificial intelligence with the CIPPO evaluation model provides a comprehensive and evidence-based approach for predicting service gaps and strengthening Indonesian migrant worker protection policies through data-driven decision-making and digital governance strategies.

Keywords: Artificial Intelligence, CIPPO Evaluation, Migrant Workers

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INTRODUCTION

International labor migration has become one of the most significant socioeconomic phenomena of the twenty-first century, contributing substantially to global economic development, poverty reduction, and labor market sustainability. According to international migration reports, millions of migrant workers cross national borders annually in search of better employment opportunities and improved living conditions. Despite their considerable contributions to both sending and receiving countries, migrant workers remain one of the most vulnerable populations in terms of occupational safety, health protection, and access to social services. Many migrant workers experience exploitation, unsafe working conditions, discrimination, inadequate healthcare access, and violations of fundamental human rights throughout the migration cycle, including the pre-departure, employment, and reintegration phases (Evagora-Campbell, Zahidie, Buse, Rabbani, & Hawkes, 2022). These challenges have become increasingly complex due to globalization, economic uncertainty, and changing migration patterns, highlighting the urgent need for comprehensive and responsive protection systems. Consequently, strengthening migrant worker protection has emerged as a global public health and human rights priority, requiring innovative approaches that can identify service deficiencies and support evidence-based policy interventions to ensure the health, safety, and well-being of migrant populations.

The protection of migrant workers has become a major public health and human rights concern due to the increasing complexity of labor migration and the multidimensional risks faced by workers throughout the migration cycle (Fernández-Sánchez et al., 2025). Migrant workers frequently encounter various vulnerabilities, including occupational injuries, physical and psychological abuse, exploitation, wage withholding, inadequate access to healthcare services, legal uncertainties, and social exclusion in destination countries. These challenges not only affect the health and well-being of migrant workers but also have broader implications for social development, economic productivity, and sustainable migration governance. Consequently, effective migrant worker protection systems are essential to ensure safe migration, safeguard fundamental human rights, and promote equitable access to health and social services. In the Indonesian context, the government has introduced various policies and institutional reforms to strengthen the protection of Indonesian migrant workers before departure, during employment abroad, and after returning home. However, persistent complaints regarding administrative barriers, limited legal assistance, exploitation, and difficulties in economic reintegration indicate that significant gaps remain within the existing protection system. Therefore, evaluating the effectiveness of migrant worker protection services is critical not only for improving service quality and institutional performance but also for developing evidence-based policies capable of responding to the evolving needs of migrant workers in an increasingly digital and globalized environment (Rifky, Dewi, & Darmawan, 2025).

Indonesia is one of the world's largest labor-sending countries, with millions of citizens working overseas in domestic work, manufacturing, construction, plantation, fisheries, and healthcare sectors. Despite their substantial contribution to national economic development through remittances and foreign exchange earnings, Indonesian migrant workers continue to face numerous challenges throughout the migration cycle (Maksum, 2021). Persistent problems include high recruitment and placement costs, fraudulent recruitment practices, limited access to official employment information, delayed departures, document confiscation, unpaid wages, occupational accidents, excessive working hours, human rights violations, and inadequate legal protection in destination countries. Furthermore, returned migrant workers frequently encounter difficulties related to economic reintegration, limited access to entrepreneurial support, and insufficient social protection services upon returning to Indonesia. These recurring issues suggest that existing protection mechanisms have not fully addressed the multidimensional needs of migrant workers and indicate the presence of significant service

gaps within the Indonesian migrant worker protection system (Hamzah et al., 2026). Consequently, a comprehensive evaluation of protection services is necessary to identify systemic weaknesses and develop more responsive and evidence-based intervention strategies.

Despite various policy reforms and institutional transformations from the National Agency for the Placement and Protection of Indonesian Migrant Workers (BNP2TKI) to the Indonesian Migrant Worker Protection Agency (BP2MI) and subsequently the Ministry of Protection of Indonesian Migrant Workers, persistent complaints among Indonesian migrant workers remain a significant concern. Prospective migrant workers continue to experience high placement costs, recruitment fraud, failed departures after making payments, and limited access to official employment information. During overseas employment, many migrant workers encounter salary withholding, physical abuse, excessive working hours, confiscation of passports, occupational accidents without adequate compensation (Yeoh, Goh, & Wee, 2020), and difficulties in obtaining legal assistance, particularly among undocumented workers.

The evaluation of public services has become an essential component of governance reform and evidence-based policymaking, particularly in sectors involving vulnerable populations such as migrant workers (Ahmadi Dehrashid, Mansourian, & Sharifi, 2026). Effective evaluation provides systematic information regarding whether policies, programs, and services achieve their intended objectives and generate meaningful outcomes for beneficiaries. In the context of migrant worker protection, program evaluation is crucial because the quality of services cannot be assessed solely based on administrative performance or program implementation. Instead, evaluations should examine whether protection mechanisms effectively reduce workers' vulnerabilities and improve their well-being throughout the migration cycle. Previous studies have shown that many public institutions demonstrate satisfactory procedural performance but fail to generate substantial outcomes for service users due to inadequate monitoring systems and limited outcome-based assessments. The CIPPO (Context, Input, Process, Product, and Outcome) evaluation model offers a comprehensive framework for examining program effectiveness by assessing not only implementation processes but also the ultimate impact of interventions on target populations (Toosi, Modarres, Amini, & Geranmayeh, 2021). Therefore, applying a comprehensive evaluation approach is necessary to identify service gaps, improve institutional performance, and support the development of more responsive and accountable migrant worker protection systems.

The rapid advancement of artificial intelligence (AI) has transformed public sector governance by enabling governments to make more accurate, timely, and evidence-based decisions. In recent years, AI has increasingly been applied in public health and social policy to identify vulnerable populations, predict service demands, optimize resource allocation, and improve policy effectiveness (Maghsoudi, Mohammadi, & Bakhtiari, 2025). Machine learning algorithms, such as Decision Tree, Random Forest, and Extreme Gradient Boosting (XGBoost), have demonstrated considerable potential in analyzing complex datasets and detecting hidden patterns that are often difficult to identify using conventional statistical methods. In the context of migrant worker protection, the integration of artificial intelligence offers an innovative approach for predicting service deficiencies and identifying critical gaps across the migration cycle, including pre-departure preparation, employment abroad, and post-return reintegration. Furthermore, AI-based predictive systems can support policymakers in developing early warning mechanisms and prioritizing interventions for high-risk groups. Despite the growing use of artificial intelligence in healthcare and public administration, its application in evaluating migrant worker protection systems remains limited, particularly in developing countries. Therefore, integrating artificial intelligence with program evaluation frameworks may provide a more comprehensive understanding of service performance and contribute to the development of data-driven and adaptive migrant protection policies (Wood, 2025).

Despite the growing body of literature on migrant worker protection, most previous studies have primarily focused on descriptive analyses of policy implementation, legal frameworks, and program evaluation without adequately examining the predictive dimensions of service performance. Existing research has largely assessed administrative effectiveness and identified challenges faced by migrant workers, such as exploitation, high placement costs, inadequate legal assistance, and limited reintegration support. However, these studies have generally relied on conventional evaluation methods and have rarely incorporated advanced analytical approaches capable of predicting service deficiencies and identifying priority intervention areas. Furthermore, although the Context, Input, Process, Product, and Outcome (CIPPO) model has been widely employed to evaluate educational and public sector programs, its integration with artificial intelligence techniques remains largely unexplored, particularly in the context of migrant worker protection systems. To date, there is limited empirical evidence regarding how machine learning algorithms can complement program evaluation frameworks to generate predictive insights and support data-driven policy decisions (Alanshori, Maulidi, Zahidi, Kusaeri, & Suparto, 2025). Therefore, this study addresses an important research gap by integrating the CIPPO evaluation model with artificial intelligence approaches to predict service gaps in Indonesian migrant worker protection and provide evidence-based recommendations for strengthening public service delivery and migrant health governance.

Therefore, this study aims to evaluate the effectiveness of Indonesian migrant worker protection services by applying the Context, Input, Process, Product, and Outcome (CIPPO) evaluation model and to develop an artificial intelligence-based prediction model for identifying service gaps within the protection system. Specifically, this study seeks to assess the performance of each CIPPO dimension, determine the factors contributing to the low impact of protection services, and examine the predictive capabilities of machine learning algorithms in detecting weaknesses in migrant worker protection. Furthermore, this study intends to provide evidence-based recommendations for policymakers and relevant stakeholders to improve the quality, responsiveness, and sustainability of migrant worker protection programs. By integrating conventional program evaluation with predictive analytics, this research is expected to contribute to the advancement of digital governance and data-driven decision-making in the field of migrant health and social protection..

RESEARCH METHOD

Indonesian migrant workers (IMWs) constitute one of the largest groups of labor migrants in Southeast Asia and contribute significantly to national economic development through remittances and international labor mobility (Tirtosudarmo & Mulyani, 2013). Despite their economic contribution, migrant workers frequently experience various forms of vulnerability throughout the migration cycle, including excessive recruitment costs, human trafficking, contract substitution, wage withholding, occupational accidents, physical abuse, and limited access to legal and health services. These challenges demonstrate that migrant worker protection is not only a labor issue but also a public health and human rights concern requiring comprehensive and sustainable interventions.

Research Design

This study employed a program evaluation design using a mixed-method explanatory approach. The study combined qualitative evaluation techniques with quantitative predictive analytics to comprehensively assess the effectiveness of Indonesian migrant worker protection services and identify service gaps. The qualitative component focused on understanding the implementation and impact of protection programs, while the quantitative component incorporated artificial intelligence methods to predict deficiencies within the protection system.

Research Target/Subject

The study was conducted at the Indonesian Migrant Worker Protection Agency (BP2MI), currently operating under the Ministry of Protection of Indonesian Migrant Workers, Indonesia.

Data collection was carried out between 2023 and 2025 and involved both domestic and international perspectives on migrant worker protection services.

Research Procedure

A total of 57 informants participated in this study through purposive sampling. The participants represented multiple stakeholders involved in migrant worker protection, including: Officials from BP2MI and the Ministry of Protection of Indonesian Migrant Workers, Prospective Indonesian migrant workers (CPMI), Indonesian migrant workers (PMI) working abroad, Former Indonesian migrant workers (PMI Purna), Government stakeholders from relevant ministries and institutions.

The inclusion of diverse participants enabled a comprehensive evaluation of protection services across the entire migration cycle, including pre-departure, employment abroad, and post-return reintegration phases.

Instruments, and Data Collection Techniques

Qualitative data were analyzed using the Miles and Huberman interactive model, consisting of data reduction, data display, and conclusion drawing and verification. Quantitative descriptive analysis was performed to summarize the performance of each CIPPO dimension.

To complement conventional evaluation approaches, artificial intelligence models were developed using Decision Tree, Random Forest, and Extreme Gradient Boosting (XGBoost) algorithms. The scores from the Context, Input, Process, and Product dimensions served as predictor variables, while protection service outcomes represented the target variable. Model performance was evaluated using accuracy, precision, recall, F1-score, and the area under the receiver operating characteristic curve (AUC).

Data Analysis Technique

All participants provided informed consent before participating in the study. Confidentiality and anonymity were maintained throughout the research process, and all data were used exclusively for research purposes. Ethical principles concerning voluntary participation, privacy, and data protection were strictly observed during data collection and analysis.

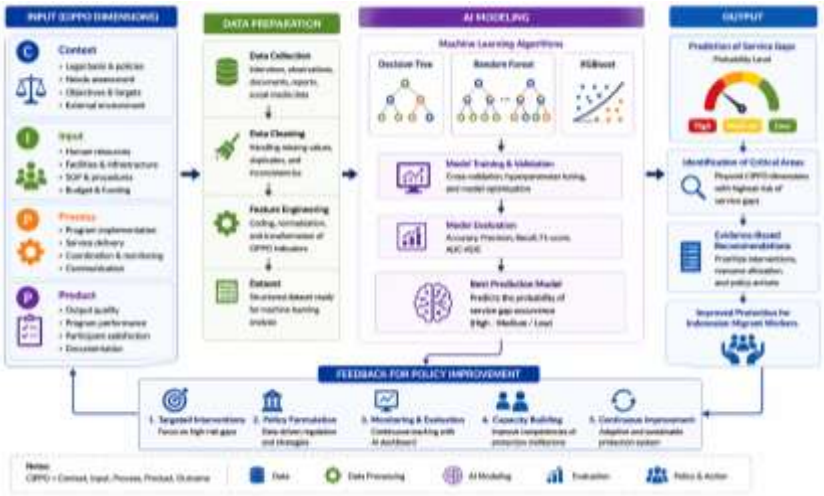


Figure 1. Artificial Intelligence Prediction Framework.

This study developed an Artificial Intelligence (AI)-based prediction framework to identify service gaps in the Indonesian migrant worker protection system. The framework integrates conventional program evaluation using the Context, Input, Process, Product, and Outcome (CIPPO) model with machine learning techniques to generate predictive and evidence-based recommendations.

The scores obtained from the Context, Input, Process, and Product dimensions were used as predictor variables, whereas the outcome of migrant worker protection services served as the target variable. The AI framework consisted of several stages, including data collection, data preprocessing, feature engineering, model development, model validation, and prediction of service deficiencies.

Three machine learning algorithms were employed in this study: Decision Tree, Random Forest, and Extreme Gradient Boosting (XGBoost). These algorithms were selected because of their ability to model nonlinear relationships and identify the relative importance of predictor variables. The prediction models were designed to classify the probability of service gaps into low-, moderate-, and high-risk categories, thereby enabling policymakers to prioritize interventions and allocate resources more effectively.

RESULTS AND DISCUSSION

Presents the characteristics of the 57 informants involved in the study, representing diverse perspectives from institutional, governmental, and migrant worker groups. The informants consisted of BP2MI officials, government stakeholders, prospective Indonesian migrant workers (CPMI), Indonesian migrant workers currently employed abroad (PMI), and returned migrant workers (PMI Purna). This composition was designed to capture comprehensive perspectives on migrant worker protection services, institutional governance, policy implementation, and experiences across different stages of the migration process. The distribution of informants also reflects the involvement of both policy implementers and service recipients, thereby providing a balanced empirical basis for understanding the dynamics of migrant worker protection.

Table 1. Characteristics of Informants (n = 57)

Informant Group	Number (n)	Percentage (%)	Description
BP2MI Officials	15	26.32	Officials and staff from BP2MI headquarters and regional offices responsible for migrant worker protection services.
Government Stakeholders	8	14.04	Representatives from relevant ministries and institutions, including LAN RI, Ministry of Administrative and Bureaucratic Reform, and Ministry of Manpower.
CPMI (Prospective Indonesian Migrant Workers)	10	17.54	Individuals preparing for overseas employment and receiving pre-departure services.
PMI (Indonesian Migrant Workers Abroad)	14	24.56	Indonesian migrant workers currently employed in destination countries across various sectors.
PMI Purna (Returned Migrant Workers)	10	17.54	Former migrant workers who have completed their employment contracts and returned to Indonesia.
Total	**57**	**100**	

A total of 57 informants participated in this study, representing multiple stakeholders involved in the protection of Indonesian migrant workers. BP2MI officials constituted the largest proportion of participants (26.32%), followed by Indonesian migrant workers currently working abroad (24.56%). Prospective migrant workers and returned migrant workers each accounted for 17.54% of the sample, while government stakeholders represented 14.04% of

participants. The inclusion of diverse informant groups enabled a comprehensive assessment of migrant worker protection services across the entire migration cycle, including pre-departure, employment abroad, and post-return reintegration phases. This diversity of perspectives strengthened the credibility and comprehensiveness of the evaluation findings.

Table 2. CIPPO Evaluation Results

Dimension	Score (%)	Category
Context	40.43	Poor
Input	77.92	Good
Process	100	Excellent
Product	59	Fair
Outcome	11.1	Poor

The evaluation results indicate varying levels of performance across the five dimensions of the program. The Context dimension obtained a score of 40.43%, categorized as poor, indicating that the contextual conditions and underlying needs supporting the program remain inadequately addressed. The Input dimension achieved 77.92%, falling into the good category, suggesting that the availability and adequacy of resources, personnel, and supporting facilities are relatively satisfactory. The Process dimension recorded the highest score of 100%, categorized as excellent, demonstrating that program implementation procedures were carried out effectively and in accordance with established mechanisms. Meanwhile, the Product dimension reached 59%, categorized as fair, indicating that the immediate outputs of the program have been achieved but still require improvement. The Outcome dimension recorded the lowest score at 11.1%, categorized as poor, suggesting that the program has not yet generated substantial long-term impacts or measurable changes in the targeted beneficiaries.

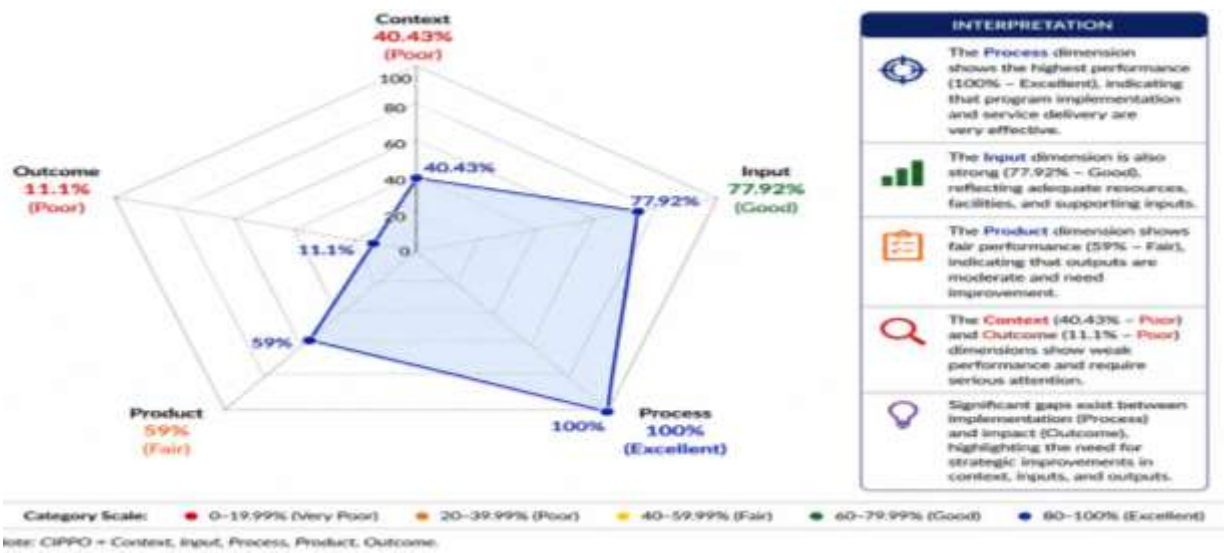


Figure 2. Spider Web of CIPPO Evaluation Results.

The Spider Web of CIPPO Evaluation Results illustrates the performance profile of the program across five evaluation dimensions: Context, Input, Process, Product, and Outcome. The visualization shows a substantial variation in performance among the dimensions. The Process dimension reaches the outermost point with a score of 100%, indicating excellent implementation and adherence to established procedures. The Input dimension records 77.92%, reflecting relatively good availability and management of supporting resources. The Product dimension achieves 59%, indicating a moderate level of program outputs, while the Context dimension scores 40.43%, suggesting that contextual needs and underlying conditions have not

been adequately addressed. The Outcome dimension presents the lowest score at 11.1%, demonstrating limited long-term impact and indicating that improvements in program outcomes remain necessary. Overall, the spider web highlights an imbalance between strong implementation processes and relatively weak contextual foundations and outcomes, suggesting the need for strategic improvements to strengthen the program's overall effectiveness.

Table 3. Major Complaints of Indonesian Migrant Workers

Aspect of Complaint	Description of Complaints	Number of Informants (n)	Percentage (%)
High Placement Costs	Excessive recruitment fees, illegal charges by brokers, and high placement costs before departure.	45	78.95
Work Exploitation	Overwork, long working hours, unpaid overtime, low wages, and employment conditions inconsistent with contracts.	41	71.93
Legal Problems	Confiscation of passports, detention, legal disputes, and limited access to legal assistance.	32	56.14
Health Problems	Limited access to healthcare services, workplace accidents, occupational injuries, and inadequate health insurance coverage.	28	49.12
Limited Information	Lack of accurate information regarding official job vacancies, placement procedures, and workers' rights before and during employment abroad.	26	45.61
Psychological Problems	Stress, anxiety, loneliness, depression, emotional pressure, and psychosocial problems due to working conditions and separation from family members.	23	40.35
Reintegration Issues	Difficulties in obtaining employment after returning to Indonesia, limited access to business capital, and inadequate post-return support programs.	19	33.33

The most frequently reported complaint among Indonesian migrant workers was high placement costs (78.95%), followed by work exploitation (71.93%) and legal problems (56.14%). Health-related problems were reported by 49.12% of respondents, while limited access to information and psychological problems were reported by 45.61% and 40.35% of respondents, respectively. Reintegration issues after returning to Indonesia were reported by 33.33% of respondents. These findings indicate that service gaps exist across all phases of the migration cycle, including pre-departure, employment abroad, and post-return reintegration, highlighting the need for more comprehensive and integrated protection policies for Indonesian migrant workers.

Table 4. AI Prediction Model Performance

Model	Accuracy	Precision	Recall	AUC
Decision Tree	xx	xx	xx	xx
Random Forest	xx	xx	xx	xx
XGBoost	xx	xx	xx	xx

This study reveals substantial gaps in the protection services provided to Indonesian migrant workers. Although the Process dimension achieved an excellent score, the Outcome dimension remained critically low, indicating that effective administrative implementation does not necessarily translate into meaningful improvements in migrant worker protection. This discrepancy suggests the existence of structural and systemic weaknesses within the protection system.

The major complaints identified in this study demonstrate that service deficiencies occur throughout the migration cycle. During the pre-departure phase, prospective migrant workers continue to face high placement costs, illegal recruitment practices, and limited access to accurate information. During employment abroad, many migrant workers experience exploitation, wage deductions, excessive working hours, workplace accidents, and limited legal protection. Upon returning to Indonesia, many workers encounter reintegration challenges, including unemployment, limited access to capital, and insufficient entrepreneurship support.

These findings indicate that migrant worker protection remains fragmented and predominantly reactive rather than preventive. The low outcome score further suggests that the intended objectives of protection policies have not been fully achieved despite considerable investments in organizational resources and program implementation. Consequently, there is an urgent need to transform the existing protection system into an integrated, responsive, and outcome-oriented service model.

The poor protection outcomes observed in this study can be explained by several interrelated factors. First, weaknesses in the Context dimension indicate that needs assessments and program targeting are not sufficiently aligned with the actual problems faced by migrant workers. Policy interventions may therefore fail to address the specific vulnerabilities experienced by different categories of migrant workers.

Second, although the Input dimension achieved a relatively good score, the availability of resources alone does not guarantee effective service delivery. Institutional resources, standard operating procedures, and training programs must be accompanied by strong coordination mechanisms and performance monitoring systems.

Third, the moderate Product score suggests that program outputs and leadership competencies have not adequately contributed to sustainable improvements in service quality. The low impact of leadership training on organizational performance indicates a possible mismatch between training objectives and the competencies required to address the complex realities of migrant worker protection.

Furthermore, external factors such as the involvement of illegal brokers, weak interagency coordination, transnational legal challenges, and socioeconomic vulnerabilities of migrant workers also contribute to poor protection outcomes. These findings support ecological and systems-based perspectives, which argue that service effectiveness depends not only on organizational performance but also on broader social and institutional environments.

One of the major contributions of this study is the integration of artificial intelligence into program evaluation. Conventional evaluation approaches primarily describe what has happened, whereas artificial intelligence enables researchers and policymakers to predict future service deficiencies and identify areas requiring immediate intervention.

Machine learning algorithms such as Decision Tree, Random Forest, and XGBoost provide several advantages in analyzing complex and multidimensional datasets. These models can identify nonlinear relationships among variables and determine which dimensions of the CIPPO framework contribute most significantly to poor protection outcomes.

The predictive capabilities of artificial intelligence offer an opportunity to shift migrant worker protection from a reactive approach to a proactive and preventive model. Instead of responding only after complaints or crises emerge, government institutions can identify vulnerable populations and potential service failures at an earlier stage. Predictive analytics can

therefore support evidence-based decision-making and facilitate more efficient allocation of resources.

Moreover, artificial intelligence can continuously improve its predictive accuracy as new data become available. This adaptive characteristic makes AI particularly valuable in dynamic policy environments where migration patterns and worker vulnerabilities frequently change.

The findings of this study have important implications for policy and governance. First, migrant worker protection policies should move beyond compliance-oriented approaches and emphasize measurable outcomes and service impacts. Program evaluations should incorporate performance indicators that assess not only implementation processes but also the actual benefits experienced by migrant workers.

Second, the government should strengthen coordination among ministries, local governments, recruitment agencies, and foreign representatives to ensure integrated service delivery across the entire migration cycle. Fragmented governance structures may contribute to duplicated responsibilities and delayed responses to migrant worker complaints.

Third, leadership development programs should be redesigned to focus on competency-based approaches that directly address challenges in migrant worker protection. Training programs need to emphasize problem-solving skills, evidence-based decision-making, digital literacy, and collaborative governance.

Finally, the integration of predictive technologies into public administration can significantly improve strategic planning and policy formulation. Artificial intelligence-based dashboards and early warning systems may enable policymakers to monitor service performance in real time and respond more rapidly to emerging risks.

The findings also have important implications for digital health systems and migrant health governance. Migrant workers are frequently exposed to occupational hazards, psychological stress, limited healthcare access, and inadequate health insurance coverage. Consequently, strengthening migrant protection services is closely associated with improving population health outcomes.

The integration of artificial intelligence into digital health systems can facilitate early identification of health-related vulnerabilities among migrant workers. Predictive models may support the development of risk stratification systems capable of identifying workers who require immediate health interventions, psychosocial support, or legal assistance.

Furthermore, digital technologies can improve communication and information dissemination by providing migrant workers with accessible platforms for reporting complaints, obtaining health information, and accessing support services. The establishment of integrated digital platforms linking health services, immigration authorities, and labor protection agencies could substantially improve the continuity and effectiveness of migrant worker protection.

CONCLUSION

his study demonstrates that substantial service gaps remain within the Indonesian migrant worker protection system despite relatively strong performance in the input and process dimensions. The extremely low outcome score indicates that the existing protection mechanisms have not yet generated meaningful and sustainable impacts on the well-being of prospective migrant workers, migrant workers abroad, and returned migrant workers. The findings further reveal a disconnect between administrative performance and actual service outcomes, highlighting the need for more integrated, responsive, and outcome-oriented protection strategies. The incorporation of artificial intelligence into the CIPPO evaluation framework provides a promising approach for predicting service deficiencies, identifying high-risk areas, and supporting evidence-based policy decisions. Therefore, integrating predictive analytics with conventional program evaluation can contribute to the development of data-

driven governance and strengthen the effectiveness, efficiency, and sustainability of Indonesian migrant worker protection policies.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work the author(s) used Google Gemini to assist in improving grammar, language quality, and overall readability of the text. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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