Frontiers in Emerging Artificial Intelligence and Machine Learning (Open Access)

Volume 03, Issue 03, March 2026

DOI: https://doi.org/10.64917/feaiml/Volume03Issue03-01 PageNo.01-07

Government AI Readiness and National Logistics Performance: An Exploratory Cross-Country Data Analytics Study

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RECEIVED - 01-11-2026, **RECEIVED REVISED VERSION** - 02-14-2026, **ACCEPTED**- 02-27-2026, **PUBLISHED**- 03-12-2026

Abstract

Digitalization and artificial intelligence function as vital components that improve supply chain operational performance. Existing research primarily studies AI implementation in business operations but there is no study that examines the impact of these systems on national logistics infrastructure. This study examines how government artificial intelligence readiness affects national logistics performance. It combines three public datasets from 2023 which include the World Bank Logistics Performance Index (LPI) and the Oxford Insights Government AI Readiness Index and World Bank GDP per capita data. By using a cross-sectional dataset from 115 countries ordinary least squares regression modeling has been applied. The research findings indicate that AI readiness explains 79% of the total variation in LPI scores. The inclusion of log GDP per capita as a control variable does not reduce the positive relationship between AI readiness and LPI scores and the model explains logistics performance slightly better. Statistical analysis indicates that government AI readiness creates a strong link with logistics performance which exists independently of economic variations. This research only evaluates the national digital and AI technology readiness and its effects on logistics performance, but it does not connect these factors directly. Overall, the research suggests that countries with superior digital and AI capabilities will obtain better logistics results.

Keywords: Logistics Performance Index, artificial intelligence, digital government, data analytics, regression analysis, public sector digitalization, cross-country analysis.

1. INTRODUCTION

Trade competitiveness and economic development depend on efficient logistics systems and supply chain management. International organizations and governments have allocated major funding to develop infrastructure, enhance customs operations and trade facilitation initiatives which improves logistics performance. In parallel, many countries have begun AI strategy development, digital government platform and data infrastructure system construction because public sector reform needs digitalization and artificial intelligence.

The World Bank Logistics Performance Index (LPI) uses a composite metric to evaluate national logistics performance through its assessment of customs efficiency and infrastructure quality and logistics competence and tracking and tracing capabilities and delivery speed [1]. The Government AI Readiness Index developed by Oxford Insights evaluates a countries readiness to adopt AI in public service through three components which include governance, data and infrastructure, and technology sector maturity [2]. Despite widespread academic use of these indices, limited research has explored the relationship between government AI readiness and national logistics performance.

Existing literature on logistics and AI primarily investigates applications at the firm level which includes vehicle routing systems and warehouse automation and predictive maintenance and demand forecasting [3], [4]. While this research demonstrates that AI and analytics enhance

operational performance while decreasing expenses, but it does not prove that countries which implement AI better at the national level achieve superior logistics results. Similarly, research about national logistics performance has primarily examined infrastructure development and trade accessibility and institutional stability but AI and digitalization have not received sufficient study [5], [6].

This study examines government AI readiness effects on national logistics performance through quantitative analysis of recent international data. Specifically, it investigates which nations using AI at high government levels obtain better logistics performance while maintaining their economic stability.

The analysis evaluates government AI readiness effects on national logistics performance through quantitative analysis of 115 countries during 2023. The research evaluates government AI readiness impact on logistics performance through a regression model which analyzes LPI overall score as the outcome variable while controlling for GDP per capita.

The research makes two essential contributions to the field. The research establishes itself as one of the first studies to connect government AI readiness indices with World Bank LPI data from a single cross-country dataset. The research provides essential methods for data analysis which enables researchers to work with public data.

The remainder of the paper is structured as follows. Section II reviews relevant literature. Section III describes the data sources and methodological approach. Section IV presents the empirical results, followed by a discussion in Section V. Section VI outlines limitations and directions for future research, and Section VII concludes the paper.

2. Related Work

2.1 Logistics Performance and Macroeconomic Drivers

The Logistics Performance Index serves researchers to study both the elements which affect logistics performance and the resulting effects. Multiple research studies use LPI as their outcome variable to investigate how trade openness and infrastructure development and governance systems and geographical locations affect logistics performance across different countries [5], [6]. Research studies investigate how LPI affects both export performance and supply chain reliability according to [7]. Research shows that logistics performance results from the interaction between physical infrastructure development and institutional quality and policy implementation changes.

2.2 Digitalization, AI and Logistics

Research conducted at the individual level shows increasing interest in AI and machine learning and advanced analytics for logistics and supply chain management operations. The applications of AI technology include optimizing vehicle routes and last mile delivery and demand prediction and warehouse automation and equipment predictive maintenance [3], [4], [8]. Research reviews show AI technology improves operational performance while reducing costs and enhancing customer experiences, but they also reveal multiple deployment obstacles and limited access to data.

Research studies now use global data to study how digitalization affects logistics performance. Research shows that digital trade facilitation systems working with automated customs operations lead to better LPI results and shorter customs processing times [9]. The research examines particular policy changes in particular locations instead of studying the entire worldwide human population.

2.3 AI Readiness and Digital Government

The Government AI Readiness Index evaluates public service AI adoption through three assessment areas which include government institutions and technology sectors and data management systems and infrastructure [2]. Research using this index has established relationships between the index and innovation metrics and governance standards and workforce development [10]. Research links e-government development indices to better administrative outcomes and improved citizen service delivery [11].

2.4 Research Gap and Contribution

Research shows that logistics performance and AI readiness share mutual relationships with development indicators and state capacity measures but no study exists to link the Government AI Readiness Index with the LPI through a single cross-country evaluation. Research studies

about AI and logistics performance analyze specific country groups through digitalization metrics yet they fail to evaluate government readiness and they focus only on G20 nations or individual geographic regions.

The research investigates 115 countries through a single cross-sectional analysis which combines the 2023 World Bank LPI with the 2023 Government AI Readiness Index and GDP per capita data. The research functions as an exploratory data analytics study which investigates the relationship between government AI readiness and logistics performance without attempting to establish cause-and-effect relationships.

3. Methodology

3.1. Data Sources

Three public datasets for the year 2023 are used.

The World Bank compiles the Logistics Performance Index 2023 which uses a 1 to 5 scoring system to evaluate economic performance through logistics assessment [1]. The official 2023 Excel file titled "International LPI from 2007 to 2023" contains the overall LPI score and component scores for 139 economies.

The Government AI Readiness Index 2023 emerges from Oxford Insights which assesses how well countries can use AI for public service delivery [2]. The 2023 detailed scores dataset enables researchers to evaluate AI readiness of 193 countries through complete assessment results which include total scores and pillar-specific evaluations. The research depends on the complete AI readiness score to explain its findings.

The World Bank World Development Indicators provide GDP per capita GDP data for 2023 through indicator code NY.GDP.PCAP.CD [12]. The World Bank releases GDP per capita data in current US dollars through a multi-year CSV file which includes metadata that separates individual countries from combined regional data. The year 2023 was selected because it represents the most recent period for which harmonized and complete versions of all three datasets were publicly available

3.2. Data Cleaning and Integration

The LPI Excel file received import treatment which allowed researchers to extract specific data fields. The "Economy" field now shows as "Country" while "LPI Score" has been renamed to "LPI_Overall."The "Year" field maintained a fixed value of 2023 throughout the analysis which concentrated on these three particular fields.

The AI readiness CSV file contains its header information within the file structure. The analysis treated the first data row as the header while reinterpreting all subsequent data rows. The analysis kept only two columns from the dataset which included "Country" and "Total" and renamed "Total" to "AI_Readiness."The AI readiness scores received numerical value assignment while researchers discarded all entries containing missing data points.

The World Bank CSV file contains GDP per capita data for 2023 which researchers accessed after skipping standard offset rows. The analysis retained three columns from the dataset which included "Country Name" and "Country Code" and the 2023 data point and assigned them new names "Country" and "ISO3" and "GDP_per_capita."The system combined data with country code metadata to create region information after it removed the aggregate entities "World" and "Euro area" from the dataset. The analysis excluded all observations which contained missing GDP data points.

The LPI and AI datasets joined through an inner join operation based on the "Country" variable. The analysis included only those economies which appeared in both datasets. The system used a left join operation to link GDP per capita data with the "Country" field. The analysis excluded Cuba and Somalia because they lacked GDP data which resulted in a final analysis dataset containing 115 countries.

3.3. Variables

The research uses three main variables throughout its analysis.

- The Logistics Performance Index overall score for 2023 ranges from 1 to 5 in the LPI_Overall variable.
- The AI readiness score for 2023 in the Government AI readiness score ranges from 0 to 100 according to the AI_Readiness variable.
- The GDP per capita data from 2023 appears in the GDP_per_capita variable which uses current US dollar values.

- The log_GDP_pc variable represents the natural logarithm of GDP_per_capita data which helps reduce skewness and study how income levels affect results.

3.4. Analytical Approach

The research follows a two-stage approach for its analysis. The research starts by producing descriptive statistics and performing calculations to determine the relationship between LPI_Overall and AI_Readiness and GDP_per_capita. The research uses ordinary least squares regression to study the relationship between AI readiness and logistics performance while it accounts for income level variations.

Two models are specified:

Model 1: $LPI\_Overall_i = \beta_0 + \beta_1 AI\_Readiness_i + \varepsilon_i$ - (1)

Model 2: $LPI\_Overall_i = \beta_0 + \beta_1 AI\_Readiness_i + \beta_2 \log(GDP\_pc_i) + \varepsilon_i$ - (2)

The model uses index i to represent countries in the analysis. The research investigates how AI readiness affects logistics performance through Model 1. The analysis in Model 2 uses log GDP per capita as a control factor to determine how income levels affect the results.

The researchers performed their analysis using Python together with the statsmodels package. The researchers documented R squared values and adjusted R squared values as standard goodness-of-fit metrics. The researchers performed two sets of checks to evaluate their data through residual inspection and independent variable multicollinearity assessment using variance inflation factors.

The research uses cross-sectional data to identify relationships, but it does not prove cause-and-effect relationships. Robust standard errors were also tested as a sensitivity check and yielded substantively similar results.

4. RESULTS

4.1 Correlation and Scatter Plot (Figure 1)

X-axis: Government AI Readiness Score
Y-axis: Logistics Performance Index (Overall Score)
Source: World Bank LPI and Oxford Insights Government AI Readiness Index (2023)
Figure 1 - Relationship between AI readiness and logistics performance

Interpretation: Figure 1 illustrates that points cluster along an upward sloping line, indicating that countries with higher government AI readiness tend to have higher logistics performance.

4.2 Regression Results (Table I)

A compact regression table can be reported as:

Table I - OLS regression results (Dependent variable: LPI_Overall, 2023)

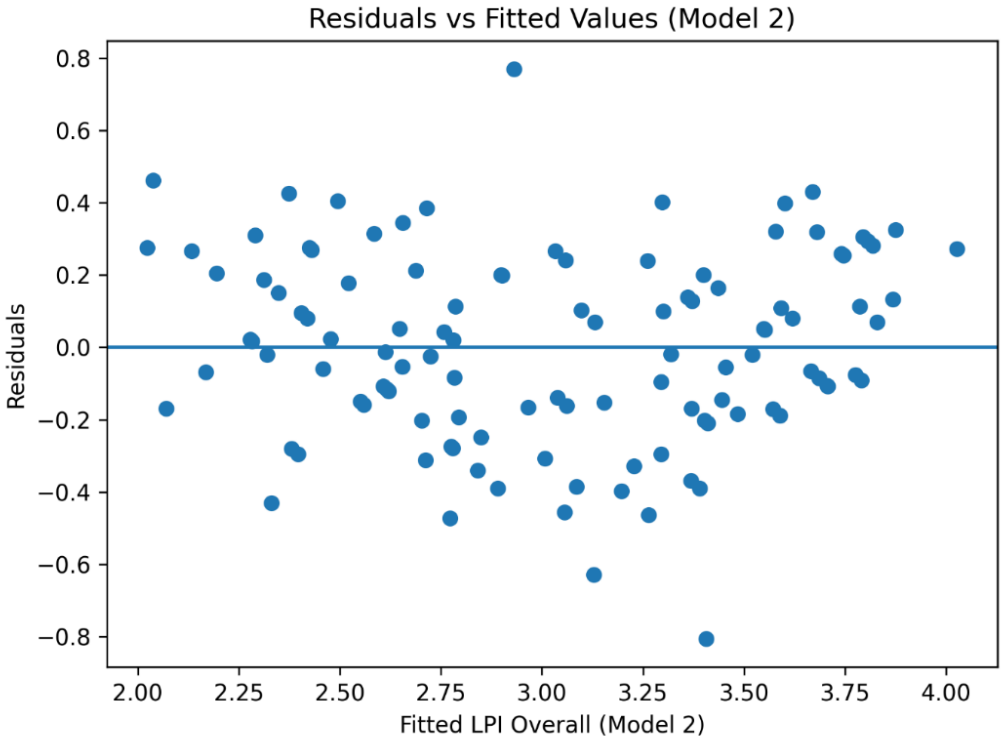
Variable	Model 1	Model 2
Constant	1.47 (0.09)***	1.15 (0.18)***
AI_Readiness	0.0313 (0.0019)***	0.0273 (0.0023)***
log_GDP_pc	-	0.0558 (0.020)***
R-squared	0.791	0.796
Adjusted R^2	0.789	0.792
N	115	115

Note: Standard errors are shown in parentheses.
*** $p < 0.01$

Interpretation:

Table I reports that in Model 1, AI_Readiness has a positive and highly significant coefficient. A 10-point increase in AI readiness is associated with about a 0.31 increase in LPI_Overall. In Model 2, AI_Readiness remains positive and significant after adding log_GDP_pc, although the coefficient decreases slightly. The coefficient for log_GDP_pc is positive and significant, meaning that richer countries tend to have better logistics performance. The R^2 value increases slightly from Model 1 to Model 2, suggesting that AI readiness explains a large share of the variation.

4.3. Residual Diagnostics (Figure 2)



Source: World Bank LPI, Oxford Insights AI Readiness Index, and World Bank WDI (2023)

Figure 2 - Residuals versus fitted values (Model 2)

Interpretation: Figure 2 illustrates that residuals are scattered around zero without a strong pattern, suggesting that the linear model is a reasonable approximation and that there are no dominant non linearities or single outliers.

6. Discussion

The research results show that government AI readiness directly enhances national logistics operational performance. The Government AI Readiness Index shows a direct relationship with LPI overall scores which remains significant after researchers include GDP per capita as a control variable.

The research findings confirm that digital government capabilities together with data infrastructure and AI governance practices lead to better logistics system performance. Governments which demonstrate high AI readiness tend to create digital customs platforms and real-time tracking systems and data-based port and transport management systems that enhance supply chain speed and reliability.

The findings suggest that digital and AI readiness functions as a fundamental competitiveness factor for logistics which produces results that exceed economic performance because GDP per capita adds only a minimal effect. Middle-income nations that develop strong digital government systems can match or surpass logistics performance of high-income countries which lack AI and data infrastructure readiness.

The analysis indicates that AI readiness has a statistically significant connection to state capacity and institutional quality and human capital development. The research data demonstrates a strong statistical link between AI readiness and logistics performance but it does not establish that AI readiness leads to better logistics results.

Limitations and Future Work

Key limitations include:

- The study uses 2023 data exclusively which prevents researchers from establishing cause-and-effect relationships or tracking changes over time.
- The analysis lacks essential variables which include trade openness and infrastructure investment and education levels.
- The LPI and AI readiness indices use composite measurement approaches which depend on survey responses and methodological decisions that could produce biased results.
- The process of uniting datasets requires countries to receive standardized names which creates potential small-scale data alignment problems.
- Future research could further decompose the LPI into its sub-components, such as customs efficiency, infrastructure quality, and timeliness, to provide more granular insights.

The future research should progress through three methods which involve analyzing multiple LPI waves with panel data and adding more control variables and complex econometric techniques to solve endogeneity problems. Research that combines quantitative cross-country analysis with case studies about AI implementation in logistics operations will generate more detailed understanding of implementation processes. As with most cross-sectional studies, potential endogeneity may arise from reverse causality or omitted institutional variables. Future research could address this limitation using panel data, instrumental variable approaches, or quasi-experimental designs.

7. Conclusion

The research assessed 115 nations across 2023 to establish their AI readiness which determined their logistics operational effectiveness. The study used World Bank LPI data together with Government AI Readiness Index and GDP per capita to show AI readiness enhances logistics performance through simple regression models.

The research establishes quantitative evidence which demonstrates that government readiness for digital and AI technology determines national logistics system operational performance. The study indicates that AI readiness and digital government infrastructure development should receive funding support from policymakers who want to improve logistics performance and trade facilitation.

From a policy perspective, the findings suggest that investments in government AI readiness should be viewed as long-term strategic initiatives. Strengthening data governance, digital infrastructure, and public sector AI capabilities may support sustained improvements in logistics performance. Future policy efforts could focus on

integrating AI readiness into national logistics and trade facilitation strategies.

Declaration

Data availability

- The code and experimental data used in this paper are available on https://lpi.worldbank.org/international

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