Data Analysis & Visualisation

May 8, 2025

Cybersecurity Readiness Index

Presented By
Josef Zemlicka
D00250606

1. Introduction

This report presents findings from the development of a composite Cybersecurity Readiness Index. The index assesses national preparedness using a multidimensional data-driven methodology that reflects cybersecurity capabilities and vulnerabilities.

2. Data and Indicators

The index integrates publicly available indicators across cybersecurity and socioeconomic domains, including internet usage, cybercrime losses, and AI readiness. Each dataset was standardized, cleaned, and merged using ISO3 country codes.

Indicator	Dimension	Type	Source
Internet Usage	Technical Readiness	Input	World Bank
Loss per Capita	Financial Exposure	Output	Kaggle (Loss Dataset)
AI Readiness Score	Governance Capacity	Input	Oxford Insights
GCI Score	Cybersecurity Capacity	Output	ITU
Tax Revenue (% GDP)	Socioeconomic Context	Input	World Bank
Urban Population	Socioeconomic Context	Input	World Bank
Unemployment Rate	Socioeconomic Context	Input	World Bank

3. Data Preparation

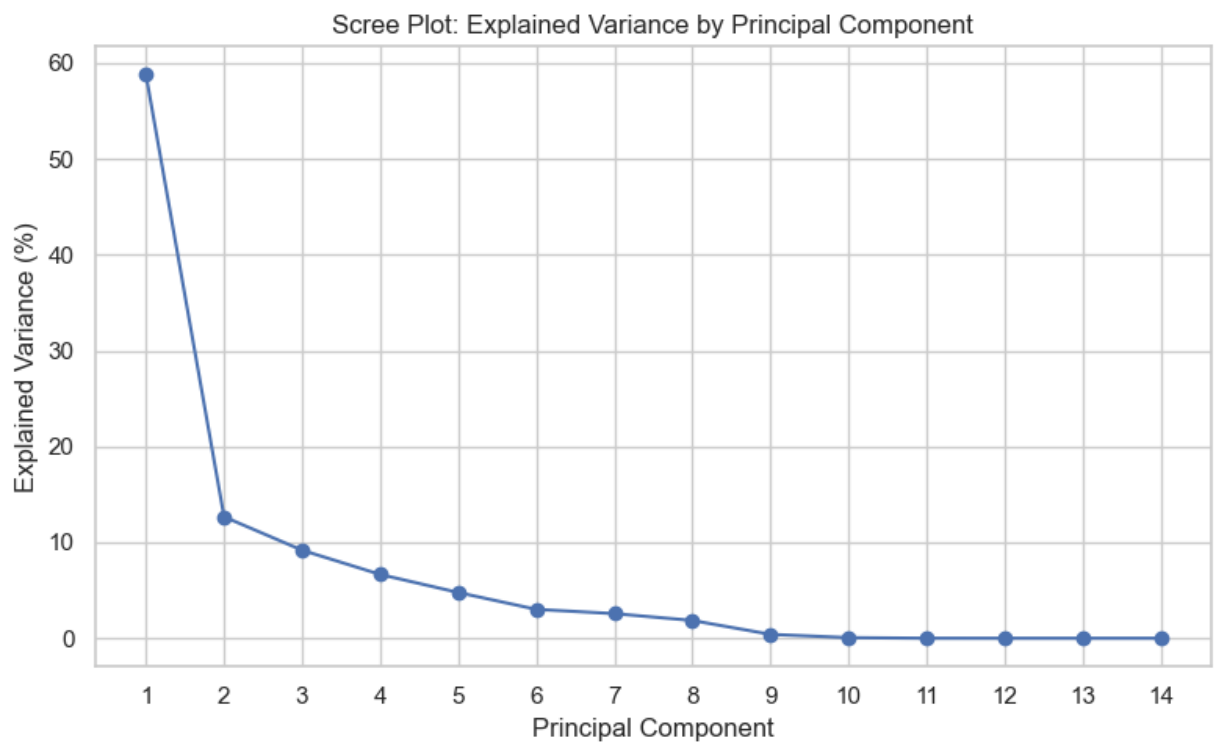
Preprocessing involved renaming, merging, and aligning datasets. Mean imputation was used for missing values to maintain completeness without introducing significant bias.

4. Normalization

All indicators were normalized using Z-score standardization. This ensures consistent scaling and comparability across heterogeneous variables.

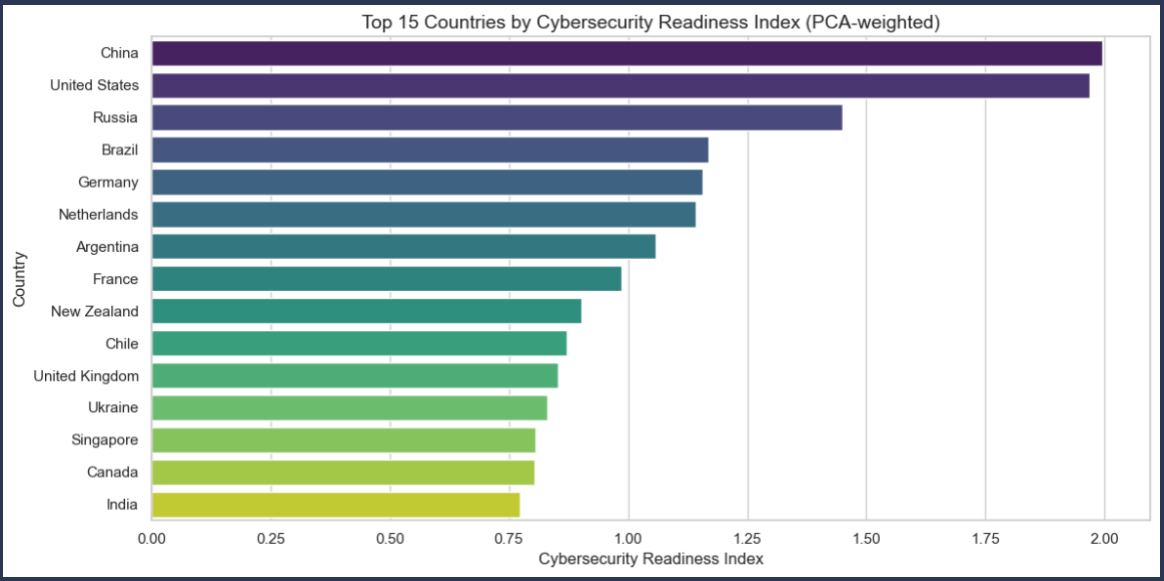
5. Weighting and PCA

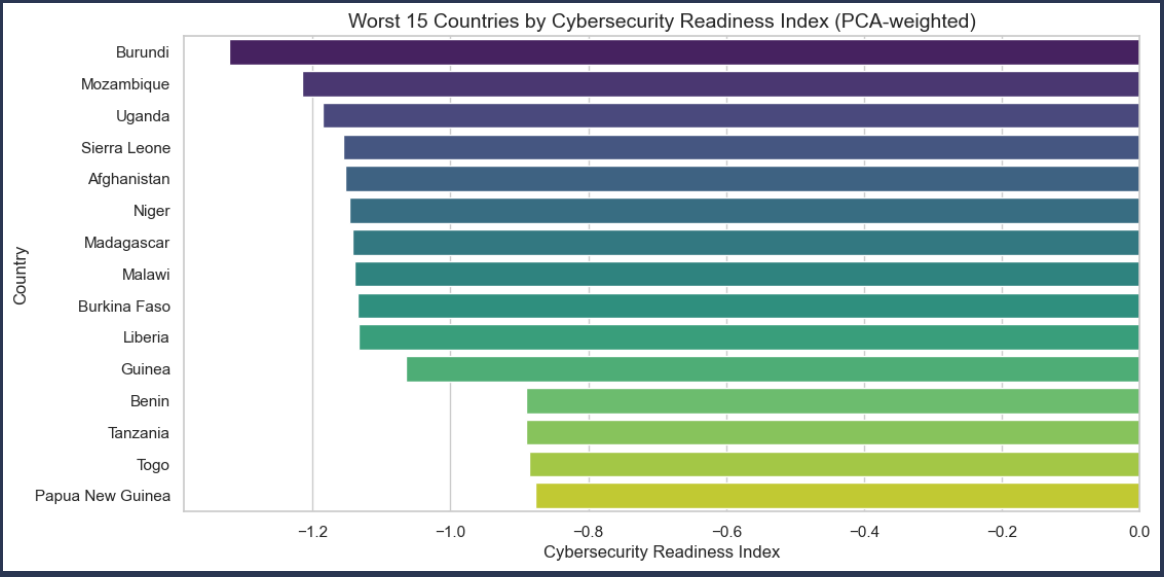
Principal Component Analysis (PCA) was applied to the normalized data to extract variance-based weights.
A scree plot was used to determine how much variance was explained by each principal component.



6. Composite Index Construction

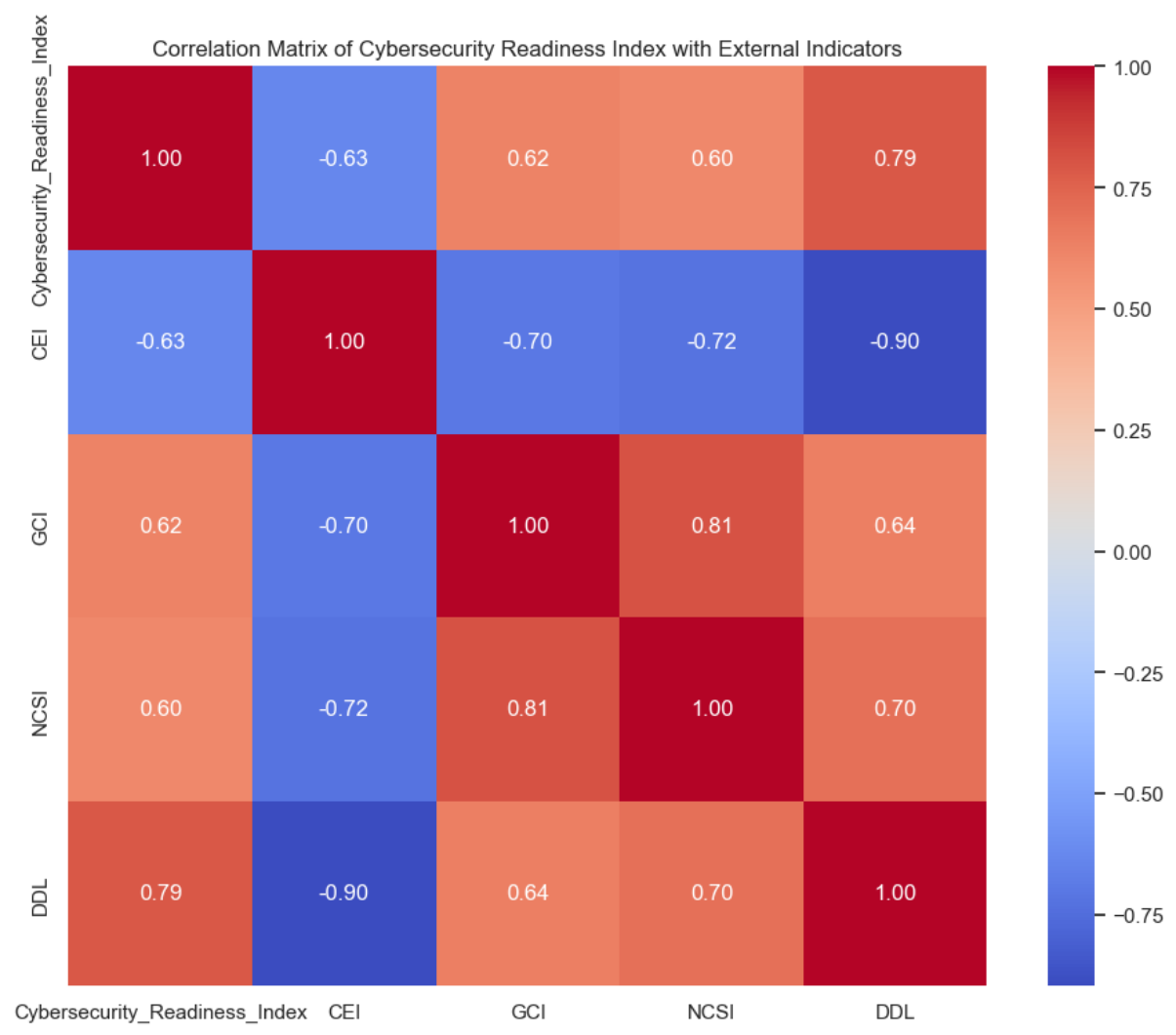
Two scoring models were developed: one using PCA-derived weights and another using equal weights for comparison. Index scores were scaled to a 0–100 range for interpretability.





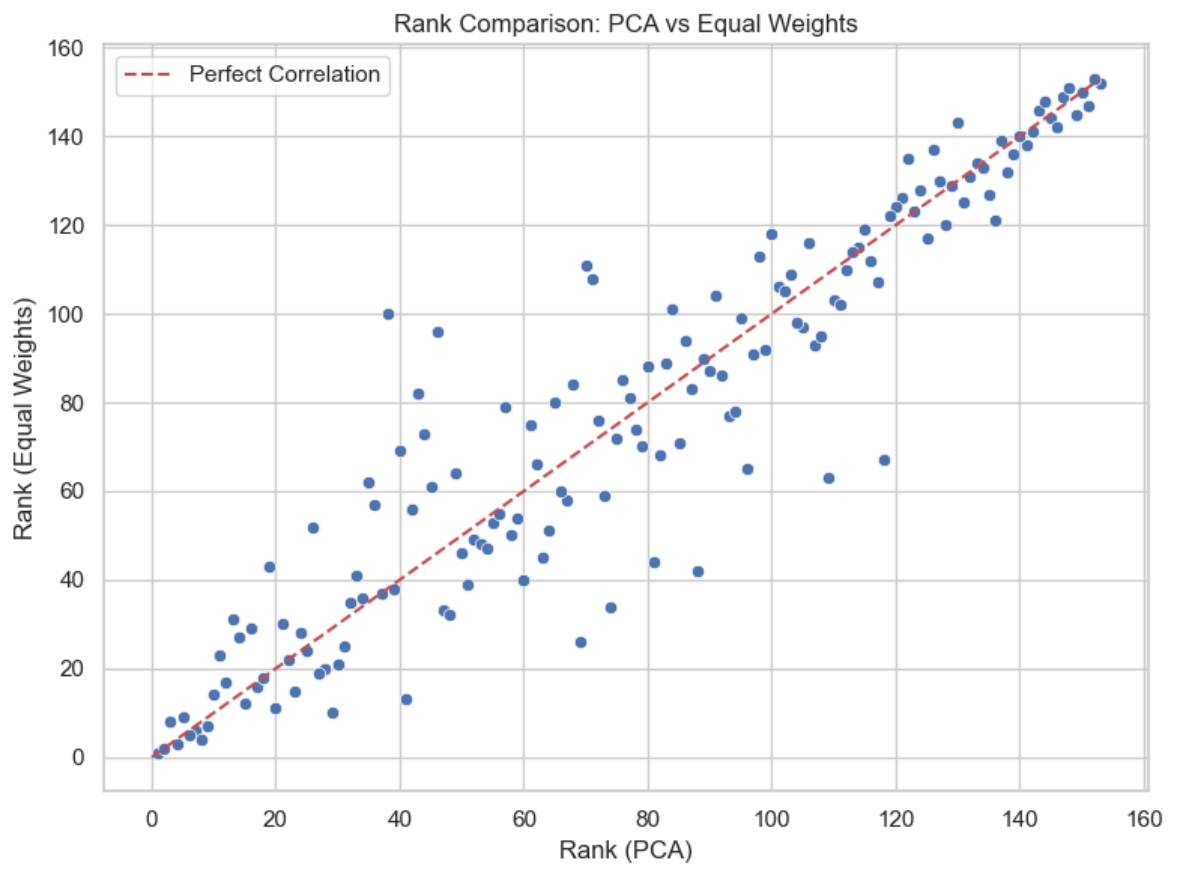
7. Validation Against Global Indices

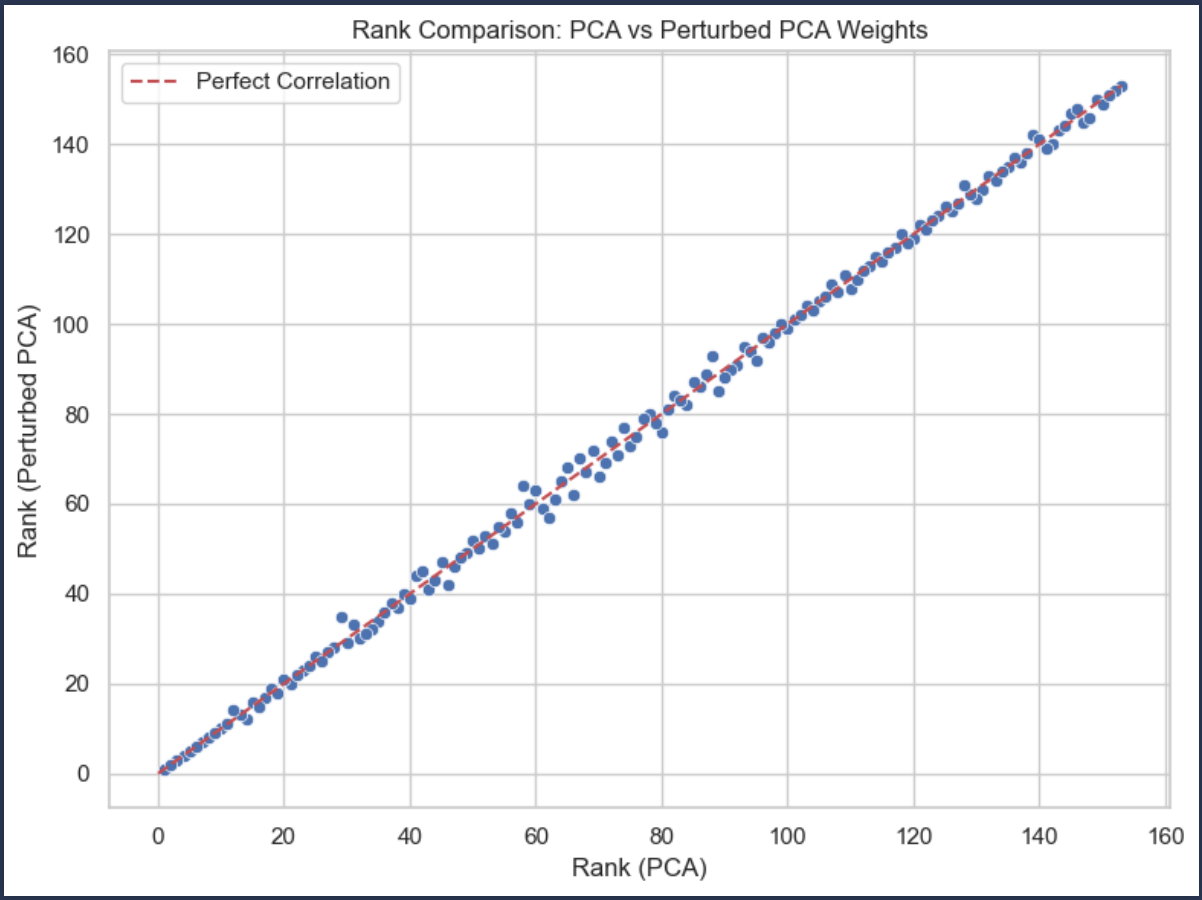
The final scores were validated through correlation with global indices such as the ITU Global Cybersecurity Index (GCI) and the Oxford AI Readiness Index. Strong correlations confirmed the credibility of the constructed index.



8. Sensitivity and Ranking Comparison

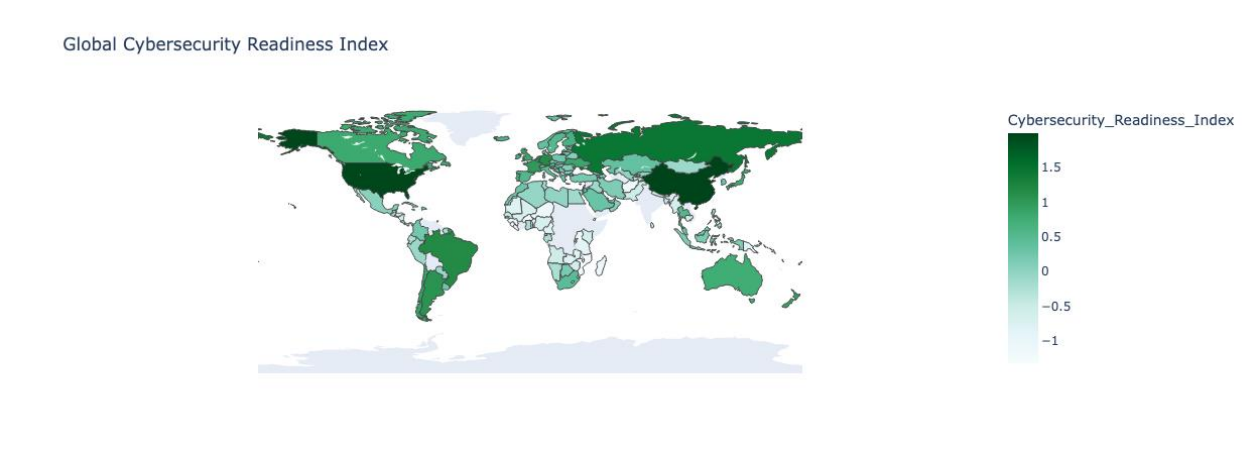
Scatter plots compared PCA-weighted and equally-weighted ranks to identify consistency across models and highlight countries whose rank varied significantly depending on the weighting scheme.




Rank Comparison: PCA vs Perturbed PCA Weights
Perfect Correlation
Rank (Perturbed PCA)
Rank (PCA)
0
20
40
60
80
100
120
140
160

9. Visualisations

Visualisation techniques included correlation matrices, rank scatter plots, and global choropleth maps. These aided in identifying outliers, confirming relationships, and communicating key insights.



10. Conclusion

The composite Cybersecurity Readiness Index effectively synthesizes multi-domain indicators into an interpretable national readiness score. Future iterations will extend coverage to legal and incident response domains and explore non-linear or non-compensatory aggregation techniques.

13. Theoretical Framework and Expert Consultation

The conceptual structure of this index was developed in collaboration with a domain expert using ChatGPT (model: o4-mini). The discussion helped align the composite indicator with OECD principles and current cybersecurity frameworks.

https://chatgpt.com/share/6818b095-9f5c-800b-80f7-7feef9805477

14. Reproducibility

The analysis was conducted using the Jupyter notebook titled: *'cybersecurity_readiness_index.ipynb'.* All relevant code, transformations, and plots are available in the linked repository.

https://github.com/almezj/DATA_AND_VISUALISATION_CA1

15. References

- OECD, 2008. *Handbook on Constructing Composite Indicators: Methodology and User Guide*. Paris: OECD Publishing.
- International Telecommunication Union (ITU), n.d. *Global Cybersecurity Index (GCI) Methodology*. [online] Available at: https://www.itu.int/en/ITU-D/Cybersecurity/Pages/GCI.aspx [Accessed 5 May 2025].
- Oxford Insights, 2023. *Government AI Readiness Index 2023*. [online] Available at: https://www.oxfordinsights.com/government-ai-readiness-index [Accessed 5 May 2025].
- World Bank, 2023. *World Development Indicators*. [online] Available at: https://data.worldbank.org/ [Accessed 5 May 2025].
- Meleshenko, K., 2023. *Cybersecurity Indexes Dataset*. [online] Kaggle. Available at: https://www.kaggle.com/datasets/katerynameleshenko/cyber-security-indexes [Accessed 5 May 2025].