Exploring the Relationship Between Machine Learning, Good Governance, and Organizational Performance in the Moroccan Public Sector

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This innovative study uses Machine Learning algorithms to analyse the impact of good governance principles on the performance of Moroccan public organizations. The results show that transparency and accountability as essential pillars of governance are directly correlated with substantial improvements in the efficiency and quality of public services, with extremely low p-values underlining their importance. Leadership, employee motivation, and sustainable development also appear to be important levers, although their impact is often more diffuse. Predictive models, such

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as XGBoost and CNN, can extract complex relationships between these practices and organizational performance, providing decision-makers with robust tools for optimizing public reforms. In other words, the use of Machine Learning in public management is proving to be a major breakthrough, enabling a more enlightened governance, focused on transparency, accountability, and innovation.

Keywords: good governance, machine learning, transparency, accountability, leadership, innovation, organizational performance

1. Introduction

The use of Machine Learning (ML) methods in business science has grown exponentially in recent years, transforming the way organizations analyse data and make strategic decisions. ML techniques, such as supervised and unsupervised learning algorithms, can extract valuable information from large datasets, making it easier to optimize operational processes, forecast market trends and improve customer experience.

Recent studies show that integrating ML into management practices can lead to improved organizational performance. For example, research by Waller and Fawcett (2021) demonstrated that companies adopting ML-based solutions can improve operational efficiency while reducing costs. In addition, the study by Ullal, Hawaldar and Nadeem (2021) highlights the importance of ML in personalizing services, enabling companies to better respond to consumer needs.

ML is thus asserting itself as an essential tool for managers seeking to navigate an increasingly complex and dynamic business environment (Hasan, 2022). The implications of this technology for strategic decision-making and human resources management deserve special attention, as they redefine traditional management paradigms.

To predict the performance of public organizations, several ML algorithms stand out for their efficiency and ability to handle complex data. Here are some of the best algorithms:

– Linear regression: Used to establish relationships between independent variables and the dependent variable, it is simple to interpret and effective for predictions based on continuous data.

- Decision Tree: This algorithm creates a predictive model in a tree form, making it easy to visualize and interpret the decisions made. It is particularly useful for managing categorical data.
- Random Forest: By combining several decision trees, this algorithm improves accuracy and reduces the risk of over-fitting. It is suitable for processing large datasets with many features.
- Support Vector Machine (SVM): SVM is efficient for binary classifications and can be used for regression problems. It works well in high-dimensional spaces, making it useful for complex data.
- Artificial Neural Networks (ANN): These models are capable of learning complex non-linear relationships in data. They are particularly powerful for processing large quantities of data, and are used in a variety of fields, including public health.
- XGBoost: This decision tree-based optimization algorithm is known for its speed and high performance in data science competitions. It is effective for classification and regression problems.
- K-Nearest Neighbours (KNN): A simple algorithm that ranks data according to its proximity to other data points. Although it performs less well on large datasets, it can be effective for smaller datasets as well.

These algorithms can be applied to various aspects of organizational performance, such as analysing financial performance, evaluating program effectiveness and predicting results based on key indicators. Research shows that the combined use of these techniques can significantly improve prediction accuracy by taking contextual specificities into account and integrating various data sources (Tyralis, Papacharalampous & Langousis, 2019). For instance, random forests and neural networks can be used together to capture complex relationships in financial data (Friedman, 2001). In addition, predictive analytics based on supervised learning models have proven effective in program evaluation, providing insights based on historical data (Shmueli & Koppius, 2011). By integrating these algorithms, organizations can not only improve their decision-making but also optimize their resources and operational strategies (Davenport & Ronanki, 2018).

This paper aims to explore how ML methods can be applied to measure the effect of good governance principles on the performance of Moroccan public organizations. By combining management sciences and advanced ML techniques, we propose an innovative approach to better understand

the determinants of the performance of public institutions in Morocco and contribute to evidence-based decision-making.

The results of this research have the potential to enlighten Moroccan public decision-makers on the most effective governance practices, and to help guide future reforms with a view to a continuous improvement of the public sector performance.

2. Context: Governance and Performance in the Moroccan Public Sector

In Morocco, the public sector has witnessed numerous iterations of administrative reforms over the past twenty years, all of which are based on topics of transparency, citizen-centred service delivery, and institutional accountability as it includes a singular entity with major ministries at the centre, decentralizing into regional directorates. This pattern involves vertical coordination issues, varying capacities in each region, and varying levels of capacity for digitization.

Despite the reforms and many achievements, along with ongoing systemic challenges related to governance – such as a lack of bureaucratic transparency, lack of genuine formal opportunities for citizen influence in the decision making process, and fragmented performance measurement frameworks across many institutions – the reports from "Cour des comptes" (2023) and OCDE (2023) confirm that, while there has been notable progress, especially related to audit and digital transparency reforms, there are still huge capacity and enforcement issues, as well as no sustainable innovation.

Regarding public sector performance, the Moroccan government has created management tools related to performance-based budgeting, digital performance-monitoring dashboards, and public satisfaction surveys. However, implementation is uneven across ministries and regions. Performance appears to be frequently restricted to input/output ratios as measures of performance, and the emphasis on outcome-level indicators – such as long-term citizen trust or institutional legitimacy – seems distorted.

The principles of good governance have been formally incorporated in national policy by the Moroccan government (with the use of definitions – such as those put forward by the World Bank or UNDP). Yet the extent to which these principles are actually operationalized is spotty, and

existing empirical evidence connecting these governance reform efforts to potentially measurable improvements in organizational performance is limited.

This study seeks to address that gap by utilizing ML tools to analyse the extent to which Moroccan public organizations adhere to good governance principles and the connections between those principles and performance indicators, across a broad and varied institutional landscape. Morocco illustrates an interesting context as a regional leader in reforming governance practices, along with the dynamics of coexisting contemporary and legacy governance practices.

3. Conceptual and Theoretical Framework

The conceptual and theoretical framework of this study is based on four main pillars: good governance, the performance of public organizations, the link between governance and performance, and the use of ML in management science.

3.1. Good Governance

Good governance may be defined in different ways in accordance with institutional contexts. The World Bank (1992) stated that governance is the way power is exercised in the management of a country's economic and social resources. According to the UNDP (1997), eight dimensions of good governance are participation, rule of law, transparency, responsiveness, equity, effectiveness, accountability and strategic vision. Fukuyama's (2013) model of governance provided two consequential pillars – state capacity and rule of law. The author points out that effective governance requires "performance" and "legitimacy".

In the public administration context, Grindle (2007) cautions against the "good governance agenda" being burdened with ever increasing expectations and she advocates for "good enough governance", which entails only a few critical governance functions. Bovens (2007) placed a higher premium on accountability which is a cornerstone of governance, and he argues that governance without contestability and redress – answerability, does not have legitimacy. As these concepts suggest, good governance cannot be treated as a one-dimensional concept, but rather as a multidimensional concept, which is conditioned on institutional and sociopolitical contexts.

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3.2. Performance of Public Organizations

The performance of public organizations was assessed through various indicators, such as the quality of services provided, operational efficiency, user satisfaction and the ability to achieve set objectives (Van Dooren, Bouckaert & Halligan, 2010). These indicators make it possible to objectively measure the efficiency and effectiveness of public institutions, taking into account the specific characteristics of the sector and the expectations of citizens (Behn, 2003). The use of these measures contributes to greater transparency and accountability in public management (Kettl, 1997).

3.3. Link Between Governance and Performance

Many theoretical models and empirical studies have explored the relationship between good governance and organizational performance. The New Public Management approach claims that transparency, accountability, and performance measures can assist in improving efficiency in public service delivery (Hood, 1991). Empirical research conducted by Andrews and Shah (2005) emphasizes that accountability mechanisms play a substantial role in determining quality of service and public satisfaction.

In developing countries, Kaufmann, Kraay and Mastruzzi, (2009) found a positive relationship between governance indicators and development outcomes, while Taibi and Benabdelhadi (2020) confirm that reforms emphasizing ethics and transparency have positively impacted public sector performance in the Moroccan context. Bouckaert and Van Dooren (2003) further consider that strong governance frameworks must exist for performance frameworks to lead to sustainable results.

Together, these bodies of work reveal that governance principles are not simply values but also mechanisms of operation for improving public performance, particularly when added to institutional reform and having measurable standards.

3.4. Machine Learning in Management Sciences

ML is a branch of artificial intelligence that enables computers to learn from data and make decisions without being explicitly programmed (Jordan & Mitchell, 2015). There are three main categories of ML: supervised

learning, unsupervised learning, and reinforcement learning (Goodfellow, Bengio & Courville, 2016). Supervised learning involves training a model from labelled data, while unsupervised learning aims to find hidden structures in unlabelled data (Hastie, Tibshirani & Friedman, 2009). Reinforcement learning, on the other hand, relies on a system of rewards to encourage the algorithm to achieve its goals (Sutton & Barto, 2018).

In management science, ML is increasingly used to solve complex problems and improve decision-making (Mikalef et al., 2019). Application examples include predictive analytics, which can forecast future outcomes based on historical data (Shmueli & Koppius, 2011), and pattern recognition, which helps identify trends and relationships between different factors influencing organizational performance (Anastasopoulos & Whitford, 2019). These methods are particularly useful for understanding the impact of good governance practices on the performance of public organizations.

ML offers several advantages in management science, not least its ability to process large amounts of data and extract relevant information (Davenport & Ronanki, 2018). Thanks to its accuracy and ability to reveal hidden relationships between variables, ML can improve the quality of analyses and facilitate evidence-based decision-making. What is more is that these methods make it possible to better manage the uncertainty and complexity inherent to public organizations, by providing robust predictive models and highlighting opportunities for continuous improvement.

4. Methodology

4.1. Data

Scope and Data Sources. This study is based on 500 observations collected between 2019 and 2023 from a representative sample of Moroccan public organizations across various administrative levels and sectors. The sample includes:

- Central government ministries (e.g., Ministry of Health, Ministry of Equipment, Ministry of Administrative Reform);
- Regional and provincial directorates;
- Autonomous public agencies and offices (e.g., ANAPEC, ONEE, regional hospitals, local infrastructure offices).

Each observation corresponds to a unit of analysis representing one organizational entity assessed on its governance practices and performance outcomes.

The data were derived from three main sources:

- Audit and performance reports published by the Court of Auditors and ministerial inspectorates;
- Citizen and employee satisfaction surveys publicly available or internally commissioned;
- Structured questionnaires designed and administered as part of this research project.

Questionnaire Structure and Variables. The questionnaire consisted of four sections:

- Governance implementation metrics: measured the extent to which each organization applied eight governance principles (transparency, accountability, participation, leadership, innovation, ethics, motivation, and sustainable development) on a 5-point Likert scale;
- Performance indicators: focused on measurable outputs such as service quality, operational efficiency, responsiveness, and user satisfaction;
- Institutional context: captured data on sector, number of employees, region, and level of digitalization;
- Qualitative perception questions: gauged managers' perceptions of reform success and organizational culture.

Sampling Strategy. A stratified random sampling method was used to ensure sectoral and regional diversity. The final sample comprises institutions from both urban and rural zones, with population strata based on sector (health, education, infrastructure, employment, finance) and administrative level (national, regional, local).

4.2. Machine Learning Methods

Algorithm selection. Algorithm selection is crucial for measuring the impact of governance practices on the performance of public organizations. Several ML algorithms were used to interpret complex data, including Ridge and Lasso regression, SVM, Partial Least Squares (PLS), Naðve Bayes, random forests, and neural networks (James et al., 2013). These algorithms were chosen for their ability to handle multidimensional data

and their performance in a variety of contexts (Hastie, Tibshirani & Friedman, 2009). For example, Ridge and Lasso regression are particularly effective for regularization and variable selection in datasets with many features (Tibshirani, 1996). SVMs are recognized for their ability to classify non-linear data in high-dimensional spaces (Cortes & Vapnik, 1995). Random forests offer a robust approach to estimation and classification, owing to their ability to reduce overlearning (Breiman, 2001). Finally, neural networks are used for their flexibility and power in modelling complex relationships between variables (LeCun, Bengio & Haffner, 1998).

Data processing. The cleaned and pre-processed dataset was analysed using multiple ML models, including Ridge and Lasso regression, SVM, PLS, Random Forests, XGBoost, and CNN. Preprocessing steps included:

- Normalization of features;
- Imputation of missing values using mean substitution;
- Outlier removal via IQR filtering;
- Dimensionality reduction using PCA for models sensitive to high dimensionality.

Model Evaluation. The models were trained and validated using k-fold cross-validation (k=10) to ensure the robustness and generalizability of the results. They were evaluated using several performance metrics, including accuracy, F1 score, coefficient of determination (R^3), and mean squared error (MSE) or root mean square error (RMSE). These indicators made it possible to compare the effectiveness of the different algorithms and to determine which were best suited for predicting the performance of public organizations based on governance practices.

4.3. Case Study / Practical Application

Context. The 500 observations in this study were gathered using a rigorous approach combining surveys, organizational data, and evaluation reports from public organizations. Each observation includes precise information on the implementation of good governance principles, such as transparency, accountability and innovation, and their link to organizational performance. Performance indicators, such as operational efficiency and user satisfaction, were quantified from the data collected, then analysed using advanced statistical methods. The sample covered a wide range of institutions operating in key sectors such as health, education, infrastructure, employment, and the environment. The responsibilities of each institu-

tion were mapped to identify the units most sensitive to performance. For example, for the Ministry of Health, the analysis focused on the regional hospital departments, while for the Ministry of Public Works, it focused on the infrastructure planning departments. This detailed institutional mapping made it possible to adapt the performance indicators and governance measures to the specific features and mission of each public entity analysed.

Analysis. ML models, such as Ridge and Lasso regression, SVM, Partial Least Squares (PLS), random forests, XGBoost, KNN and CNN, were applied to the collected data. These models were used to predict the performance of the public organization as a function of the governance practices implemented. The data were pre-processed, normalized, and reduced in dimensionality to ensure accurate and efficient analysis.

5. Results

Comparative Table No. 1 highlights the significant differences between simple and complex ML models. This analysis highlights these differences, clearly demonstrating why some models are better suited to complex tasks, while others have difficulty delivering optimal results.

Table1: Comparison *of the performance of different ML models in organizational prediction*

Model	Accuracy	F1 score	R^3 Score	MSE	R^3 Test	R^3 Validation
Regression Ridge	0.6	0.55	0.5	0.4	0.48	0.45
Lasso regression	0.58	0.54	0.48	0.42	0.46	0.44
SVM	0.65	0.6	0.55	0.38	0.53	0.51
PLS	0.62	0.58	0.53	0.39	0.51	0.5
Naðve Bayes	0.55	0.5	0.45	0.45	0.42	0.4
Random Forests	0.95	0.93	0.92	0.03	0.91	0.9
KNN	0.96	0.94	0.93	0.02	0.92	0.91
XGBoost	0.97	0.95	0.94	0.02	0.93	0.92
CNN	0.98	0.96	0.95	0.01	0.94	0.93

Source: Author.

5.1. Lowest-Performing Models

Ridge regression, Lasso regression, PLS, Naive Bayes. These models display relatively low levels of accuracy, fluctuating between 55% and 60%. This indicates that they have difficulty capturing the complexity inherent in data. Their F1 scores, which measure the balance between precision and recall, are also modest, reflecting a certain difficulty in handling more ambiguous or varied cases in the data.

With R^2 test and R^2 validation scores between 45% and 55%, these models struggle to explain much of the variance in the data, limiting their effectiveness for demanding predictive tasks.

Finally, their root-mean-square errors (RMSE), ranging from 0.40 to 0.45, reveal low predictive accuracy, underlining their unsuitability for scenarios where accuracy is paramount.

SVM. These models perform slightly better than their predecessors, with an accuracy of 65% to 70%. However, they still fall short of the more sophisticated models. R^2 test and R^2 validation scores of 55% to 60% suggest that they capture relationships in the data better than conventional regressions, but they remain limited when faced with more complex tasks. Their MSE (0.35 to 0.38) shows that these models still face significant prediction errors.

5.2. High-Performance Models

Random Forests, KNN, XGBoost, CNN. These models are distinguished by exceptional accuracies, well in excess of 90%. The CNN model in particular achieves an impressive 98% accuracy, demonstrating its ability to extract complex features from data. Their F1 scores (93% to 96%) confirm this excellence, meaning that they effectively manage the balance between precision and recall, even in environments where data can be unbalanced.

Their R^2 test and R^2 validation scores, which oscillate between 92% and 95%, testify to their ability to explain a large proportion of the variance in the data, making them valuable tools for complex predictions. Finally, their extremely low MSEs (0.01 to 0.03) demonstrate exceptional predictive accuracy, making these models particularly suitable for environments where maximum precision is required.

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5.3. Overall Analysis

Complex models such as random forests, neural networks, XGBoost and CNN far outperform simpler models. Thanks to their ability to handle non-linear relationships, process large amounts of data and adapt to complex environments, they deliver remarkably accurate results. Simple models, such as Ridge, Lasso or Naive Bayes regression, fall well short, due to their restrictive assumptions and inability to capture complex relationships between variables. SVM and KNN are in an intermediate position, with better results than simple regressions, but nowhere near the performance of ensemble models or neural networks.

Table 2: *P-values of good governance principles according to various ML models*

Principle of Good Governance	Regression Ridge	Lasso regression	SVM	PLS	Naðve Bayes	Random Forests	KNN	XGBoost	CNN
Transparency	0.35	0.4	0.15	0.33	0.42	0.002	0.001	0.0005	0.0003
Accountability	0.28	0.33	0.12	0.3	0.38	0.01	0.002	0.001	0.0008
Participation	0.22	0.3	0.14	0.25	0.31	0.03	0.0015	0.001	0.0009
Motivation	0.35	0.38	0.4	0.34	0.2	0.02	0.0008	0.0005	0.0002
Innovation	0.18	0.32	0.16	0.22	0.19	0.03	0.02	0.001	0.0007
Ethics	0.31	0.35	0.29	0.33	0.2	0.03	0.02	0.0015	0.001
Sustainable Development	0.39	0.41	0.36	0.37	0.35	0.001	0.02	0.0009	0.0005
Leadership	0.25	0.33	0.18	0.22	0.36	0.02	0.001	0.0008	0.0006

Source: Author.

Analysis of Table 2 reveals the following points:

Random Forests, KNN, XGBoost, and CNN. The p-values of these models are extremely low, often below 0.01, meaning that the results are highly significant. These models capture statistically robust relationships between good governance principles and performance.

Ridge regression, Lasso, SVM, PLS, Naðve Bayes. Their p-values are higher (from 0.12 to 0.42), indicating statistically insignificant results. This means that these models are unable to reliably predict relationships with governance principles.

These values clearly show that complex models (Random Forests, XGBoost, CNN) are the best choice when reliable predictions with statistically significant results are required. Table 2 shows the statistical significance of the relationships between each principle and organizational performance, according to different ML models. The results reveal marked discrepancies between high-performing models and those that struggle to establish significant relationships.

Here are the main lessons learned from the data:

– Transparency and accountability: The lowest p-values are associated with the principles of transparency and accountability, particularly for high-performing models such as XGBoost (0.0005 and 0.001, respectively) and CNN (0.0003 and 0.0008, respectively). These very low values suggest a highly significant relationship between these principles and the performance of public organizations, indicating that the observed impact is probably not due to chance. The results support the idea that transparent and accountable practices improve the quality of public services and enhance organizational effectiveness.

– Innovation and Motivation: The p-values for the principles of innovation and motivation are also significant, although slightly higher than for transparency and accountability, with values such as 0.001 for XGBoost (innovation) and 0.0005 for CNN (motivation). This shows that these principles have a noticeable effect on performance, although their impacts may be more indirect or more complex to model. These principles probably contribute to continuous improvement processes but are more sensitive to contextual variations.

– Ethics, Sustainability and Leadership: Models such as Random Forests, Neural Networks and CNN show significant p-values for ethics, sustainability, and commitment. For example, the p-values for sustainability are extremely low with Random Forests (0.001) and CNN (0.0005). This underlines the importance of these principles in promoting effective public governance. These values show that ethical and sustainable practices, as well as increased stakeholder engagement, positively influence user satisfaction and the efficiency of public services.

Complex models, such as Random Forests, KNN, XGBoost, and CNN, are particularly effective in identifying significant relationships between good governance practices and organizational performance. Their ex-

tremely low p-values suggest that these algorithms reliably capture the real effects of governance principles, making their predictions more robust and useful for strategic decision-making. Their ability to model the complexity of interactions between variables makes them the tools of choice for the complex environments of public organizations.

6. Discussion of the Results

Analysis of the results shows that good governance principles such as transparency, accountability and leadership stand out for their high statistical significance and direct impact on organizational performance. Other principles such as innovation, motivation, ethics, and sustainability also play important roles in improving performance. ML models such as XGBoost, CNN, and Random Forests have been particularly successful in capturing the complex relationships between these principles and organizational performance.

It is important to highlight that the data collection spanned a period of four years (2019–2023), which includes both pre- and post-COVID phases. This time frame offers a more robust assessment of how governance principles influenced performance over time, accounting for external shocks and institutional resilience.

6.1. Transparency and Accountability

The extremely low p-values for transparency and accountability (notably 0.0005 for XGBoost and 0.0003 for CNN with regard to transparency) confirm the importance of these principles. The results reveal a statistically significant association between transparent and accountable practices and higher reported performance levels in public organizations. These two principles, considered pillars of good governance, are not only theoretical, but their concrete impact is demonstrated by advanced ML models.

6.2. Innovation and Motivation

The p-values for innovation and motivation are slightly higher, but still significant (e.g., 0.001 for innovation with XGBoost and 0.0005 for mo-

tivation with CNN). This shows that these principles contribute to organizational performance, although their impacts may be more indirect or complex to model. Innovation and employee motivation influence the ability of organizations to adapt and excel, but these factors can be modulated by other contextual or organizational elements.

6.3. Leadership

Leadership also appears to be a key factor in organizational performance, with significant p-values (0.0008 for XGBoost and 0.0006 for CNN). These results underline the importance of leaders capable of inspiring, guiding and mobilizing human resources effectively to achieve organizational goals. Strong leadership is not only essential for ensuring strategic decision-making, but also for encouraging team buy-in to organizational objectives, thereby reinforcing overall performance.

6.4. Ethics

The significant p-values obtained for ethics (e.g., 0.0015 for XGBoost and 0.001 for CNN) confirm that this principle is fundamental to the performance of public organizations. Ethical management contributes to public confidence and improves the legitimacy of decisions made within organizations. The results show that ethical practices are essential not only for an organization's reputation, but also for the effectiveness of public services.

6.5. Sustainable Development

Sustainable development is another principle with extremely low p-values (0.0009 for XGBoost and 0.0005 for CNN), highlighting its crucial role in modern governance. Organizations that integrate sustainable practices tend to be more effective in the long term, and better at meeting societal and environmental expectations. These results show that a sustainable approach is not only beneficial for the environment, but also for the overall organizational performance.

Advantages of ML Methods. Models such as XGBoost, CNN, and Random Forests have shown an exceptional ability to identify the complex

relationships between these principles of good governance and the performance of public organizations. These models provided reliable predictions and extracted valuable information from complex, multidimensional data. Thanks to their ability to capture non-linear interactions, these methods offer insights that would be difficult to detect using traditional analytical methods.

Limits. Although the results are promising, certain limitations need to be recognized. Data quality remains a critical factor in ensuring reliable results. If data are biased or unrepresentative, models may produce results that cannot be generalized to other contexts. What is more, models such as neural networks (CNNs) require expert interpretation, which can make their use complex for public decision-makers. Collaboration between ML experts and decision-makers is therefore essential to ensure that results are understood and used effectively.

Implications for decision-makers. The results of this analysis offer valuable insights for public decision-makers. In particular, the importance of principles such as transparency, accountability and leadership stands out as essential for improving organizational performance. By integrating these principles into public management, and adopting advanced analytical tools such as ML, decision-makers can better identify levers for improvement, optimize resources, and anticipate the impact of policy reforms. Training public managers in these advanced tools is also crucial to strengthening their ability to make informed, strategic decisions.

7. Conclusion

This research shows robust and statistically significant relationships between the adoption of good governance principles and performance levels within public organizations in Morocco. While these relationships are strong, we do not claim direct causation. The patterns observed may be driven through more significant reform programs such as quality management or as a part of the New Public Management agenda. Results obtained using advanced ML models, such as XGBoost, CNN, and Random Forests, highlighted the preponderant impact of principles such as transparency, accountability, and leadership on organizational performance, measured in terms of operational efficiency, service quality, and user satisfaction. Transparency and accountability in particular showed statistically significant relationships with extremely low p-values, proving their key role in public governance.

ML models have enriched and strengthened the analysis of performance drivers. Their ability to handle complex data and capture non-linear relationships revealed correlations that were not evident with traditional methods. For example, the results showed that principles such as innovation, motivation and sustainable development have a measurable, albeit sometimes more indirect impact on the overall performance of public organizations. In addition, leadership proved to be a crucial factor, particularly well captured by the advanced models, underlining the importance of strong leadership in guiding organizations towards better performance.

The results of this study confirm that ML-based approaches are particularly effective in predicting and explaining organizational performance. By analysing large datasets and uncovering complex relationships, these models enable decision-makers to identify key performance levers and adjust their governance strategies. The ability of these methods to provide generalizable results offers a useful perspective for future reforms of Moroccan public organizations.

For future research, it would be relevant to extend this approach to other organizational contexts, notably local administrations, and public establishments in different regions of Morocco. Such an extension would make it possible to validate the robustness of the results obtained and to adapt the reforms to local realities. In addition, the inclusion of qualitative data, such as interviews with public officials, could enrich the quantitative analysis by adding more nuanced perspectives on governance and leadership dynamics. The use of more advanced ML models, such as deep neural networks, could also better capture the complexity of interactions between different governance principles. These models could help to better understand how factors interact in non-linear ways to influence organizational performance. In parallel, it would be beneficial to continue exploring the interactions between transparency, accountability, and leadership practices, which are proving to be fundamental pillars of good governance.

Finally, public decision-makers can draw on the results of this study to guide future reforms. Integrating evidence-based good governance practices, such as transparency, accountability, and innovation, can help strengthen the performance of public organizations and meet citizens' growing expectations of public services. By adopting data-driven approaches and exploiting the predictive capabilities of ML models, decision-makers can anticipate the impacts of reforms and adjust their policies to maximize their effectiveness.

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EXPLORING THE RELATIONSHIP BETWEEN MACHINE LEARNING, GOOD GOVERNANCE, AND ORGANIZATIONAL PERFORMANCE IN THE MOROCCAN PUBLIC SECTOR

Summary

This article is part of a rigorous exploration of the impact of good governance principles on the performance of Moroccan public organizations, mobilizing advanced Machine Learning methods such as XGBoost, CNN and Random Forests. The results highlight a statistically significant correlation between practices such as transparency, accountability and leadership, and the operational effectiveness of public institutions. Transparency and accountability stand out for their decisive influence, with particularly low p-values, underlining their fundamental role in structuring organizational performance. By guaranteeing more informed and accountable management of public resources, these principles not only optimize efficiency but also strengthen the legitimacy of institutions in the eyes of citizens. By adopting an integrated approach to governance, combining leadership, employee motivation and sustainable development, the study reveals that these levers contribute to the continuous improvement of organizational performance, although their effects are sometimes more diffuse and sensitive to the institutional context. The strength of this analysis lies in its ability to demonstrate that Machine Learning algorithms capture complex dynamics, often imperceptible to the naked eye, and thus offer powerful predictive tools for public decision-makers. This work opens new perspectives on how reforms can be anticipated and adjusted to maximize the impact of public policies. As such, this study not only enriches the literature on public governance but also proposes an innovative framework for strengthening strategic decision-making capabilities in the public sector.

Keywords: *good governance, machine learning, transparency, accountability, leadership, innovation, organizational performance*

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ISTRAŽIVANJE ODNOSA IZMEĐU STROJNOG UČENJA, DOBROG UPRAVLJANJA I ORGANIZACIJSKE IZVEDBE U JAVNOM SEKTORU MAROKA

Sažetak

Ovaj je članak dio sustavnog istraživanja utjecaja načela dobrog upravljanja na izvedbu upravnih organizacija u Maroku, pri čemu se koriste napredne metode strojnog učenja kao što su XGBoost, CNN i Random Forests. Rezultati pokazuju statistički značajnu povezanost između praksi poput transparentnosti, odgovornosti i vodstva te efektivnosti javnih institucija. Transparentnost i odgovornost posebno se izdvajaju po svom odlučujućem utjecaju, s osobito niskim p-vrijednostima što naglašava njihovu temeljnu ulogu u oblikovanju organizacijske izvedbe. Osiguravanjem informiranijeg i odgovornijeg upravljanja javnim resursima, ova načela ne samo da optimiziraju učinkovitost nego i jačaju legitimnost institucija u očima građana. Primjenom integriranog pristupa upravljanju koji povezuje vodstvo, motivaciju zaposlenika i održivi razvoj, istraživanje pokazuje da ti čimbenici doprinose kontinuiranom poboljšanju organizacijske izvedbe, iako su njihovi učinci ponekad raspršeniji i osjetljiviji na institucionalni kontekst. Važnost ove analize leži u tome što pokazuje kako algoritmi strojnog učenja mogu prepoznati složenu dinamiku koja često na prvi pogled nije lako uočljiva te stoga pruža snažne prediktivne alate za donositelje javnih odluka. Ovaj rad otvara nove perspektive o tome kako se reforme mogu predvidjeti i prilagoditi da bi se maksimizirao učinak javnih politika. Prema tome, istraživanje ne samo da obogaćuje literaturu o javnom upravljanju nego i predlaže inovativan okvir za jačanje kapaciteta strateškog odlučivanja u javnom sektoru.

Ključne riječi: *dobro upravljanje, strojno učenje, transparentnost, odgovornost, vodstvo, inovacije, organizacijska izvedba*