FIT-FOR-PURPOSE CADASTER ARCHITECTURE FOR MOROCCAN LAND-USE PLANNER: PROPOSAL AND PERCEPTION

Youssef Rissouni [1], ElHassan Jamal[1], Hicham JAMIL[1], Rachid AL ANSARI[1], Bouabid EL MANSOURI[2], Jamal CHAO[2], Aniss MOUMEN[1].*

[1]Systems Engineering Laboratory, Kenitra ENSA, Ibn Tofail University, Morocco
[2]Natural Resources Geosciences Laboratory, Kenitra Faculty of Sciences, Ibn Tofail University, Morocco

Abstract. The influx of foreign investment in Morocco necessitates a robust and integrated land information system to support informed decision-making and ensure sustainable growth. The fit-for-purpose cadastre emerges as a promising solution, offering transparency, efficiency, and data-driven land management. However, its full potential remains untapped due to persistent challenges: fragmented data across government agencies, opaque information exchange mechanisms, and outdated infrastructure.

This research delves into these challenges by investigating the perspectives of diverse stakeholders crucial to successful cadastre implementation: land tenure specialists, public policymakers, spatial planners, and investors. Through in-depth interviews, we illuminate the current state of land information management in Morocco, pinpoint critical roadblocks hindering transparency, efficiency, and sustainability, and propose a multi-pronged approach to unlock the transformative potential of a fit-for-purpose cadastre system.

Keywords: Big Data Analytics, Fit-for-purpose Cadastre, Land Information Management, Data Governance, Sustainable Development.

* Corresponding author: youssef.rissouni@gmail.com

1 Introduction

The intricate relationship between land tenure, spatial planning, and sustainable development necessitates a robust and integrated land information system [1]. In this realm, the concept of a fit-for-purpose cadastre has emerged as a promising avenue for fostering transparency, efficiency, and informed decision-making in land administration. However, the actualization of this transformative potential hinges on overcoming persistent challenges associated with data fragmentation, opaque data exchange mechanisms, outdated infrastructure, and fragmented business processes [2].

To navigate these roadblocks and unlock the full potential of a fit-for-purpose cadastre, this research delves into the perspectives of diverse stakeholders representing land tenure specialists, public policymakers, spatial planners, and investors. Through in-depth interviews and an evidence-based approach, we illuminate the current state of land information management, pinpoint critical limitations, and propose a multi-pronged approach for implementing a successful fit-for-purpose cadastre system [3].

This research contributes to the existing body of knowledge in several key ways. Firstly, it offers a comprehensive understanding of the current challenges and opportunities surrounding fit-for-purpose cadastre implementation, informed by the diverse perspectives of key stakeholders. Secondly, it proposes a holistic and evidence-based roadmap for overcoming these challenges and unlocking the system's transformative potential [4]. Finally, it highlights the critical role of collaboration and intersectoral cooperation in successfully realizing a fit-for-purpose cadastre and fostering sustainable land management practices.

By exploring these themes, this research aims to inform policymakers, land information stakeholders, and researchers alike as they navigate the path towards a future where a robust and integrated land information system empowers informed decision-making, fosters transparency, and paves the way for sustainable land management for generations to come.

2 Methodology

The selection of interview participants for this study was conducted with meticulous attention to capturing diverse perspectives and expertise relevant to the research aims. We prioritized individuals capable of offering profound insights into the crucial elements of our research topic, particularly as it pertains to the successful execution of the study. In total, 11 individuals were strategically chosen, representing four distinct stakeholder groups with substantial influence on the research domain (Table 1).

- **Land Tenure:** This stakeholder group comprised individuals with in-depth knowledge of land ownership rights and associated regulations. Their expertise covered legal frameworks, customary practices, and emerging trends in land tenure systems.
- **Public Policy and Land Governance:** Professionals actively involved in formulating and implementing land-related policies and governing frameworks constituted this group. Their perspectives brought insights into regulatory landscapes, policy instruments, and governance challenges.
- **Land Development and Spatial Planning:** This stakeholder group included specialists responsible for land use planning, infrastructure development, and the spatial organization of urban and rural landscapes. Their expertise provided understanding of spatial dynamics, infrastructure requirements, and land-use patterns.
- **Investment:** Stakeholders actively engaged in land-based investments from both public and private sectors were included in this group. Their perspectives shed light

on investment trends, financing mechanisms, and the role of various actors in land-based investments.

- **Table 1.** Consulted stakeholder's cluster.

Category	Stakeholders
Land Tenure	• Topographic and cartography firms (Private sector)
Public Policy and Land Governance	• Urban Agency • Environment • Digital Transition and Administrative Reform
Land Development and Spatial Planning	• Urban Agency • Department of Urban Planning • Land Planning Department
Investment	• Regional Investment Center • Industry and Commerce

1. Pre-Interview Engagement and In-Depth Stakeholder Consultations

Prior to conducting in-depth interviews, we established preliminary communication with stakeholders through email correspondence. This initial contact served to introduce the research project and invite participants to engage in a subsequent videoconference session. The primary objective of the videoconference was to provide contextual grounding for the research, ensuring all stakeholders possessed a shared understanding of the study's parameters and intrinsic objectives. This harmonization aimed to establish a common language and conceptual framework within which discussions could occur. Additionally, the videoconference offered an opportunity to share relevant perspectives inherent to the field of Fit-for-purpose Cadastre, showcasing national best practices and their corresponding benefits. This immersive exercise served as a springboard for the subsequent, individual consultations.

2. In-Depth Interviews for Comprehensive stakeholder insights:

Following the introductory videoconference, each stakeholder was invited to participate in a semi-structured, one-to-one-and-a-half-hour interview session, primarily conducted via video conferencing. These in-depth interviews provided a conducive platform for delving into the specific stakes, expectations, and needs of each stakeholder group.
The interview structure was designed to gather comprehensive data across two key areas (Table 2):

❖ **Needs and Data Landscape:**

- Identifying the specific needs of each stakeholder group.
- Establishing an exhaustive list of data generated and consumed within their respective activities.
- Understanding current procedures and the regulatory framework governing land information management, including associated challenges.

❖ **Information Systems and Legal Framework:**

- Collecting detailed information on the technical specifications of the target system used by each stakeholder group.

- Understanding the standards and norms applied to these systems.

This two-pronged approach ensured a holistic understanding of stakeholders' perspectives on both the practical data management aspects and the broader legal and regulatory context surrounding land information.

- **Table 2.** Core Interview Axes for a Fit-for-purpose Cadastre Initiative.

	Purpuse	**Description**	**Profile**
Needs and Data Landscape	Develop stakeholder understanding and buy-in	Gather insights and expectations on the challenges of setting up a digital Fit-for-purpose cadastre	Business profile
	Business needs assessment	Assessing business data producers' and consumers' needs and their points of contention / agreement.	Business profile
	Current state of cadastral information	Characterize data flows, encompassing generation and consumption	Business profile
Information Systems and Legal Framework:	Information Systems Inventory	Understand the complexity of today's territorial information systems	Information System Managers
	Overview of existing legal texts	Understand the current legal context and the necessary regulatory requirements	Legal experts

3. Transcription:

After the interviews were transcribed and analyzed, stakeholders were invited to a virtual validation session to refine the findings. The session was held via video conferencing platform.

The session began with a presentation of the study's findings, followed by a question-and-answer period. Stakeholders then had the opportunity to review the findings and provide feedback. The feedback was used to finalize results.

3 Results & Discussion

Following a thorough analysis of the results of interviews conducted with stakeholders, respectively on the business, legal, and technological aspects, we are able to formulate the following summaries:

- **Table 3.** Emerging Needs and Recommendations for a Fit-for-purpose Cadaster: Insights from Stakeholder Interviews

Challenge	**Class**	**Testimonial**	**Recommendation**
Technological	Data quality	Data are siloed, duplicated, and inconsistent due to the absence of shared data	Centralized Big Data Repository: Implement a centralized big data repository to

		repositories between different entities.	consolidate cadastral data from various entities. Integrate Data Quality Management tools with machine learning algorithms to automate data cleansing, deduplication, and anomaly detection.
	Data exchange	There is a lack of transparency in the devices related to the exchange of data and cadastral information.	Secure Data Exchange: Develop a blockchain-based data exchange protocol with audit trails and access controls to ensure secure and transparent data sharing
	Data structure	Traditional databases and Excel spreadsheets are used despite the large volume and heterogeneity of the data used.	Migrate to a scalable data management system like a NoSQL database or cloud-based data warehouse to handle diverse data formats and volumes efficiently [5].
	Interoperability	Interoperability requirements are often neglected.	Implement a data integration hub powered by master data management and data virtualization tools to provide a single point of access to all cadastral data, regardless of its location or format.
	Analysis and visualization	The analysis aspect is absent.	**Big Data Analytics Suite:** Implement a big data analytics suite with interactive dashboards and visualization tools. **Predictive Analytics Models:** Develop AI-Based predictive analytics models to forecast future trends in land use, property values, and potential risks for investment [5] **Location Intelligence Platform**: Utilize location intelligence

			platforms to combine cadastral data with spatial data sources like satellite imagery and GIS maps for deeper insights into land use and development patterns.
Businesses	Process and Workflow	The production and use of cadastral information are governed by a multitude of processes, often with inadequate documentation.	Streamline and document business processes for cadastral information management.
Legal	Legal	There is no legal regulation in place that encourages the sharing and exchange of land information.	Advocate for the development of legal frameworks that incentivize and regulate the sharing of land information among authorized entities.

4 Fit-for-purpose cadastre architecture for Moroccan land-use planner

The adoption model proposed herein fosters the proposed implementation of a fit-for-purpose cadastre in Morocco through a multi-pronged approach. It goes beyond mere technological solutions, encompassing three key dimensions that address technical, organizational, and contextual challenges (Table 3)

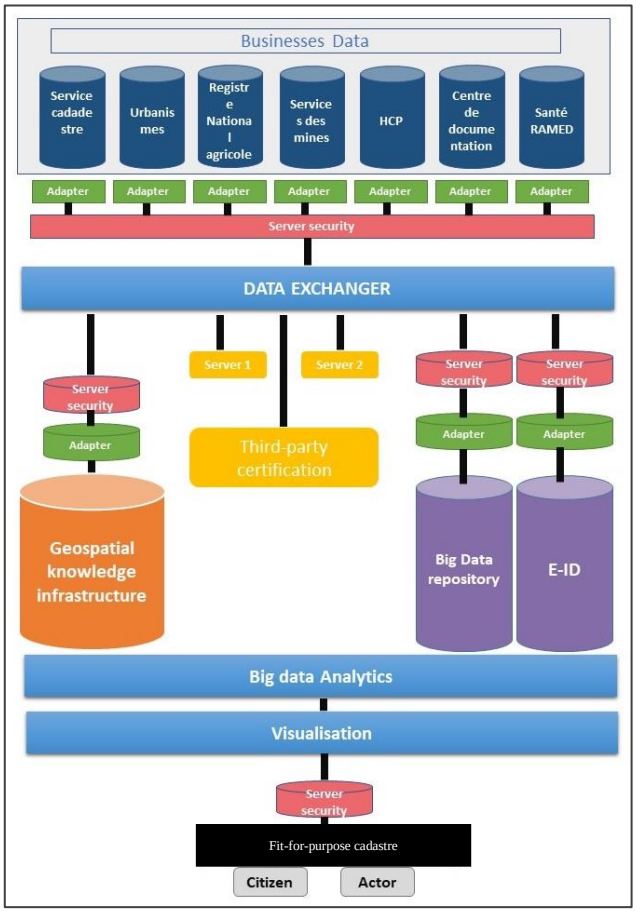

Fig. 1.: Conceptual framework of the fit-for-purpose cadastre, highlighting the interplay between stakeholders, data, and sustainable land management.

5 Conclusion

This study, drawing on in-depth interviews with stakeholders across land tenure, public policy, spatial planning, and investment domains, offers a comprehensive examination of the current challenges and prospective pathways for realizing a fit-for-purpose cadastre system. The findings underscore critical limitations hindering the current system, namely data fragmentation, lack of transparency in data exchange, outdated infrastructure, and inefficient business processes. These constraints impede the efficiency, accessibility, and trustworthiness of land information management [6].

To address these challenges, this research proposes a multi-faceted approach rooted in stakeholder insights. Firstly, establishing a centralized data repository, equipped with robust data quality management tools, is paramount to ensure data integrity and consistency. Simultaneously, implementing secure data exchange protocols, such as blockchain-based solutions with audit trails, would foster trust and collaboration among stakeholders. Furthermore, migrating to a modern data management infrastructure, capable of handling diverse data formats and volumes, is essential for scalability and flexibility.

In addition to these technological advancements, standardized APIs and data integration solutions must be adopted to data exchanger and facilitate seamless communication.

Moreover, integrating big data analytics and visualization tools would unlock valuable insights from the aggregated land information, guiding informed decision-making and strategic planning [7]. Concurrently, streamlining and documenting business processes associated with cadastral information management would enhance efficiency and accuracy. Finally, advocating for a supportive legal framework that incentivizes data sharing and establishes clear regulations is crucial to build trust and promote responsible data utilization. By implementing these interconnected recommendations, policymakers and land information stakeholders can harness the transformative potential of a fit-for-purpose cadastre [8]. This integrated system would not only enhance transparency and efficiency in land administration but also enable sustainable land management practices for future generations. Thus, this research, grounded in stakeholder perspectives and evidence-based insights, provides a roadmap for a transformative land information ecosystem, fostering informed decision-making and propelling sustainable land governance.

6 ACKNOWLEDGMENT

We acknowledge the invaluable support of diverse stakeholders in this land policy research, particularly private sector topographic and cartography firms, and all participants. Their insights and contributions significantly enriched this work.

References

[1] P. Krigsholm, K. Riekkinen, et P. Ståhle, « The Changing Uses of Cadastral Information: A User-Driven Case Study », *Land*, vol. 7, nº 3, p. 83, juill. 2018, doi: 10.3390/land7030083.

[2] L. A. Rocha, J. Montoya, et A. Ortiz, « Quality Assurance for Spatial Data Collected in Fit-for-Purpose Land Administration Approaches in Colombia », *Land*, vol. 10, nº 5, p. 496, mai 2021, doi: 10.3390/land10050496.

[3] « Le Foncier au Maroc : un levier fondamental pour le développement durable et l'inclusion sociale ».

[4] R. M. Bennett, E.-M. Unger, C. Lemmen, et P. Dijkstra, « Land Administration Maintenance: A Review of the Persistent Problem and Emerging Fit-for-Purpose Solutions », *Land*, vol. 10, nº 5, p. 509, mai 2021, doi: 10.3390/land10050509.

[5] J. Elhassan, M. Aniss, et C. Jamal, « Big Data Analytic Architecture for Water Resources Management: A Systematic Review », in *Proceedings of the 4th Edition of International Conference on Geo-IT and Water Resources 2020, Geo-IT and Water Resources 2020*, Al-Hoceima Morocco: ACM, mars 2020, p. 1-5. doi: 10.1145/3399205.3399225.

[6] A. O. D. Silva et R. A. S. Fernandes, « Smart governance based on multipurpose territorial cadastre and geographic information system: An analysis of geoinformation, transparency and collaborative participation for Brazilian capitals », *Land Use Policy*, vol. 97, p. 104752, sept. 2020, doi: 10.1016/j.landusepol.2020.104752.

[7] S. Bennani, Y. Lakhrissi, G. Khaissidi, A. Mansouri, et Y. Khamlichi, Éd., *WITS 2020: Proceedings of the 6th International Conference on Wireless Technologies, Embedded, and Intelligent Systems*, vol. 745. in Lecture Notes in Electrical Engineering, vol. 745. Singapore: Springer Singapore, 2022. doi: 10.1007/978-981-33-6893-4.

[8] T. Yomralioglu et J. McLaughlin, Éd., *Cadastre: Geo-Information Innovations in Land Administration*. Cham: Springer International Publishing, 2017. doi: 10.1007/978-3-319-51216-7.