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FOOD ENVIRONMENTS FEMOZ MOZAMBIQUE

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Importance of Data when Analyzing Food Environments

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Summary

1. Data Acquisition:
   - Identify relevant data sources and establish partnerships with local organizations.
2. Data Governance and Data Modeling:
   - Define data governance policies.
   - Develop a data model and create metadata management processes.
3. Data Provision and Maintenance:
   - Set up a local food data repository and establish data integration processes.
   - Implement data quality monitoring.
4. Data Visualization and Accessibility:
   - Select a data visualization tool and design intuitive dashboards.
   - Ensure accessibility.
5. Data Analysis:
   - Identify key food environment indicators.
   - Conduct exploratory data analysis.
   - Utilize advanced analytics techniques.
6. General Recommendations:
   - Establish a local food data governance committee.
   - Provide training on food environment data analysis.
   - Implement role-based access controls and regularly back up and secure data.
   - Define data retention policies and develop a comprehensive food data catalogue.
   - Enable localized self-service analytics.
   - Conduct periodic audits of data governance practices.
   - Foster collaboration with local institutions.
   - Continuously monitor and evaluate impact.

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Executive Summary

By harnessing the power of data-driven insights, our project FEMOZ ('Strengthening The Resilience Of Rural Food Environments In The Context Of Disaster Risk And Climate Change In Mozambique') as well as any other food environment related project in this area seek to uncover the complex interplay of factors affecting food security. Through analysis, interpretation, and collaboration, they aim to provide actionable recommendations and interventions tailored to the unique challenges faced by different regions, ultimately contributing to the resilience and sustainability of food environments.

The FEMOZ project has addressed the critical challenges posed by climate change and disaster risks to food environments in the case of Mozambique. Through a comprehensive approach, the project emphasized the importance of data-driven insights as a fundamental tool in understanding, planning, and ensuring the resilience of food systems.

This project's policy recommendation paper encompasses several key areas, starting with data acquisition. The acquisition of diverse data sources, facilitated by the cooperation between governments, researchers, and NGOs, serves as the foundation for informed decision-making. However, it is crucial to address capacity challenges at the regional and local levels to ensure effective data collection.

Data modeling emerged as a powerful technique in predicting the impacts of climate change and disasters on food environments, offering insights into crop yields, market responses, and disaster risk reduction strategies. Coupled with robust data governance, data modeling enhances data management, communication, and value, enabling informed decision-making.

The aggregation and maintenance of data within secure databases were underscored as essential for uncovering valuable connections and trends. Regular updates, data quality checks, and ethical data governance practices contribute to data reliability and usefulness.

Data visualization, especially through interactive dashboards, democratizes data, making it accessible and understandable to a wide range of stakeholders. Real-time monitoring and knowledge sharing further empower stakeholders to respond to changes promptly.

Lastly, data analysis and model building have demonstrated the potential of predictive models in identifying influential variables and estimating food insecurity situations. These insights enable policymakers to make strategic decisions, allocate resources effectively, and contribute to more resilient food environments.

Introduction

Climate change and disaster risks pose significant threats to food environments worldwide. These threats not only exacerbate food insecurity but also disrupt agricultural supply chains, especially in regions prone to disasters and resource constraints.

In this context the FEMOZ project aimed to increase the resilience of Mozambique's rural food environments, recognized as one of the most exposed and vulnerable to such threats. As a critical tool for understanding these complex issues, enabling informed planning, and ensuring resilience in food environments, **FEMOZ emphasized the importance of data-driven insights**.

To achieve these objectives, the project conducted research to explore the **multifaceted dimensions of food environments**. The insights derived from this research are instrumental in **formulating recommendations** for rural development and improving the nutritional status of the population. **Strategies** such as increasing agricultural production, raising incomes, and reducing food prices were explored to address food insecurity.

Aspects like food availability, prices, market structures, product characteristics, marketing strategies, and regulatory measures make up **the external domain** of the FEMOZ food environment framework. Simultaneously, **the personal domain** delved into factors such as accessibility, affordability, convenience, and desirability of food options.

These considerations are vital in ensuring that rural communities have access to nutritious food, even in the face of adversity.

1. Data acquisition

Data acquisition served as the **first step** in building a comprehensive understanding of food environments. We recommend the acquisition of data encompassing diverse aspects such as **agricultural productivity**, **weather patterns**, **market prices**, **land use**, and **socio-economic factors**. These data sources provide valuable insights into the current state of food environments and their vulnerability to the dual threats of climate change and disasters.

In order to harness the full potential of data, we also suggest leveraging the advancements in remote sensing, thus enabling real-time data collection. The cooperation between **governments**, **researchers**, and **NGOs** is essential to establish a robust data acquisition framework that supports the objectives mentioned above.

We further recommend including **local specialists** in the **data acquisition** pipeline, who can contribute valuable knowledge particular to the regions. However, it has been our observation that challenges persist at the regional and local levels, where **capacities** and **competencies** in these fields are relatively underdeveloped. The collection, analysis, and reporting of local data to national institutions are heavily impacted by limited local capacities.

This gap hinders the **effective implementation** of **national strategies** and policies tailored to the unique needs of communities in bridging disaster risk management and food security.

Thus, we are convinced that an effective development of a data acquisition pipeline can only succeed with an adequately equipped staff and sufficient authority. **Other important aspects** for generating knowledge from acquired data are outlined **below**.

2. Data governance and Data modeling

Data governance and especially **data modeling** involve the creation of structured frameworks to store, process, and analyze data, and are the next instrumental steps in the efforts to predict, plan, and ensure the resilience of food systems.

Data **governance** and **modeling** are intricately connected in the realm of **managing** and **utilizing data**, especially in critical areas like food systems and beyond. However, institutions and other stakeholders involved in projects often face challenges in harnessing these capabilities due to a lack of in-house expertise.

This is where data governance comes into play. To maximize the potential of data models, governments need to build their data science and AI capacities. Establishing a robust data governance framework is essential. It ensures data is well-managed, secured, and compliant with regulations like local GDPRs, and HIPAAs, thus mitigating risks associated with sensitive information.

Furthermore, data models foster **collaboration** and **communication within organizations**, enabling the different stakeholders to address data flow issues. The synergy between data modeling and data governance enhances database performance, simplifies data mapping, reduces errors, and increases data value. Ultimately, this **combination empowers governments** to **make informed decisions**, safeguard sensitive data, and optimize their data resources for the betterment of society.

3. Data provision and Maintenance

Aggregating data from various sources into databases is an essential cornerstone of modern **information management**. The process of amassing data from diverse origins and consolidating it within secure and efficient databases facilitates the profound analysis needed to uncover valuable connections and insights.

To achieve this, governments and organizations must prioritize substantial investments in the development of robust, secure, and user-friendly databases. These databases should possess the capability to **seamlessly store** and **manage** vast and **heterogeneous datasets**, ensuring the **accessibility**, **longevity**, and **relevance** of the **contained information**.

However, maintaining this data is equally critical. Regular **updates**, **data cleaning**, and stringent **quality checks** are imperative to uphold the **accuracy**, **reliability**, and **usefulness** of the **data lakes over time**. In this context, the implementation of rigorous data governance policies becomes indispensable. These policies should serve as guiding principles, overseeing the collection, **storage**, **sharing**, and **utilization** of **data** while upholding ethical and responsible practices. Such a holistic approach to data management not only enhances the value of individual data sources but also empowers data analysts to uncover meaningful connections and trends that can drive informed **decision-making**.

4. Data visualization and Accessibility

Data visualizations, particularly in the form of **interactive dashboards**, serve as powerful tools for making complex data accessible and comprehensible to a wide range of stakeholders. These stakeholders include **policymakers**, **farmers**, **traders**, and other **key actors** in the **food supply chain**. Interactive dashboards transform data into visual narratives, enabling users to gain valuable insights at a glance. This democratization of data empowers individuals and organizations to make informed decisions that can have a significant impact on food security and resilience.

One of the key benefits of data visualizations is their ability to provide real-time monitoring of food environments. This means that changes in climate patterns or the **occurrence** of **disaster events** can be tracked and responded to promptly. For instance, short-term food (in)security prediction maps are generated and delivered to respective institutions such as SETSAN, INGD and ROSA, where they are seamlessly connected to **interactive dashboards** for **visualization**. This integration allows stakeholders to stay informed about the current state of food security and make timely interventions when necessary.

Furthermore, the accessibility of data visualization tools is paramount. User-friendly and interactive dashboards also ensure that stakeholders with varying levels of technical expertise can **navigate** and **interpret** the **data effectively**. This inclusivity ensures that even those without extensive data analysis skills can benefit from the insights generated by every project.

As part of the **knowledge-sharing process**, the Institute of Information Science of the University of Applied Sciences in Cologne, Germany (TH Köln) transferred their expertise to project partners (especially UEM and Rovuma university) through special training courses and summer schools. This ensures that stakeholders in Mozambique have the skills and knowledge necessary to utilize data visualization tools effectively, further **strengthening** the **capacity** for **data-driven decision-making** in the project.

5. Data Analysis and Model Building

One of the key applications of data analysis and especially model building is the development of advanced predictive models.

For example, regression models can be employed to pinpoint the most influential **climate variables affecting crop yields**. This analytical approach allows for **identifying critical factors that can significantly affect food production**, thereby guiding resource allocation and intervention strategies.

Furthermore, classification models can be used to pre**dict the likelihood of food insecurity in different regions**, drawing upon various factors such as climate data, socio-economic conditions, and historical patterns.

By applying such models that employ various techniques, such as **statistical approaches**, **machine learning algorithms**, and **simulation models**, we could show that they are effective means in predicting the potential consequences of climate change and disasters on food environments. They can assist in

estimating crop yields under different climate scenarios, projecting market responses during extreme weather events, and simulating the outcomes of different disaster risk reduction strategies, just to name a few.

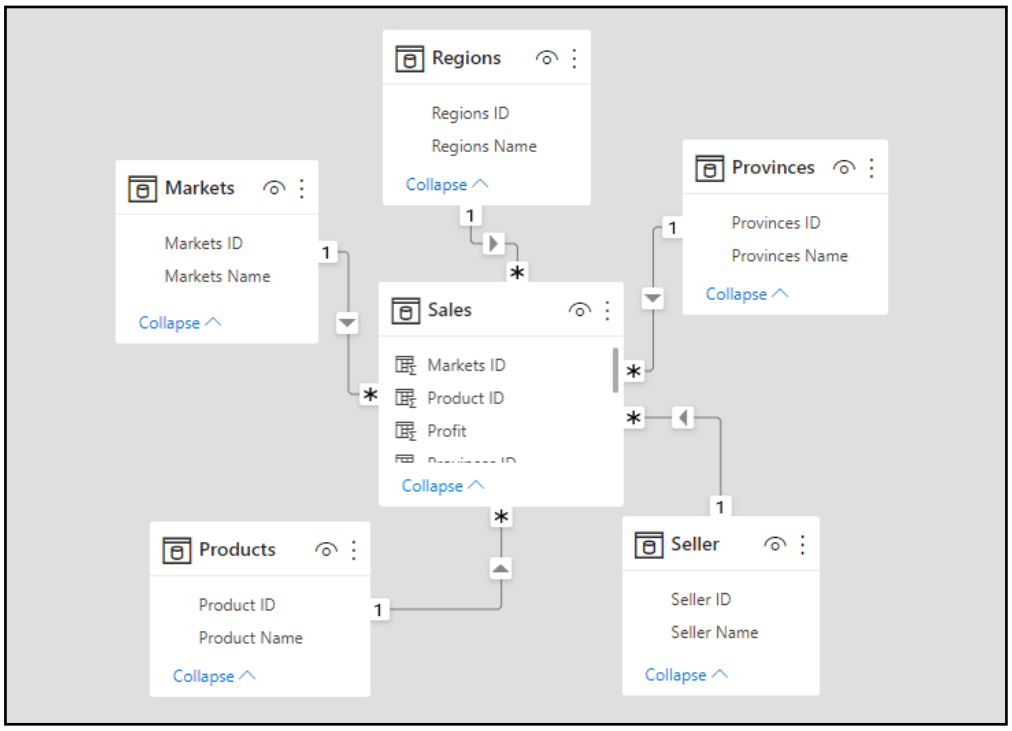
Once these predictive insights are visualized appropriately (see section above) they are capable to enable policymakers and stakeholders to make informed decisions, formulate effective policies, and allocate resources strategically, ultimately contributing to the development of more **resilient food environments**.

Through the utilization of prediction models, our project demonstrated how to equip **decision-makers** with the tools and information required to make informed strategic decisions that promote both food security and sustainability.

Our recommendations for setting up a data driven environment within your organization (INGD)

- Data Acquisition:
  - Identify relevant data sources: Determine local sources of data such as national agriculture databases, health statistics, and food consumption surveys.
  - Establish partnerships with local organizations: Collaborate with government agencies, research institutions, and NGOs to access relevant datasets and exchange data.

- Data Governance and Data Modeling:
  - Define data governance policies: Establish guidelines for data management specific to food environments, including data privacy, ethical considerations, and consent mechanisms.
  - Develop a data model: Design a data model that captures key variables like food availability, affordability, quality, and nutritional information to analyze food environments effectively (see below).

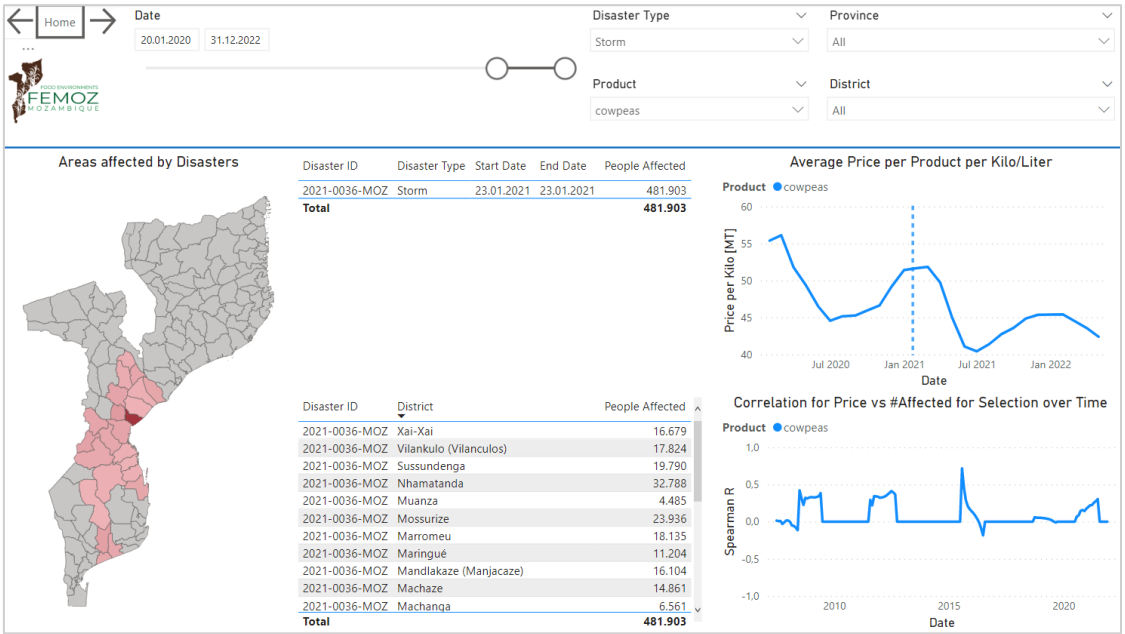


  - Create metadata management processes: Maintain comprehensive metadata to track the origin, reliability, and update frequency of the data used in food environment analysis.

- Data Provision and Maintenance
  - Set up a local food data repository: Create a centralized data repository for storing and managing local food-related datasets, ensuring data security and access controls.
  - Establish data integration processes: Develop data integration pipelines to collect and consolidate relevant datasets, including agricultural data, market prices, and health indicators.
  - Implement data quality monitoring: Regularly assess data quality, identify data gaps, and establish processes to clean, validate, and harmonize the collected data (see figure below).

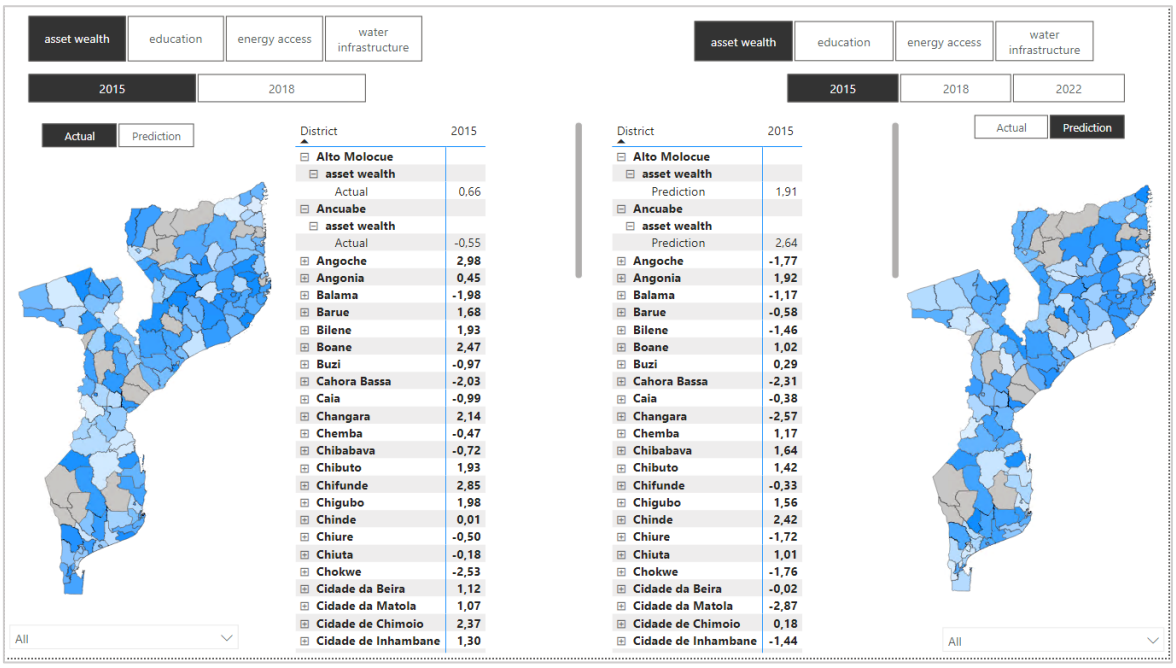
market_id	market_layer	market_cat	region_id	province_id
1	Alto Molocue	urban	1	5
2	Beira	urban	2	2
3	Bela Vista	urban	3	3
4	Boane	urban	3	3
5	Buzi	urban	2	2
6	Caia	urban	2	2
7	Chemba	rural	2	2
8	Chibabava	rural	3	2
9	Cidade da Matola	urban	3	3
10	Gorongosa	urban	2	2

- Data Visualization and Accessibility
  - Select a data visualization tool: Choose a tool that allows interactive visualization of food environment data, making it easier to identify patterns and trends.
  - Design intuitive dashboards: Create user-friendly dashboards that provide a comprehensive view of food environments, including access to nutritious food, food deserts, and population health indicators (see e.g. one FEMOZ dashboard page below).



- Ensure accessibility: Optimize visualizations for different devices and ensure compatibility with screen readers and other assistive technologies to make them accessible to all stakeholders.

- Data Analysis:
  - Identify key food environment indicators: Define relevant indicators like food insecurity rates, proximity to grocery stores, availability of fresh produce, and affordability of nutritious food.
  - Conduct exploratory data analysis: Analyze the collected data to identify spatial patterns, correlations, and disparities in food environments across different regions in Mozambique.
  - Utilize advanced analytics techniques: Apply techniques such as clustering analysis, geospatial analysis, and predictive modeling to uncover insights and forecast future trends in food environments (see below for an example from the FEMOZ project).



- General recommendations:
  - Establish a local food data governance committee: Form a committee consisting of representatives from government agencies, NGOs, and local communities to oversee data governance initiatives related to food environments.
  - Provide training on food environment data analysis: Conduct workshops and capacity-building sessions to enhance the data analysis skills of INGD staff and other relevant stakeholders.
  - Implement role-based access controls: Ensure that sensitive data related to food environments is accessible only to authorized personnel to protect privacy and maintain data security.
  - Regularly back up and secure data: Implement robust data backup mechanisms and establish data security protocols to prevent data loss and unauthorized access.
  - Define data retention policies: Establish policies for data retention, archiving, and disposal in compliance with local regulations and ethical considerations specific to food environment analysis.
  - Develop a comprehensive food data catalog: Create a catalog that documents available food-related datasets, including descriptions, sources, and usage guidelines for easy reference and data sharing.

- Enable localized self-service analytics: Empower local stakeholders, including policymakers and community organizations, with self-service analytics tools to explore and analyze food environment data independently.
- Conduct periodic audits of data governance practices: Regularly evaluate the effectiveness of data governance policies and procedures specific to food environment analysis and identify areas for improvement.
- Foster collaboration with local institutions: Collaborate with local universities, research organizations, and community groups to share knowledge, exchange data, and gain diverse perspectives on food environment analysis.
- Continuously monitor and evaluate impact.