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A Business Intelligence Approach to Visualizing and Mapping Families at Risk of Stunting Using Microsoft Power BI: Evidence from Bengkulu

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Abstract: *Stunting is a chronic nutritional problem that affects children's physical growth and cognitive development and remains a national priority in Indonesia. Bengkulu Province continues to face challenges in managing Families at Risk of Stunting (KRS) data, which are complex and difficult to analyze efficiently using conventional reporting methods. This study aims to design an interactive dashboard for visualizing and mapping Families at Risk of Stunting (KRS) using Microsoft Power BI to support monitoring, evaluation, and evidence-based decision-making at the Bengkulu Provincial BKKBN. The study adopts the Business Intelligence Roadmap, consisting of the justification, planning, business analysis, design, and construction stages. Official secondary KRS data for the 2022–2025 period were preprocessed in Python through data integration, cleaning, validation, and transformation, followed by Exploratory Data Analysis (EDA) to identify data characteristics and regional patterns before dashboard development. The results indicate that the number of families at risk of stunting reached 302,667, with an average risk percentage of 23.39%. Trend analysis revealed a decline in 2024 followed by an increase in 2025, while Bengkulu City, North Bengkulu, and Rejang Lebong consistently recorded relatively higher numbers of families at risk of stunting. The developed dashboard provides interactive visualizations that improve data analysis and support evidence-based decision-making for accelerating stunting reduction in Bengkulu Province.*

Keywords: *Stunting, Business Intelligence, Data Visualization, Microsoft Power BI,*

1. Introduction

Stunting remains one of the most significant public health challenges and a national development priority in Indonesia due to its long-term impact on children's growth and the quality of the human resource. According to the 2023 Indonesian Health Survey (SKI), the national prevalence of stunting among children under five remains 21.5%, while Bengkulu Province recorded a prevalence of 20.2%, indicating that stunting continues to be a major public health concern requiring sustained intervention [1]. Stunting refers to impaired growth and development in children under five caused by chronic malnutrition, repeated infections, and inadequate nutritional intake during critical periods of development [2]. Beyond affecting physical growth and resulting in children being shorter than the standard height for their age, stunting also impairs cognitive development, educational achievement, and future productivity. Consequently, reducing stunting has become a strategic objective of the Indonesian government to improve human capital and support sustainable national development.

The National Population and Family Planning Agency (BKKBN) plays a central role in implementing Indonesia's population, family planning, and family welfare programs. In accordance with Presidential Regulation No. 72 of 2021 on the Acceleration of Stunting

Reduction, BKKBN has been designated as the leading institution responsible for coordinating national efforts to reduce stunting through cross-sector collaboration [3], [4]. As part of this responsibility, BKKBN manages the Families at Risk of Stunting (KRS) data, which contain information on households that require priority intervention based on various socioeconomic and health-related indicators [5], [4].

At the provincial level, the Bengkulu Provincial BKKBN is responsible for implementing various family development programs to accelerate the reduction of stunting [6]. The Bengkulu Provincial BKKBN was selected as the case study because, under Presidential Regulation No. 72 of 2021, it has the authority to coordinate stunting-reduction programs and to manage comprehensive Families at Risk of Stunting (KRS) data collected from all districts and municipalities in Bengkulu Province [3], [4]. However, despite the availability of comprehensive data, information management remains largely dependent on spreadsheet-based tabular reports, making it difficult to identify regional disparities, analyze temporal trends, and support timely evidence-based decision-making. Therefore, this study proposes a Business Intelligence dashboard using Microsoft Power BI to facilitate visualization and mapping of KRS data, thereby improving information accessibility for monitoring and evaluation activities in Bengkulu Province.

The growing volume and complexity present significant challenges for data management and utilization. The data are primarily stored in spreadsheet-based formats and are commonly presented in static reports, limiting stakeholders' ability to analyze, identify spatial patterns, compare districts, and monitor temporal trends efficiently. These challenges highlight the need for a Business Intelligence approach that transforms complex KRS data into interactive, easily interpretable visual information to support evidence-based decision-making at both the provincial and district/city levels [7].

Business Intelligence (BI) and Microsoft Power BI have been widely used to support data visualization and decision-making across organizations through dashboards [8], [9]. Previous studies have demonstrated the effectiveness of Power BI in presenting complex information through dashboards. However, limited research has specifically implemented a comprehensive Business Intelligence approach to visualize and spatially map official Families at Risk of Stunting data managed by BKKBN at the provincial level. In addition, the integration of Python-based data preprocessing, exploratory descriptive analysis, and the Business Intelligence Roadmap into a unified analytical workflow for supporting monitoring and evaluation of stunting reduction programs remains limited.

Based on the identified research gap and practical challenges, this study aims to develop a Business Intelligence-based dashboard using Microsoft Power BI to visualize and spatially map Families at Risk of Stunting data in Bengkulu Province. Furthermore, this study contributes by integrating Python-based data preprocessing, exploratory descriptive analysis, and the Business Intelligence Roadmap into a structured analytical workflow that supports evidence-based decision-making to accelerate stunting reduction programs within the Bengkulu Provincial BKKBN.

2. Literature Review

Li et al. [10] developed a Microsoft Power BI dashboard to analyze the performance of 869 faculty members, using multidimensional visualizations by department, academic position, and age group. The study demonstrated the effectiveness of Power BI in presenting complex institutional data through interactive dashboards that support managerial decision-making. However, the proposed system primarily focused on data visualization and did not incorporate

a comprehensive Business Intelligence workflow, including Python-based data preprocessing, exploratory data analysis, or spatial visualization.

Kulbayeva et al. [11] employed Microsoft Power BI to analyze and visualize synthetic financial data for detecting money laundering and terrorist financing. The study demonstrated Power BI's ability to transform complex datasets into interactive visualizations that facilitate pattern recognition and analytical decision-making. However, the proposed framework relied primarily on dashboard visualization and did not integrate a comprehensive Business Intelligence workflow, including data preprocessing, exploratory analysis, or spatial visualization.

Murtiwiyati et al. [12] developed a Microsoft Power BI-based dashboard to visualize demographic data in Tangerang Regency, presenting information on population distribution by gender, religion, occupation, and age group. The study demonstrated the effectiveness of Power BI in improving the accessibility and presentation of government demographic data for public information purposes. However, the proposed dashboard primarily relied on descriptive visualizations and did not adopt a structured Business Intelligence development framework or integrate data preprocessing and exploratory analysis into the analytical process.

Heru Stiawan et al. [13] developed a Microsoft Power BI-based dashboard to visualize the distribution of medicinal and rare plants in Kediri Regency through charts and geographic mapping. The study demonstrated Power BI's ability to present spatial information in an accessible visual format, thereby supporting data exploration and regional mapping. However, the proposed dashboard primarily focused on descriptive visualization and did not incorporate a comprehensive Business Intelligence workflow involving Python-based data preprocessing, exploratory data analysis, or a structured development framework.

Zahra and Jaman [9] implemented a Business Intelligence approach using Microsoft Power BI to analyze retail product sales data and develop a dashboard to evaluate sales performance and support strategic business decisions. The study demonstrated the effectiveness of Business Intelligence in transforming transactional data into meaningful insights for organizational decision-making [14]. However, the proposed framework was designed for commercial business analytics and did not address the challenges associated with integrating public-sector datasets, spatial visualization, or monitoring and evaluation of social programs.

Previous studies have demonstrated the effectiveness of Microsoft Power BI for visualization and decision support [15]. However, most studies focused only on dashboard development without integrating Python-based preprocessing, exploratory data analysis, the Business Intelligence Roadmap, and spatial visualization into a unified analytical workflow. Therefore, this study proposes an integrated Business Intelligence workflow to visualize and map official KRS data, supporting monitoring, evaluation, and evidence-based decision-making at the Bengkulu Provincial BKKBN.

3.Methods

a. Research Subject

The research subject consisted of KRS data obtained from the BKKBN Representative Office of Bengkulu Province. The dataset covers the 2022–2025 period and includes demographic and stunting-risk indicators from all regencies and municipalities in Bengkulu Province. These official secondary data served as the primary source for dashboard development and analysis.

b. Data Collection Methods

This study employed both literature review and field study as the primary data collection methods. The literature review was conducted to establish the theoretical foundation related to Business Intelligence, data visualization, and stunting monitoring. Meanwhile, the field study was carried out at the BKKBN Representative Office of Bengkulu Province through direct observations, interviews with the Head of Working Team 6 (Data and Information), and official data acquisition. These activities were conducted to understand the existing KRS data management process, identify the indicators used, and obtain official Families at Risk of Stunting (KRS) datasets for subsequent preprocessing, analysis, and dashboard development.

Table 1. Description of the Families at Risk of Stunting (KRS) Dataset.

Attribute	Description
Data source	BKKBN Representative Office of Bengkulu Province
Data type	Official secondary data
File format	Microsoft Excel (.xlsx)
Data period	2022–2025
Coverage	9 regencies and 1 municipality in Bengkulu Province
Number of worksheets	4 (one worksheet for each year)
Number of observations	40 records (10 regions × 4 years)
Number of variables	11 variables
Output format	CSV (.csv) after preprocessing
Data Processing Tool	Python (Pandas)

The dataset consists of regional identifiers, observation year, target households, welfare categories, the total number of Families at Risk of Stunting (KRS), and the number of families not at risk.

c. Research Workflow

Figure 3.1 illustrates the overall research workflow adopted in this study. The workflow is based on the Business Intelligence Roadmap, which consists of the justification, planning, business analysis, design, and construction phases. To facilitate the implementation of these phases, the research process was organized into four main stages: planning, data processing, visualization, and analysis. Each stage was designed to ensure that the Families at Risk of Stunting (KRS) data were systematically processed into meaningful visual information to support monitoring, evaluation, and evidence-based decision-making at the BKKBN Representative Office of Bengkulu Province.

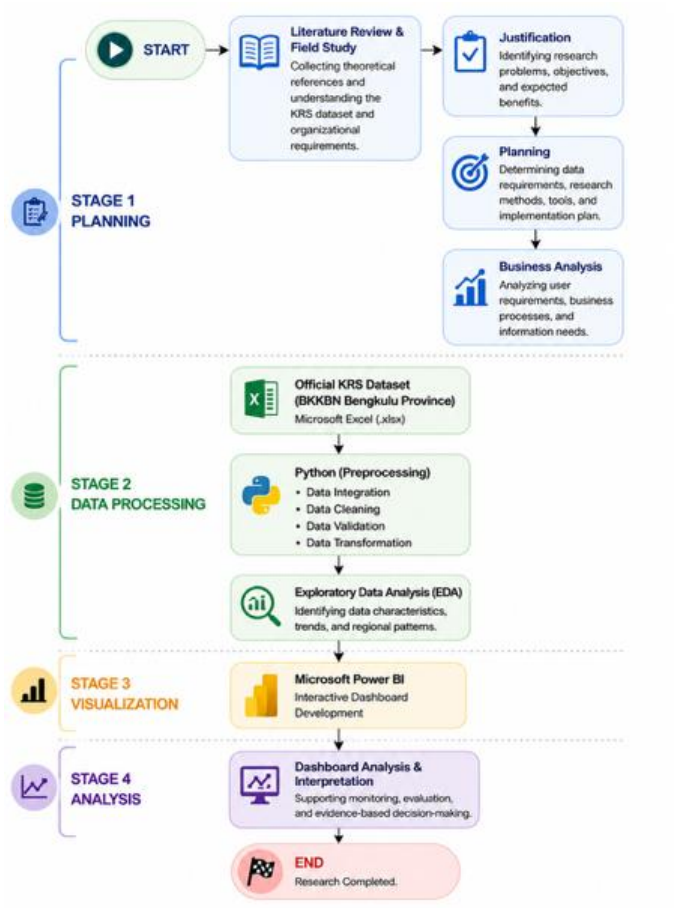

Figure 1. Research Workflow

The research workflow consists of four stages: planning, data processing, visualization, and analysis. Planning identifies user requirements and research objectives. Data processing includes integration, cleaning, validation, transformation, and exploratory data analysis (EDA). The processed dataset is then visualized in Microsoft Power BI to develop interactive dashboards, followed by analytical interpretation to support monitoring and evidence-based decision-making.

d. System Architecture

The system architecture illustrates the end-to-end data processing workflow adopted in this study, beginning with data acquisition and ending with the delivery of a dashboard for monitoring and evaluation. As shown in Figure 3.2, the official Families at Risk of Stunting dataset was obtained from the BKKBN Representative Office of Bengkulu Province in Microsoft Excel (.xlsx) format. The dataset contains annual summary data at the regency and municipality levels covering the period from 2022 to 2025.

The dataset was preprocessed in Python through data integration, cleaning, validation, and transformation. The processed dataset was then exported as data_stunting_final.csv, which served as the data source for Microsoft Power BI. Microsoft Power BI was used to develop an interactive dashboard consisting of KPIs, trend analysis, regional comparisons, and geographic mapping. The dashboard supports monitoring, evaluation, and evidence-based decision-making for stunting reduction programs.

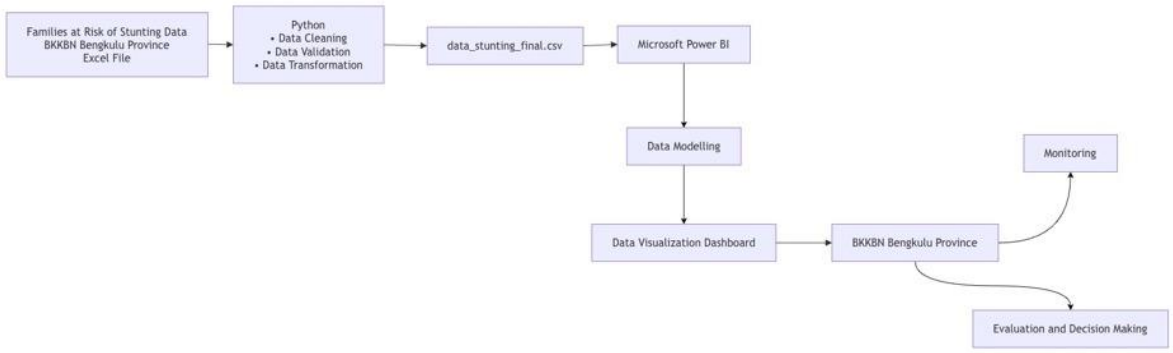

Figure 2. System Architecture

e. Data Preprocessing and Quality Validation

Data quality checks were performed after the data preprocessing stage to ensure the dataset was complete, consistent, and suitable for further analysis and visualization. This process aimed to improve the reliability of the data before it was imported into Microsoft Power BI. The data quality-checking process consisted of several validation procedures, including removing unnecessary empty columns, normalizing column names, verifying required variables, converting numeric data types, checking for missing values, detecting duplicate records, and conducting descriptive statistical analysis.

These validation procedures ensured that the dataset was complete, consistent, and free of major data quality issues before it was imported into Microsoft Power BI. The summary of the preprocessing and validation activities is presented in Table 2.

Table 2. Summary of the Data Preprocessing Process.

Step	Purpose	Output
Data integration	Merge four annual Excel worksheets (2022–2025)	Unified dataset
Year extraction	Extract year information from worksheet names	Year attribute
Column cleaning	Remove unnecessary (Unnamed) columns	Clean table structure
Column normalization	Standardize column names	Consistent variable names
Variable renaming	Rename variables into a consistent format	Standardized attributes
Data validation	Verify required variables	Complete dataset
Data type conversion	Convert attributes into numeric data types	Numeric variables
Missing value handling	Remove incomplete records	Complete observations
Duplicate checking	Remove duplicate records	Unique dataset
Data export	Export processed data for visualization	data_stunting_final.csv

4. Results and Discussion

a. Dataset Overview

This study utilized official secondary data on Families at Risk of Stunting obtained from the BKKBN Representative Office of Bengkulu Province. The dataset covers all nine regencies and one municipality in Bengkulu Province from 2022 to 2025. Each record represents the

annual summary of KRS data for a specific administrative region, resulting in a total of 40 observations that served as the basis for subsequent analysis and dashboard development.

The dataset contains key indicators related to Families at Risk of Stunting, including the number of target families, family welfare categories (Levels 1–4 and above Level 4), the total number of families at risk of stunting, the number of families not at risk, and the observation year. These variables enable the analysis of regional distributions, temporal trends, and differences in KRS characteristics across Bengkulu Province. Prior to visualization, the dataset was preprocessed and validated in Python to ensure data completeness, consistency, and reliability before being imported into Microsoft Power BI for dashboard development.

b. Python Preprocessing Results

Table 3. Structure of the Preprocessed KRS Dataset.

Variable	Data Type	Non-Null Count	Description
regency	Object	40	Regency/Municipality name
target_family_number	Integer	40	Number of target families
welfare_rank_1	Integer	40	Family Welfare Level 1
welfare_rank_2	Integer	40	Family Welfare Level 2
welfare_rank_3	Integer	40	Family Welfare Level 3
welfare_rank_4	Integer	40	Family Welfare Level 4
welfare_rank_>4	Integer	40	Family Welfare Level >4
total	Integer	40	Total families at risk of stunting
not_risky	Integer	40	Families not at risk
year	Integer	40	Observation year (2022–2025)

Table 4. Descriptive Statistics of the Preprocessed KRS Dataset.

Variable	Count	Mean	Standard Deviation	Minimum	Maximum
Number of Target Families	40	33,444.18	12,893.59	18,009	57,270
Welfare Level 1	40	1,646.08	1,037.99	337	4,149
Welfare Level 2	40	969.98	462.03	256	2,159
Welfare Level 3	40	965.05	568.99	278	2,552
Welfare Level 4	40	786.08	375.37	195	1,556
Welfare Level >4	40	3,199.50	1,657.35	1,382	8,262
Total Families at Risk	40	7,566.68	3,349.45	2,779	14,583
Families Not at Risk	40	25,877.50	10,912.29	10,358	49,290

The preprocessing stage was performed in Python to prepare the official KRS dataset for visualization in Microsoft Power BI. This process involved integrating data from multiple worksheets, removing unnecessary attributes, normalizing column names, validating data types, converting numerical variables, and checking for missing values and duplicate records. The objective of this stage was to ensure that the dataset was complete, consistent, and suitable for subsequent analysis.

Table 4.1 presents the descriptive statistics of the preprocessed KRS dataset. The dataset consists of 40 observations, representing 10 administrative regions (9 regencies and 1 municipality) over the 2022–2025 period. All analytical variables contain complete observations (count = 40), indicating that no missing values remained after preprocessing. The statistical summary also demonstrates considerable variation among administrative regions, particularly in the number of target families and the total number of families at risk of stunting, providing an appropriate basis for comparative analysis and visualization.

c. Dashboard Overview

Figure 4.1 presents the Business Intelligence dashboard developed using Microsoft Power BI for visualizing and mapping Families at Risk of Stunting in Bengkulu Province. The dashboard integrates multiple visualization components into a single interface to facilitate data exploration, monitoring, and evaluation. Interactive filtering features enable users to examine KRS information by administrative region and observation year, allowing more flexible analysis according to specific information needs.

The dashboard consists of several visualization components, including Key Performance Indicators (KPIs), the distribution of families at risk of stunting by welfare category, regional comparisons of KRS percentages, annual trend analysis, geographic mapping, and regional ranking visualizations. These visualizations collectively provide a comprehensive overview of the distribution and characteristics of Families at Risk of Stunting (KRS) across Bengkulu Province.

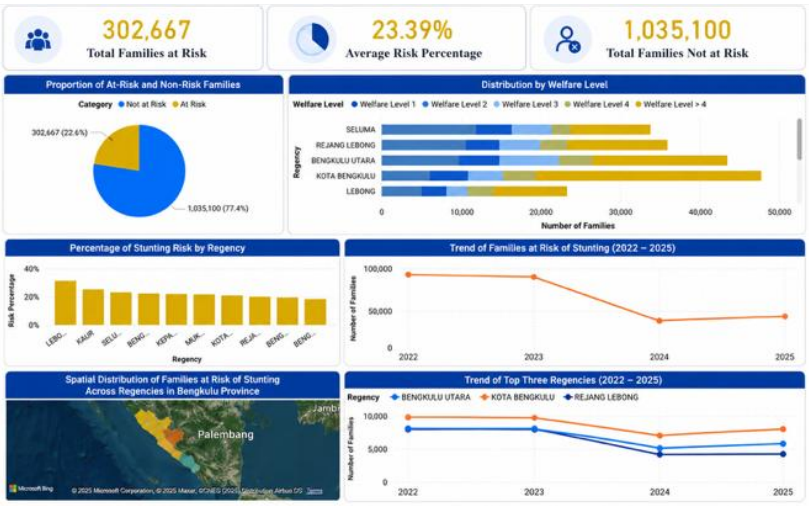

Figure 3. Interactive Dashboard for Visualizing and Mapping Families at Risk of Stunting

d. KPI Analysis

The KPIs displayed at the top of the dashboard provide a concise summary of the overall KRS conditions in Bengkulu Province during the 2022–2025 observation period. These indicators enable decision-makers to obtain an immediate overview of the current KRS situation before exploring more detailed visualizations.

The dashboard indicates that the total number of families at risk of stunting reached 302,667 households, while the total number of families categorized as not at risk reached 1,035,100 households. In addition, the average percentage of families at risk of stunting across all administrative regions was 23.39%. These KPIs provide a concise overview of KRS conditions and support evidence-based monitoring and decision-making.

e. Distribution and Trend Analysis

The dashboard presents welfare-level distribution, regional comparison, and temporal trend analysis of KRS in Bengkulu Province. These visualizations include the distribution of KRS by family welfare level, regional comparisons of KRS percentages, annual trend analysis, and the identification of regions with the highest number of families at risk of stunting. Together, these visualizations support a more comprehensive understanding of KRS characteristics beyond the overall indicators presented in the KPI section.

The welfare-level distribution indicates that Families at Risk of Stunting are present across all welfare categories, although the largest proportion is concentrated in the higher welfare categories. This finding suggests that the occurrence of stunting risk is not exclusively associated with economically disadvantaged households. This finding indicates that stunting risk is influenced by multiple factors beyond household economic status, requiring comprehensive intervention strategies.

Regional comparison further reveals considerable variation in the percentage of Families at Risk of Stunting among regencies and municipalities. Several regions exhibit substantially higher KRS percentages than others, indicating unequal spatial distribution across Bengkulu Province. These findings enable policymakers to identify priority areas for targeted monitoring and intervention.

The temporal trend analysis shows that the number of Families at Risk of Stunting declined during 2024 before increasing again in 2025, indicating that KRS conditions remain dynamic throughout the observation period. Consequently, continuous monitoring is required to evaluate changes in regional risk patterns and support future intervention planning.

f. Spatial Analysis

The preprocessing stage ensured data quality through integration, cleaning, validation, and transformation, while the dashboard presented key performance indicators (KPIs), welfare-level distributions, temporal trends, regional comparisons, and spatial mapping. The findings identified 302,667 families at risk of stunting with an average risk percentage of 23.39%, highlighting Bengkulu City, North Bengkulu, and Rejang Lebong as priority intervention areas.

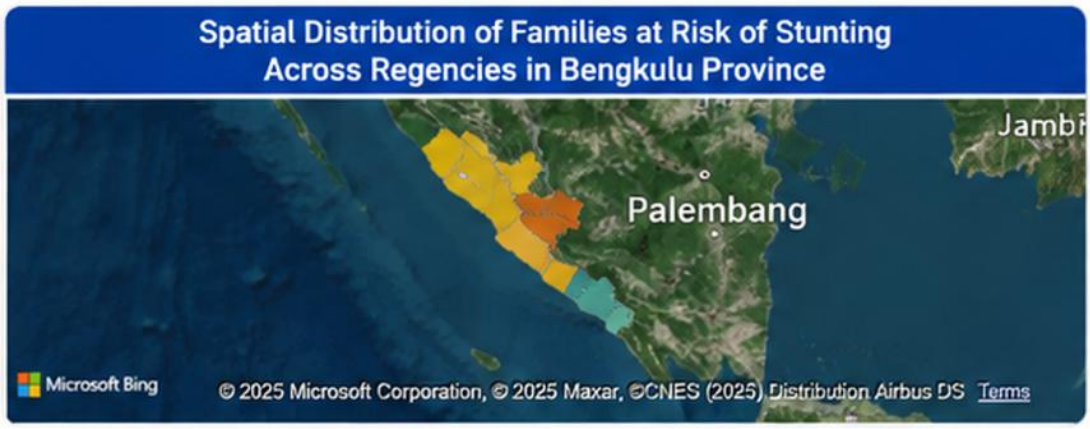

Figure 4. Spatial Distribution of Families at Risk of Stunting in Bengkulu Province

The spatial visualization integrated with interactive filtering enables users to examine KRS conditions by year and region. This capability supports regional comparison, continuous monitoring, and evidence-based identification of priority intervention areas. Compared with spreadsheet-based reports, the spatial dashboard provides a clearer representation of regional KRS distribution, allowing stakeholders to recognize geographic patterns more efficiently.

Consequently, spatial visualization strengthens monitoring, evaluation, and evidence-based decision-making for stunting reduction programs.

g. Discussion

The developed dashboard supports monitoring and evaluation by presenting key indicators, regional comparisons, temporal trends, and spatial distributions within a single analytical platform. Through these visualization features, stakeholders can identify priority intervention areas, compare KRS conditions among regencies and municipalities, and monitor changes over time without manually processing large volumes of tabular data. Consequently, the dashboard facilitates evidence-based decision-making and contributes to more efficient planning of stunting reduction programs in Bengkulu Province.

The findings of this study are consistent with previous research demonstrating that Microsoft Power BI is an effective platform for interactive data visualization and decision support. However, unlike previous studies that primarily focused on dashboard visualization in the education, finance, population, or business sectors, this study integrates Python-based data preprocessing, exploratory descriptive analysis, the Business Intelligence Roadmap, and spatial visualization into a unified analytical workflow for official Families at Risk of Stunting (KRS) data managed by the Bengkulu Provincial BKKBN. This integration is the study's primary contribution, providing a structured Business Intelligence framework to support monitoring and evaluation in the public health sector.

Despite these contributions, this study has several limitations. The analysis was conducted using secondary KRS summary data for the period 2022–2025 and focused on descriptive and exploratory analyses, without applying predictive or machine-learning techniques [16]. Furthermore, the dashboard reflects historical data and therefore does not provide real-time monitoring capabilities. Future studies may incorporate additional demographic and health indicators, apply predictive analytics, or integrate real-time data [sources to further enhance decision support for stunting reduction programs.

5. Conclusions

This study successfully designed and implemented an interactive Business Intelligence dashboard to visualize and map Families at KRS data at the BKKBN Representative Office of Bengkulu Province, using Microsoft Power BI and the Business Intelligence Roadmap. The integration of Python-based data preprocessing with Microsoft Power BI successfully transformed official KRS data into a structured, analysis-ready dataset, enabling interactive visualizations of KPIs, regional comparisons, temporal trend analysis, welfare-level distributions, and geographic mapping.

The developed dashboard provides a comprehensive overview of KRS conditions in Bengkulu Province and supports monitoring, evaluation, and evidence-based decision-making by enabling stakeholders to identify regional disparities, analyze temporal trends, and determine priority intervention areas more efficiently. The integration of Python-based preprocessing, exploratory data analysis, and interactive dashboard visualization demonstrates an effective Business Intelligence approach for improving data utilization within the Bengkulu Provincial BKKBN. Future research may extend this work by incorporating additional demographic indicators, integrating real-time data sources, and applying predictive analytics to further enhance decision support capabilities.

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