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Data Driven Housing Intelligence: A Comprehensive Analysis of Infrastructure, Contractor and Community

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Abstract- Pradhan Mantri Awas Yojana (PMAY) is a flagship initiative by the Government of India aimed at providing affordable housing to the rural and urban poor. However, at the local administrative level (Zilla Parishad), the management of beneficiary data involves processing massive, decentralized Excel datasets. This manual approach leads to data redundancy, lack of real-time monitoring, and significant difficulty in identifying stalled projects. This paper proposes "Data Driven Housing Intelligence," a web-based analytical application designed to automate and centralize PMAY data management. Developed using the Python Flask framework, the system integrates bulk data ingestion, automated data cleaning using the Pandas library, and persistent storage in a structured SQLite database. It features a multi-level drill-down dashboard with interactive visualizations (Bar and Pie charts) for block-wise analysis. Furthermore, it introduces a "Visual Audit" mechanism allowing stage-wise photo uploads for transparency and an automated algorithm to flag delayed projects. The implementation results demonstrate a significant reduction in administrative overhead and improved data accessibility for government officials.

Keywords- E-Governance, Data Analytics, Web Application, Flask, PMAY, Data Visualization, Decision Support System.

I. INTRODUCTION

The digital governance has revolutionized the monitoring and execution of public welfare programs. Among these initiatives, the Pradhan Mantri Awas Yojana (PMAY) stands out as a key program launched by the Government of India, with the objective of ensuring "Housing for All." The extensive nature of this mission results in a substantial and ongoing influx of data concerning beneficiary information, fund allocations, and construction progress. Effective management of this data is essential for maintaining transparency and ensuring the prompt delivery of benefits to both rural and urban impoverished populations. Nevertheless, the existing administrative framework at the district level (Zilla Parishad) encounters considerable difficulties in managing this data. Recent research on E-Governance has pointed out that, although there are platforms available for public data visualization, they frequently lack specialized modules for the bulk ingestion of data from unstructured local sources such as

Excel files, compelling officials to depend on manual data entry [1].
Moreover, current approaches typically involve static, offline analyses utilizing scripts that necessitate technical skills, rendering them inaccessible for routine monitoring by non-technical personnel [2].

While web technologies like Flask have demonstrated their effectiveness in transactional systems such as grievance redressal [3], they have not been fully utilized to develop comprehensive analytical dashboards for housing initiatives. In contrast, intricate architectures designed for Smart Cities utilizing Microservices are often excessively resource-demanding and costly (considered "overkill") for specific departmental requirements, such as a district-level PMAY dashboard [4].

Furthermore, contemporary NoSQL-based educational dashboards may struggle with the intricate relational queries needed to efficiently monitor contractor (RHE) performance across various blocks [5].
To address these identified deficiencies, this project, titled "Data Driven Housing Intelligence," proposes a centralized, lightweight, and automated web application. This application is intended to directly ingest raw Excel data, automate the data cleaning process, and offer interactive, drill-down analytics, thereby transforming the management of housing data

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II. LITERATURE REVIEW

The research titled "Role of ICT in Monitoring Government Schemes: A Case Study of PMAY-G" examines the influence of the national AwaasSoft Management Information System (MIS) on the execution of housing schemes. It emphasizes that centralized digital monitoring significantly mitigates corruption and enhances transparency when compared to traditional manual registers. Nevertheless, the study observes that although the central system is strong, officials at the district level frequently encounter difficulties with inflexible data entry interfaces that do not permit tailored, local-level analysis or swift ad-hoc reporting, thereby highlighting the necessity for more adaptable, localized analytical tools [6].

Research focusing on rural development management underscores the shift from paper-based documentation to digital systems. The article "A Web-Based Management

Information System for Rural Development Schemes" introduces a portal based on PHP and MySQL, aimed at monitoring development funds and the status of beneficiaries. While the system has effectively digitized records, it is heavily dependent on manual data entry through web forms. The research concludes that the absence of bulk data ingestion capabilities presents a considerable obstacle in migrating legacy data from Excel spreadsheets, resulting in delays in the adoption of the system [7].

The investigation titled "Data Visualization Techniques for Effective Governance" delves into the application of Business Intelligence (BI) tools such as Tableau and Power BI within the public sector. The authors illustrate how transforming census and housing data into interactive maps and heatmaps can significantly enhance decision- making processes. However, the study recognizes that these proprietary tools entail substantial licensing fees and steep learning curves, rendering them less accessible for smaller administrative entities like Zilla Parishad in comparison to custom-developed, open-source web applications [8].

The document named "Implementation of E-Governance using Cloud Computing in India" addresses the infrastructural challenges associated with hosting government applications. It posits that conventional on- premise servers are challenging to maintain and advocates for a transition to cloud-based architectures to achieve improved scalability is a crucial aspect.

The research highlights that contemporary web applications designed for scheme monitoring need to be both lightweight and portable to operate effectively in settings with constrained technical resources, thereby underscoring the necessity for efficient frameworks such as Flask in preference to more cumbersome enterprise solutions [9].

The study titled "Automating Public Administration: A Python-Based Approach for Data Analysis" presents an automated methodology that employs Python scripts to produce monthly progress reports from raw government CSV data. By leveraging libraries such as Pandas, the authors realized considerable time savings in contrast to traditional manual processing in Excel. Nonetheless, the study points out a significant limitation: the solution was based on scripts and did not include a Graphical User Interface (GUI), rendering it inaccessible to non-technical officials who need a visual, interactive dashboard instead of code-driven automation [10].

Title & Author	Methodoloy	Limitation s
1.“A Framework for an E-Governa nce Data Visualiza tion Portal"(A. Sharmaetal.)	Developed using PHP, MySQL, and D3.js to visualize existing public database records.	Read- Only: Lacks bulk Excel data ingesti on. Cannot process or clean raw files.
2. Exploratory Data Analysis of Public Welfare Schemes (S. Patel & R. Singh)	Used Jupyter Notebooks, Pandas, and Matplotlib fo r static statistical analysis.	Offline:Static, script-based analysis. Not a real- time, user-friendly tool for officials.
3."A Citizen Grievance Redressal Portal using Flask and NLP" (M. Reddy et al.)	Built with Flask, SQL, and NLP to classify individual user complaints .	Transacti onal:Desi gned for single entries. Not optimized for bulk analytical dashboar ding.
4"Architecting a Scalable Smart City Dashboard" (P. Gupta & Team)	Designed using Java Microservi ces to handle massive real-time sensor streams	High Complexi ty: Resou rce-heavy and expensive . Overkill for a district- level housing dashboar d.

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5."Dashboard for Monitoring Educational Schemes" (J. Fernandes et al.)	Developed using the MERN Stack (MongoDB, React, Node) for student tracking.	Query Efficiency:NoSQL (MongoDB) is less efficient than SQL for complex grouping and counting queries.

III. PROBLEM STATEMENT

The advancement of public administration through digital technologies is an essential requirement for effective governance; however, the implementation of initiatives such as PMAY at the district level frequently suffers due to dependence on outdated technical infrastructures. Administrative entities face a rigid and fragmented data environment, which forces them to rely on legacy systems that create considerable operational inefficiencies and obstruct swift execution [11].

This lack of a centralized, visualized analytical platform leads to several significant issues for both administrative personnel and the overall execution of schemes: Absence of Data Visualization for Decision Making: The existing process is deficient in its ability to convert raw financial data into insightful visual representations. Officials must analyze government expenditures and progress through static tables, which do not effectively reveal critical trends or regional differences. This deficiency in advanced visualization methods complicates the ability of authorities to make prompt, data-informed decisions, often resulting in delayed governance [12].

Inefficiency in Implementing Effective MIS: The deployment of Management Information Systems (MIS) for social welfare initiatives in developing areas is laden with difficulties. The current manual processes for data collection and aggregation are not only labor-intensive but also fail to integrate smoothly with contemporary digital tools. This disconnection leads to a system that is challenging to manage and susceptible to delays, thereby undermining the fundamental objective of social welfare delivery [13].

Lack of Real-Time Infrastructure Monitoring: On the other hand, monitoring the physical advancement of housing units is challenging without a real-time digital connection. The current system does not provide a web-based mechanism to oversee infrastructure projects as they progress on-site. This results in a significant delay between the actual construction status and the data accessible to the administration, complicating the identification of stalled projects and timely intervention.[14]

IV. PROPOSED SYSTEM

The The suggested approach is a centralized, data-centric web platform aimed at resolving the inefficiencies and data management issues typically encountered by Zilla Parishad officials in overseeing the PMAY scheme. By integrating data ingestion, processing, and visualization into a cohesive and secure interface, the system offers a streamlined and dependable analytical experience. The platform automates data cleansing through the use of

Pandas, which has been demonstrated to be effective for public sector data analysis, thereby ensuring high data integrity [15].

The platform is constructed using a lightweight and modular architecture based on the Flask framework, which guarantees efficient performance and ease of deployment on local government servers. It includes a secure user management system to safeguard sensitive beneficiary information [16].

To support data-driven decision-making, the platform features a multi-tier analytical dashboard. It employs advanced visualization libraries to create interactive graphs that instantly display block-wise performance and percentage shares. This visual methodology has been shown to significantly enhance decision- making in local governance [17].

Moreover, the backend is optimized with SQL database structures, which are more effective for these specific government data queries than NoSQL alternatives [18].

Additionally, the system enables officials to effectively visualize housing data, allowing for the identification of regional disparities and the tracking of construction progress in real-time [19].

Ultimately, the incorporation of a Visual Audit Module improves transparency in the public distribution system by associating physical progress images with financial records, thereby ensuring accountability [20].

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V. MODULES DEVELOPED

Fig. 1 Login Page

Figure 1 displays the secure user authentication interface, serving as the system's entry point. The login module guarantees that only authorized individuals can access the dashboard

and administrative functionalities. Users must input valid credentials to authenticate their sessions. The system implements role-based access control, granting administrators comprehensive privileges for data upload and user management, while limiting other users (Viewers) to analytical dashboards and monitoring tools. This authentication framework bolsters system security and mitigates the risk of unauthorized data manipulation.

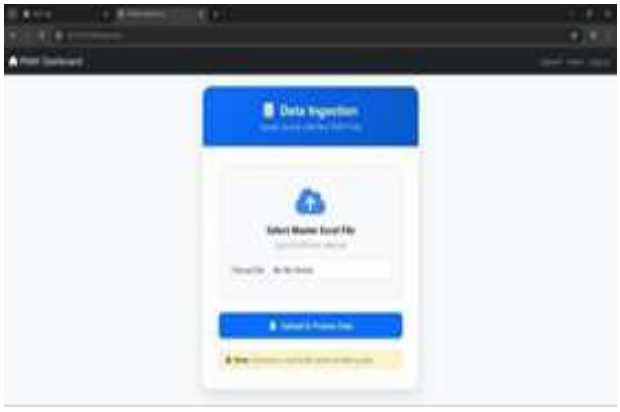

Fig. 2 Data Upload Page

Figure 2 depicts the data ingestion interface, which enables administrators to upload bulk PMAY beneficiary data via master Excel files. This module utilizes the Pandas library to automatically parse and process the uploaded datasets. During ingestion, the system conducts data validation, eliminates inconsistencies (such as empty rows or formatting errors), and prepares the data for structured storage within the SQLite database. This automated workflow supersedes manual spreadsheet processing, significantly alleviating administrative workload and data redundancy.

Fig. 3 Analytical Dashboard

Figure 3 presents the high-level analytical dashboard, offering instant insights into the PMAY scheme through interactive visualizations. The dashboard showcases block-wise statistics via Bar Charts (total sanctioned houses) and Pie Charts (percentage distribution) generated using the Chart.js library. These visual representations enable officials to swiftly comprehend housing distribution, contractor allocations, and scheme performance across various administrative blocks, providing a concise macro-level overview.

Fig. 4 Beneficiary Details Page

Figure 4 illustrates the drill-down interface for beneficiary details, where users can examine individual housing records for a specific block. This page provides comprehensive information including the beneficiary's name, registration number, village, assigned Rural Housing Engineer (RHE), and fund release status. Furthermore, the interface incorporates a dynamic Dual-Search Algorithm, allowing officials to swiftly filter thousands of records by utilizing either the RHE Name or Beneficiary Name simultaneously.

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Fig. 5 Visual Audit Module

Figure 5 showcases the visual audit module, which enables field officers to upload geo- tagged photographs of construction stages for each beneficiary project. The images uploaded correspond to specific phases: Foundation, Lintel Level, Roof Level, and Completion. This functionality establishes a digital verification trail that enhances transparency and ensures that the reported financial progress aligns with the actual physical construction activities occurring on-site.

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