

ARTICLE 7

Biometric Systems and the Problem of Usability: A Governance-Centric Intervention in Attendance Management

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Abstract

Biometric attendance systems have improved the authenticity of attendance recording in public offices, but remain largely confined to generating static data with limited administrative usability. This article addresses this gap through an in-house, practice-based intervention developed within a large public office. The intervention introduces a role-based interpretive layer over the existing Aadhaar Enabled Biometric Attendance System without modifying the underlying biometric infrastructure. By aligning attendance data with supervisory structures, coordination groups, Branch Officers, and sections, the system enables decentralised access, reduces manual processing, and supports evidence-based administrative action. Developed and coded by the author with iterative testing support from an internal team, the system is under continuous development and demonstrates how modest, configuration-driven digital interventions can convert biometric attendance from a compliance record into an effective governance tool for the public sector.

Keywords

Biometric Attendance Systems, Public Sector Governance, Administrative Usability, Role-Based Access, Attendance Management, Digital Public Administration, E-Governance and Behavioural Nudging.

7.1 Introduction

“The most serious mistakes are not being made as a result of wrong answers, but as a result of asking the wrong questions,” observed Peter Drucker. Few observations capture the challenge of contemporary digital governance better.

Imagine an office where biometric attendance is recorded flawlessly every day (BIOMETRIC ATTENDANCE, n.d.), yet a Branch Officer cannot readily answer a basic administrative question: Which employees in my section were absent today, and why? This paradox lies at the heart of many digital reforms. Data exists in abundance, but decision-ready information does not. Attendance is digitally captured, yet administrative control remains analogue. This disconnect between accurate data and usable information frames the problem that this article seeks to address.

7.2 Background and Context

Biometric attendance under the Aadhaar Enabled Biometric Attendance System (AEBAS) has standardised attendance recording in public offices by digitally capturing daily attendance data (NIC, n.d.) However, this data is typically available only as static spreadsheets and is not aligned with internal supervisory structures. As a result, although attendance data is centrally held by a nodal officer, Branch Officers who are responsible for supervision, casual leave regulation, and disciplinary control lack section-wise, usable information for timely administrative action.

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The Office of the Accountant General (A&E), West Bengal, was taken as a case study to examine this gap. The office is organised into four coordination groups Administration, Funds, Pension, and Accounts with approximately thirty-nine Branch Officers supervising multiple sections and employees. Despite this clearly defined structure, biometric attendance data is available only at a broad group level, limiting its practical usefulness for Branch Officers and senior management.

Recognising this disconnect between digital attendance data and administrative needs, an in-house initiative was undertaken in the West Bengal AG (A&E) Office to develop a role-based system that aligns attendance information with the existing administrative hierarchy. The intervention aimed to improve usability and accountability while retaining the existing biometric attendance infrastructure.

“This article presents a practice-based, in-house digital intervention implemented within a large public office to address this governance gap.”

7.3 Comparison between the Existing Biometric Attendance System and the Proposed Interpretive System.

Parameter	Official AEBAS Portal	Proposed Interpretive System	Difference
Sub-Nodal Restricted	View Technically Possible but Rigid: Manuals allow "Report Viewers." However, they see a flat list of the entire organisation or specific designations (NODAL MANUAL)	Section-Specific: Automatically isolates data so a Branch Officer (BO) sees only their specific sections. Further filtering between sections allowed.	Difference: AEBAS provides a "Window" to the whole office; the new system provides a "Mirror" of just the BO's team.
Custom Messaging	Automated Only: The portal sends SMS/Email alerts based on fixed triggers (e.g., "Absent"). The Sub-Nodal cannot type a custom text to a group (BAS USER MANUAL)	Manual & Strategic: Allows the BO or Admin to send specific custom messages (e.g., "Meeting in Hall A at 10 AM for all present staff" or "Legal Cell reporting most absentees").	Difference: AEBAS is a "Robot"; the new system is a "Broadcasting Tool."
Individual Performance	Fragmented: Visible only to the Individual Employee or the Nodal Officer via manual search. (EMPLOYEE MANUAL)	Comparative: Displays an individual's performance alongside their section average and peers.	Difference: AEBAS shows a "Selfie"; the new system shows a "Team Photo" for comparison.

Dashboard	Static/Tabular: Shows raw "In/Out" logs and basic counters. (NODAL MANUAL)	Interactive/Analytical: Uses Python to show trendlines, "Punctuality heatmaps," and charts.	Difference: AEBAS is a "Logbook"; the new system is an "Analytics Suite."
Top & Worst Performers	Non-Existent: No feature in the manuals identifies "Most Regular" or "Chronic Defaulters" automatically.	Automated Ranking: Instantly generates a "Top 10" and "Bottom 10" list daily.	Difference: You save hours of manual Excel sorting to find the slackers.
Nudging (Behavioural)	None: The system is purely for record-keeping.	Core Logic: Uses "Social Proof" (visibility of performance) to drive change. (Richard H. Thaler and Professor Cass R. Sunstein, April 8, 2008)	Difference: AEBAS is "Big Brother"; the new system is "Peer Pressure."
OD/Tour Filtering	Binary: If you don't punch, you are "Absent." Requires manual reconciliation at month-end (BAS USER MANUAL)	Integrated Reconciliation: Allows the BO to mark "On Duty" status before looking at the daily defaulter list.	Difference: Reduces 90% of the "Wrongful Absence" complaints to HR.

7.4 Why a New System became Necessary

Essentially, the existing biometric attendance system functions as a data capture mechanism, not as an attendance management system. It generates accurate raw data but fails to align with:

- the hierarchical administrative structure of the office,
- the decision-making needs of Branch Officers,
- the oversight requirements of senior management, and
- the operational realities of field duties and inspections.

It also includes a feature that allows customised messages to be issued at the branch officer or administrative level, enabling communication to be sent simultaneously to all concerned employees of a specific section.



This gap between data availability and data usability created the need for a new system one that could sit over the existing biometric infrastructure and transform static attendance logs into a role-specific, section-wise, and accountability-driven administrative tool.

7.5 Objectives of the New Attendance System

The new attendance management system was conceptualised and developed with the primary objective of bridging the gap between biometric attendance data generation and effective administrative control.

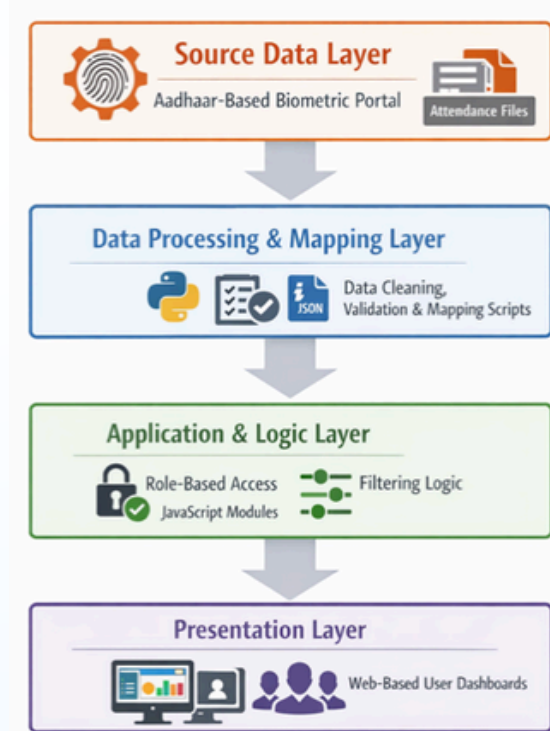
Objective Area	Concise Statement of Objective
Actionable Data Use	Transform static biometric attendance files into interactive, decision-oriented administrative information.
Administrative Alignment	Align attendance data with the actual hierarchy of coordination cells, Branch Officers, and sections.
Controlled Decentralisation	Enable role-based access that empowers Branch Officers while retaining senior-level oversight.
Accountability	Institutionalise systematic, evidence-based attendance monitoring at multiple administrative levels.
Efficiency & Accuracy	Reduce manual effort and human error through automated data processing and presentation.
Analytical Insight	Generate comparative and trend-based attendance analytics to support informed management decisions.
Operational Realism	Incorporate legitimate field duties and official engagements into attendance assessment.
Transparency & Compliance	Promote punctuality and self-compliance through transparent visibility and automated alerts.
Scalability	Create a modular, future-ready system capable of expansion without structural redesign.

7.6 Technical Architecture and Methodology

The codebase reflects a governance-first design philosophy:

- Python was used for data cleaning, validation, and master mapping
- JSON files were used to encode administrative logic transparently
- JavaScript handled role-based filtering and user interaction
- HTML/CSS provided a clean, minimal interface focused on usability

“The system was developed using an iterative, design-based methodology, with continuous validation against real administrative workflows.”



7.7 Process Narrative: System Workflow and Use of Code

The attendance management system was developed as an interpretive layer over the existing biometric attendance infrastructure, using a combination of Python, JavaScript, and standard web technologies, each applied at a distinct stage of the workflow.

The process begins with the ingestion of raw biometric attendance files generated by the Aadhaar Enabled Biometric Attendance System. These files, typically in Excel format, are first analysed using Python-based data processing routines. Python was used at this stage for its strength in handling tabular data, enabling systematic parsing of attendance files, inspection of data schemas, detection of missing supervisory linkages, and identification of inconsistencies between attendance data and existing master records.

Following this diagnostic phase, the administrative structure of the office comprising coordination groups, Branch Officers, and sections was formally encoded using configuration-driven logic. This logic was expressed through structured configuration objects, generated and validated using.

Python and subsequently consumed by the application layer. Encoding the hierarchy as configuration rather than hard-coded rules ensured transparency, auditability, and ease of modification when organisational structures change.

Step	Implementation Stage	What Was Done	Logic / Code Functionality Used
Step 1	Raw Data Analysis	Examined biometric attendance outputs and master datasets to identify missing linkages and inconsistencies	Data parsing routines to read Excel inputs, schema inspection logic, mismatch and gap detection algorithms
Step 2	Administrative Hierarchy Encoding	Encoded Branch Officer–Section–Group hierarchy as system control logic	Configuration-driven mapping logic using structured data objects to define supervisory boundaries
Step 3	Employee Master Mapping	Created and normalised a permanent employee master linked to attendance ID, section, group, and Branch Officer	Entity-mapping logic ensuring one-to-one relationships; validation routines to enforce uniqueness and integrity
Step 4	Role-Based Access Design	Implemented differentiated system access for nodal, Branch Officer, and admin users	Role-based access control (RBAC) logic with permission-driven data filtering at the application layer
Step 5	Attendance Upload & Reconciliation	Enabled daily ingestion of biometric attendance files and automated reconciliation	File ingestion logic, ID-matching algorithms, and automated assignment to supervisory units
Step 6	Branch Officer Restricted Views	Presented section-specific attendance views to Branch Officers	Dynamic filtering logic rendering data based on mapped authority and user role
Step 7	Admin & Nodal Reporting	Enabled organisation-wide visibility and comparative attendance analytics	Aggregation and summarisation logic generating branch-wise and section-wise insights
Step 8	Validation & Data Hygiene	Continuously verified data integrity prior to expansion or analytics	Iterative validation routines detecting orphan records, duplicates, and classification mismatches

Sl. No.	Function Enabled	User Level	Administrative Purpose / Use
1	Role-based login authentication	All users (Nodal, BO, Admin)	Ensures secure access and prevents unauthorised viewing or manipulation of attendance data
2	Daily biometric attendance file upload	Nodal Officer	Centralised and controlled ingestion of attendance data from biometric portal
3	Automated attendance ID matching	System (Backend)	Eliminates manual reconciliation and ensures accuracy in employee identification
4	Employee–Section–BO mapping	System (Backend)	Aligns attendance data with actual supervisory and administrative hierarchy
5	Restricted attendance visibility	Branch Officers	Enables BOs to monitor only employees under their jurisdiction
6	Organisation-wide visibility	Admin / Senior Officers	Enables top-level oversight across all branches, sections, and groups
7	Daily attendance status view	BOs, Admin	Enables quick assessment of present and absent employees
8	Date-wise attendance filtering	BOs, Admin	Facilitates retrospective attendance review for specific dates
9	Absent-only filter	BOs, Admin	Enables quick identification of defaulters without scanning full lists
10	Section-wise attendance display	Branch Officers	Supports targeted supervisory action at section level
11	Branch Officer-wise aggregation	Admin	Enables comparative assessment of attendance discipline across branches
12	Dashboard-based analytics	Admin / Nodal	Supports evidence-based management and strategic oversight
13	Identification of frequent absentees	Admin / BOs	Enables focused administrative intervention and counselling
14	Identification of regular employees	Admin	Supports recognition of consistent compliance and positive behaviour
15	Monthly attendance report generation	Admin / Senior Officers	Facilitates periodic review, accountability meetings, and documentation
16	Exception handling for field duty	Authorised Officers	Prevents penalisation of employees on legitimate official duty
17	Attendance data transparency	BOs, Admin	Reduces ambiguity and informal discretion in attendance monitoring
18	Automated attendance alerts / messaging	Employees (system-triggered)	Nudges self-compliance and reduces need for supervisory follow-up
19	Reduction of manual Excel handling	All supervisory levels	Saves administrative time and reduces clerical errors
20	Configuration-driven structure updates	Admin / System	Allows easy adaptation to organisational changes without code modification
21	Scalability for future analytics	Admin / System	Enables future expansion such as trend analysis and performance metrics

A permanent employee master dataset was then created and normalised. Python validation logic was again used to enforce one-to-one mappings between employees, attendance identifiers, sections, and Branch Officers, and to eliminate duplicates or orphan records. This validated master dataset became the authoritative reference against which all daily attendance data is reconciled.

The application layer was implemented using JavaScript, which handled role-based access control and data filtering. JavaScript logic dynamically determines what portion of the attendance data is rendered to a user based on their administrative role nodal officer, Branch Officer, or senior administrator. This ensured that the same underlying dataset could be reused while enforcing strict, authority-aligned visibility.

Daily attendance uploads are initiated through a web interface built using HTML and CSS, providing a simple, role-specific user interface. Once a file is uploaded by the nodal officer, backend processing logic matches attendance identifiers with the validated employee master using automated reconciliation algorithms, assigning each record to the appropriate section and Branch Officer without manual intervention.

Finally, JavaScript-based aggregation and filtering routines generate section-wise views for Branch Officers and organisation-wide summaries for senior management. Throughout the process, iterative validation logic implemented primarily in Python is used to maintain data integrity as new attendance files are processed and as the system continues to evolve.

In combination, Python enables robust data processing and validation, JavaScript enables dynamic role-based logic and presentation, and standard web technologies provide accessible user interaction.

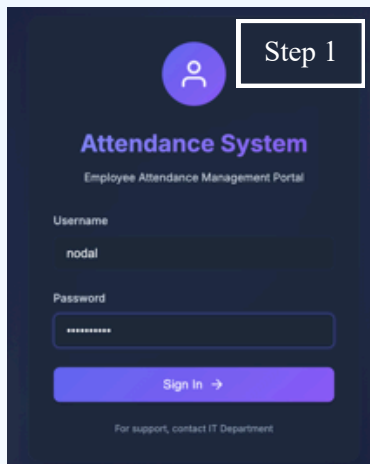
Together, these components transform static biometric attendance records into a structured, administratively usable system while leaving the underlying biometric infrastructure unchanged. Rather than replacing the biometric system, the code acts as an intelligent interpretive layer, converting raw attendance logs into administratively meaningful information.

7.8 Key Benefits throughout the Project

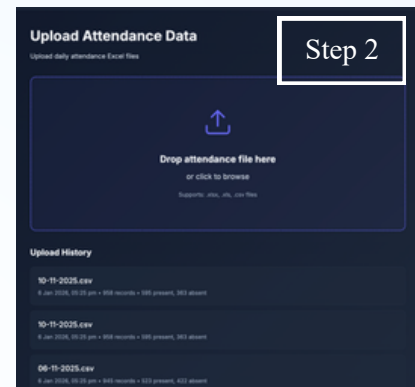
1. Administrative Usability of Biometric Data
 - a. Example: Daily Excel attendance files downloaded from AEBAS were automatically parsed, reconciled, and displayed as section-wise attendance views, enabling supervisors to identify absentees without manual sorting.
2. Alignment with Supervisory Hierarchy
 - a. Example: Attendance records were mapped to coordination groups, Branch Officers, and sections using configuration-driven hierarchy logic, ensuring that data visibility reflected actual administrative control.
3. Decentralised Accountability
 - a. Example: Each Branch Officer was provided a restricted login showing attendance only for employees under their sections, while senior officers retained organisation-wide visibility through an admin interface.
4. Reduced Manual Effort and Error
 - a. Example: Automated reconciliation of attendance IDs with a validated employee master eliminated repetitive spreadsheet handling and reduced errors arising from manual filtering and interpretation.
5. Timely Enforcement of Attendance Rules
 - a. Example: Branch Officers could immediately identify section-level absenteeism and initiate casual leave regulation based on daily, system-generated attendance views rather than delayed manual scrutiny.
6. Evidence-Based Oversight
 - a. Example: Aggregated views enabled comparison of attendance patterns across sections and Branch Officers, allowing senior management to base administrative reviews on objective trends rather than anecdotal reports.
7. Accommodation of Operational Realities
 - a. Example: The system allowed authorised officers to filter attendance data to account for legitimate official duties such as inspections or meetings outside office premises, preventing misclassification due to geofencing constraints.
8. Behavioural Nudging Without Coercion
 - a. Example: Clear visibility of attendance status and planned automated alerts made attendance outcomes predictable to employees, encouraging punctuality without introducing new disciplinary measures.
9. Non-Disruptive and Cost-Effective Reform
 - a. Example: The intervention operated entirely over existing biometric attendance outputs, avoiding changes to AEBAS, statutory rules, or procurement of new hardware or software platforms.
10. Scalable and Replicable Design
 - a. Example: The configuration-driven architecture allows additional offices or divisions to be incorporated by updating supervisory mappings without altering core system logic.

(The screenshots in the following pages depict the portal hosted on a local server; certain features of which are currently under development.)

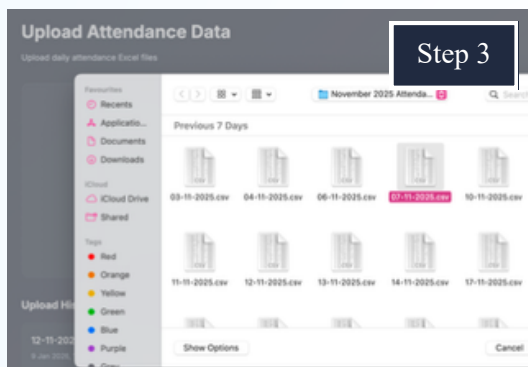
7.9 Step-wise Visual Representation of the Developed Attendance Management Portal



Step 1- This figure depicts the landing page of the portal, which serves as the common login interface. Designated users including the Nodal Officer, Branch Officers etc. access the system through their respective unique login credentials.

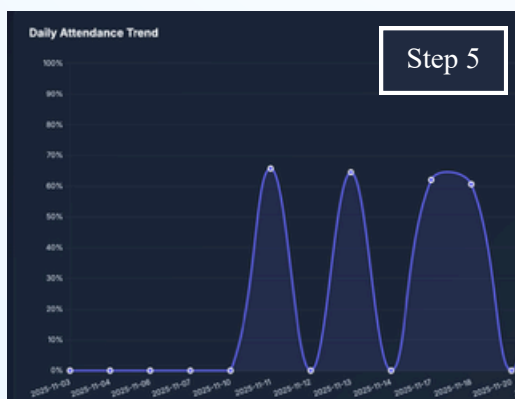
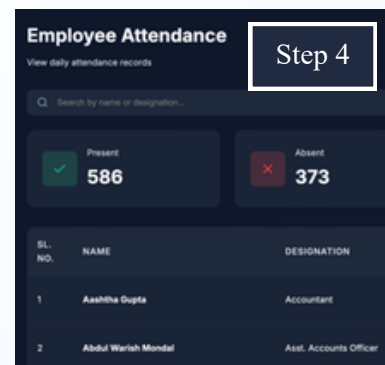


Step 2- This screen shows the nodal user interface after login, where the designated nodal officer is provided with the option to upload attendance files. At present, the system supports attendance data uploads in Excel and CSV formats.

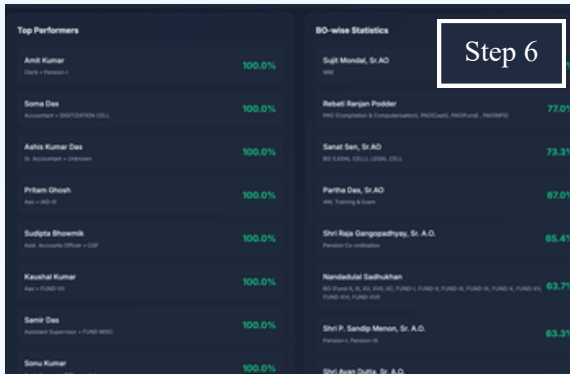


Step 3- The nodal officer can simply select and upload the daily attendance file downloaded from the biometric portal for the relevant date.

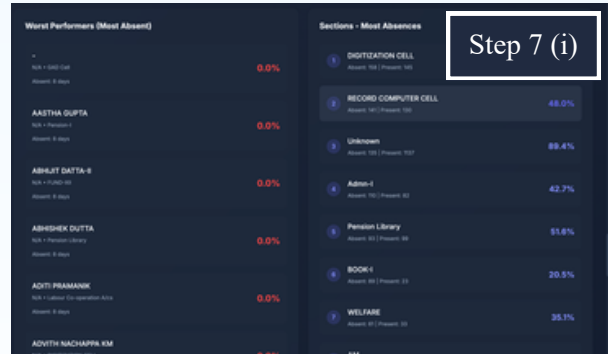
Step 4- Upon upload, the data is automatically populated, and key attendance metrics are displayed.



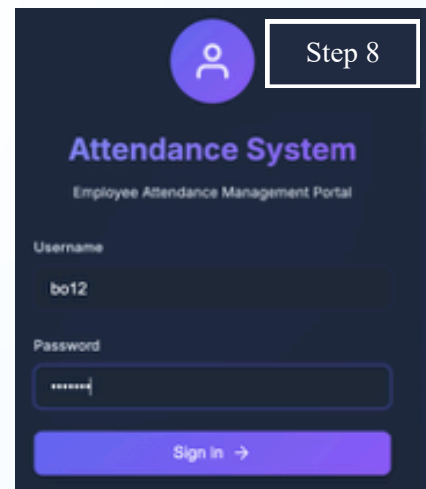
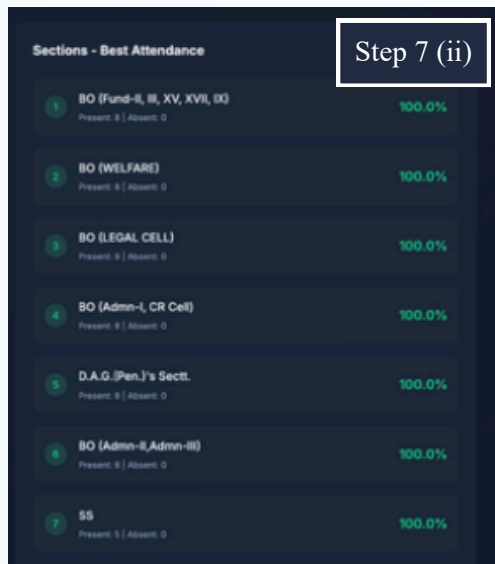
Step 5- Section-wise attendance metrics, along with additional summary indicators, are displayed on the dashboard. Attendance trends are also displayed through a trendline for analytical reference.



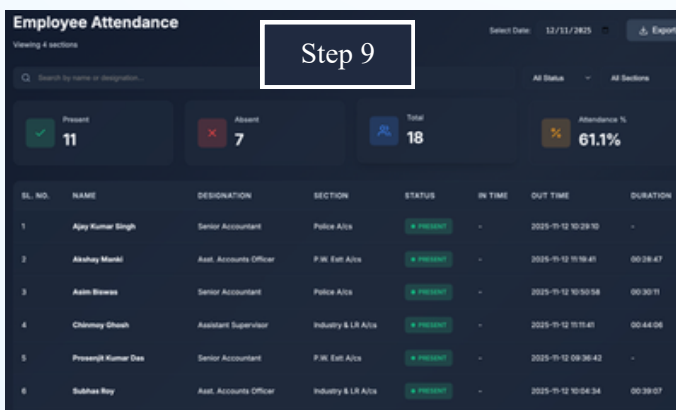
Step 6- Branch Officer-wise performance and employees identified as best performers are displayed, Section wise data is also visible.



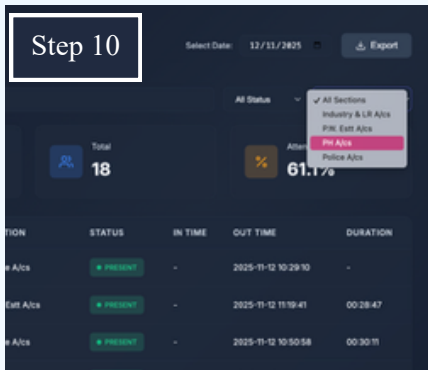
Step 7- Employees with frequent absenteeism are identified and displayed separately as defaulters.



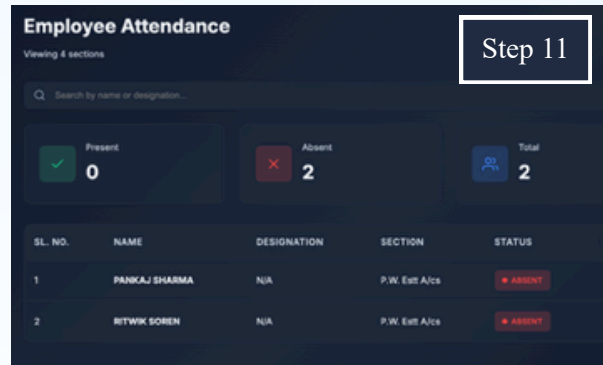
Step 8: Each Branch Officer is provided with a unique login ID, granting restricted access limited to attendance data for employees under their respective sections.



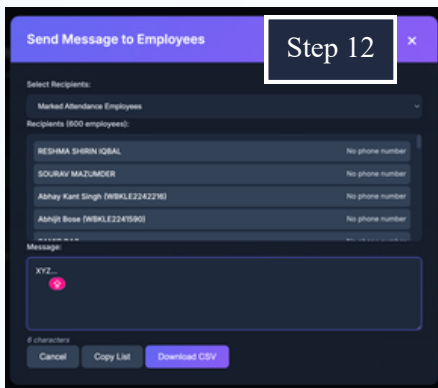
Step 9: Upon login, the Branch Officer is shown a restricted view displaying attendance data only for employees under his or her respective section.



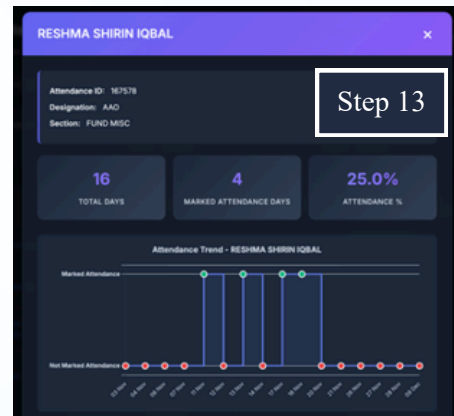
Step 10: The interface provides multiple filters, including section-wise and present/absent filters, to enable focused attendance review.



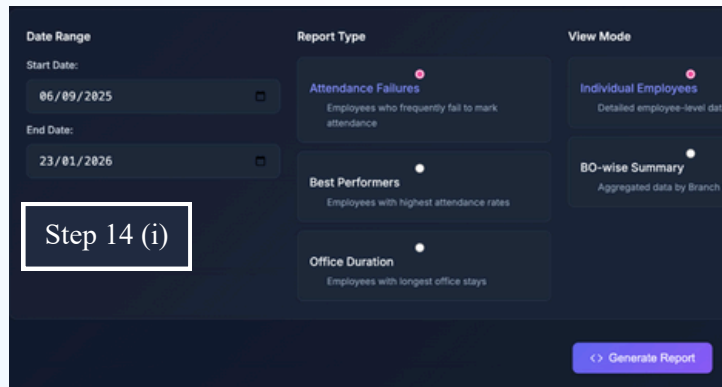
Step 11: This step illustrates the functioning of the applied filters, demonstrating how attendance data is dynamically refined based on the selected criteria.



Step 12: A custom message can be sent to employees based on any appropriate filter used.



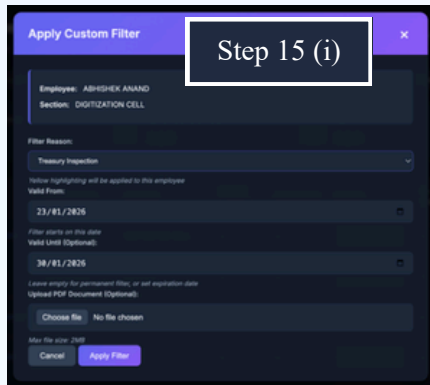
Step 13: Employee wise attendance trend is also available to be viewed.



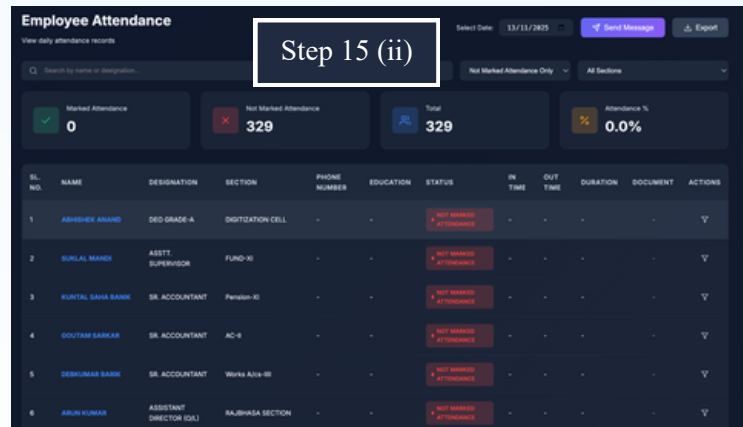
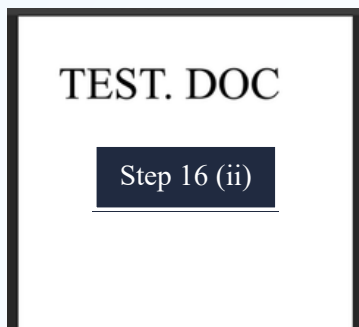
Step 14: Report generation feature – customisable

Report generated in pdf format.

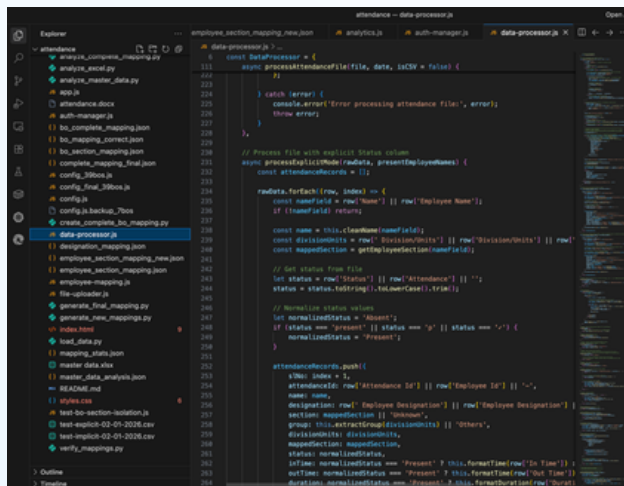
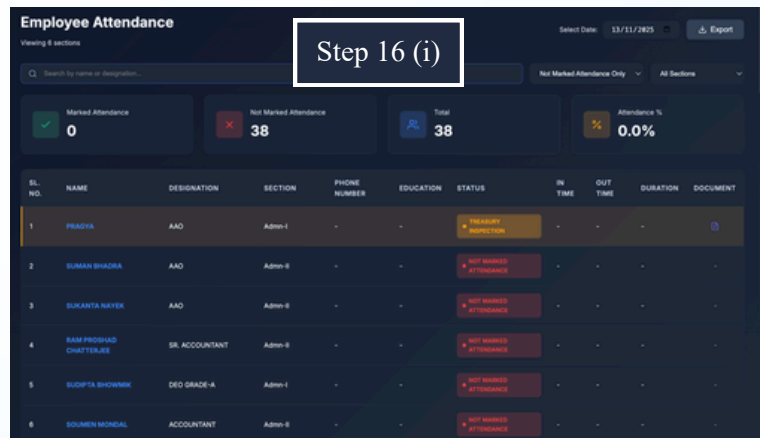




Step 15: A custom filter can be used to mark people who are not absent but either on treasury inspection, official tour etc. Office order or relevant doc can be attached.



Step 16: The filter is applied using an action option by the nodal officer, and the concerned BO will then have the particular employee visible in a different way (yellow). In this case, the concerned office order or relevant document can also be downloaded by the BO. Here 'test.doc' is the attached order.



This snapshot represents a simplified view of the extensive code logic operating in the background to support the system's functionality.

7.10 Conclusion

This project demonstrates that digital reform in public administration is effective only when technological systems are aligned with institutional authority and accountability. The behavioural impact of the system can be understood through the lens of behavioural economics. As Thaler and Sunstein argue in *Nudge*, a nudge is “any aspect of the choice architecture that alters people’s behaviour in a predictable way without forbidding any options or significantly changing their economic incentives.” (Thaler and Sunstein, 2008) The attendance framework described in this article operates precisely in this manner: by restructuring how attendance information is presented making it timely, visible, and role-specific it encourages punctuality and compliance without introducing new sanctions or coercive controls. Behavioural change emerges not from enforcement alone, but from redesigned administrative visibility

By introducing a role-based interpretive layer, attendance data is aligned with actual supervisory responsibility, restoring the linkage between information, authority, and accountability. The transformation of static attendance logs into intelligible, section-wise views reduces manual effort, improves accuracy, and enables timely administrative action while accommodating operational realities.

More broadly, the system enables continuous, evidence-based oversight without excessive surveillance and offers a scalable, replicable model for public institutions. It thus contributes to pragmatic e-governance by demonstrating how modest, well-designed digital interventions can significantly strengthen routine administrative practice.

The system has been conceptualised and coded by the author, with active testing, validation, and iterative refinement. This in-house development approach has enabled continuous experimentation within a real administrative environment, allowing the system to evolve responsively rather than as a static technological product. Certain features remain under development, reflecting the project’s incremental and adaptive design philosophy.

Data Availability

The study is based on publicly available data. All data used in this research are accessible from open sources and properly cited within the article. I confirm that any data sharing adheres to principles of privacy and confidentiality, especially for studies involving human subjects.

Ethics Statement

I confirm that the research presented in this manuscript was conducted in an ethical and responsible manner. I confirm that the data presented in this manuscript are authentic and accurate, and that no data fabrication, falsification, or manipulation has occurred. I understand that plagiarism, self-plagiarism, redundant publication, and other forms of research misconduct are strictly prohibited. I confirm that this manuscript is free from such misconduct.

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Conflict of Interest

No Conflict of Interest.

References

1. National Informatics Centre. (n.d.). Aadhaar enabled biometric attendance system. Government of India. Retrieved March, 2026, from <https://attendance.gov.in/>
2. National Informatics Centre. (2018). BAS user manual. Government of India. https://attendance.gov.in/assets/doc/bas_manual.pdf
3. National Informatics Centre. (2016). Employee manual. Government of India. https://aiims.attendance.gov.in/assets/doc/employee_manual_v1.pdf
4. National Informatics Centre. (2016). Nodal manual. Government of India. https://attendance.gov.in/assets/doc/nodal_manual_v1.pdf
5. Thaler, R. H., & Sunstein, C. R. (2008). Nudge: Improving decisions about health, wealth, and happiness. Yale University Press.