Smart Doctor Appointment Systems via ICT

Rajvardhan Kale[1], Aditya Karhadkar[2], Atharv Lanke[3], Siddhesh Katale[4], Anuraj Lonkar[5], Anurag Lonkar[6]
Vivek Nagnath[7]
[1]*Vishwakarma Institute of Technology, Solapur, India*
[2]*Vishwakarma Institute of Technology, Pune, India*
[3]*Vishwakarma Institute of Technology, Ahmednagar, India*
[4]*Vishwakarma Institute of Technology, Solapur, Rajgurunagr*
[5]*Vishwakarma Institute of Technology, Baramati, India*
[6]*Vishwakarma Institute of Technology, Akola, India*
[7]*Vishwakarma Institute of Technology, Pune, India*

***Abstract*—In the changing world of digital healthcare, securely and efficiently managing patient-related documents is essential for effective medical service delivery. The growing amount of medical records, diagnostic reports, prescriptions, and personal health information poses a significant challenge for healthcare institutions regarding accessibility, security, and organization. To tackle these issues, this paper suggests developing a Point Assistance System. This system will be part of a web-based platform designed to manage patient documents. It allows for real-time upload, classification, retrieval, and management of patient files through a centralized, encrypted database that only authorized users can access.**

The platform uses a role-based access control (RBAC) model. This ensures that patients, doctors, and administrators interact with the system based on their access privileges. It helps maintain data integrity and confidentiality. A point-based assistance system is included to prioritize document handling tasks. It assigns urgency levels to incoming records and supports workflow automation for healthcare staff. This feature also helps patients track their interaction history and get guided support through the system. The front end is designed with user-friendly principles for smooth navigation. The backend uses secure technologies for storage and data processing.

The system was tested in a simulated healthcare environment. Initial results show a significant improvement in document retrieval speed, user satisfaction, and data traceability compared to traditional paper-based and disorganized digital systems. The solution also meets basic healthcare data protection standards like HIPAA and GDPR, ensuring compliance and the ability to grow. This research sets the stage for future connections with Electronic Health Record (EHR) systems, machine learning-based document analysis, and mobile app support to further improve patient care through digital innovation.

Keywords—Information and Communication Technology (ICT), Smart Healthcare, Online Appointment System, E-Health, Telemedicine, Electronic Health Records (EHR), Patient Management.

I. INTRODUCTION

The healthcare industry is experiencing a major shift due to the need for digitization, efficiency, and patient-centered care. One of the biggest challenges for hospitals, clinics, and medical institutions is managing patient documents and medical records effectively. These documents, such as prescriptions, lab results, diagnostic images, treatment notes, discharge summaries, and consent forms, are essential for providing accurate and timely care. However, traditional paper storage systems are becoming outdated because they are prone to damage, loss, duplication, and inefficiency in retrieval. Even current digital solutions often face problems like fragmentation, lack of integration, and poor user interfaces, which hurt usability and workflow.

To tackle these issues, this paper introduces a solution called the Point Assistance System. This secure and scalable web-based platform is designed to manage patient documents. It focuses on three main users: patients, healthcare professionals (doctors, nurses), and administrators. The system allows users to upload, categorize, securely store, and access documents based on their roles in real time. A point-based assistance feature helps prioritize tasks and streamline the document processing workflow. This feature assigns points based on urgency, document type, and user interactions, helping healthcare staff manage their workloads better and ensuring that important tasks get addressed quickly.

The platform uses modern web technologies with a focus on responsive design, data encryption, and user accessibility. Important features include an easy-to-use dashboard, document categorization, search options, document version tracking, and an automated alert system. Additionally, the role-based access control (RBAC) model ensures users only see data relevant to their roles, maintaining strict compliance with global data protection laws like the Health Insurance Portability and Accountability Act (HIPAA) and the General Data Protection Regulation (GDPR). These measures protect the confidentiality and integrity of patient data.

The development of this system also considers future scalability, integration with Electronic Health Record (EHR) systems, and potential upgrades using artificial intelligence (AI) for automated document analysis and recommendation systems. We evaluated its performance in a controlled environment to assess usability, data handling speed, and user satisfaction. Early tests show a significant improvement in document retrieval time, a reduction in administrative workload, and better user interaction compared to traditional systems.

In summary, the proposed Point Assistance System offers a practical way to improve document management in healthcare environments. By using modern technology and smart workflow features, the system aims to play a valuable role in the ongoing digital transformation in healthcare, boosting both operational efficiency and the quality of patient care.

II. LITERATURE REVIEW

Healthcare services have experienced a fundamental transformation since recent developments in Information and Communication Technology (ICT) particularly regarding the management of patient appointments and records. Online appointment systems function as replacements for traditional booking methods because they provide users with better accessibility together with enhanced efficiency and convenience. The research conducted by Selvaraj and Subramani (2013) shows that Indian hospitals acknowledge the value of healthcare ICT yet adoption remains low because of infrastructural limitations and insufficient user awareness. The research points out service quality variations along with the absence of standardized features throughout hospital websites[1].

The Mr. Doc system functions as an Android-based doctor appointment application which streamlines patient scheduling while enhancing healthcare accessibility for patients. The research points out that current appointment booking methods force patients to physically visit hospitals while experiencing lengthy waiting periods. Mr. Doc offers a mobile technology-based solution that unifies a central database for doctor and patient information management.[2].

The healthcare system continues to struggle with ongoing problems in appointment scheduling and patient-doctor communication and resource distribution. Traditional appointment systems generate multiple problems which include extended waiting periods and scheduling conflicts and inadequate patient participation. The problem has been addressed through different technological solutions which include online booking systems and telehealth services and smart scheduling algorithms. [3]

Healthcare organizations need appointment scheduling because it determines how patients reach services and how providers operate and how the entire system functions. The traditional scheduling systems encounter difficulties when handling unpredictable patient arrival times and varying service durations and fluctuating provider work schedules which results in extended waiting periods and wasted resources.[4].

Healthcare service delivery depends heavily on effective appointment scheduling because it determines patient satisfaction levels and resource management efficiency and service accessibility. Traditional appointment systems create three main problems which include extended waiting periods and scheduling conflicts and operational inefficiencies that harm both patients and healthcare providers. Different appointment systems including Interactive Voice Response (IVR) and web-based applications and Unstructured Supplementary Service Data (USSD) have been created to solve these problems.[5].

III. COMPONENTS AND THEIR WORKING

The proposed Point Assistance System consists of several integrated components, each designed to contribute toward secure, efficient, and user-friendly patient document management. The major components and their functionalities are described below:

A. User Management Module
The system includes this component which enables users to register and authenticate their accounts and receive role assignments. Users receive classification into three main groups which consist of Admins and Doctors and Patients. The system grants every user access to different resources according to their assigned role through Role-Based Access Control (RBAC). The system configuration and user permissions fall under admin control while doctors maintain patient documents and patients have access to their medical information.

Working:
- Upon registration, users are authenticated via secure login.
- Role-specific dashboards and permissions are loaded dynamically.
- Passwords are encrypted using hashing algorithms (e.g., bcrypt or SHA-256).

B. Document Upload and Storage Module
Medical professionals together with administrative staff use this module to upload medical documents which consist of prescriptions and diagnostic reports and discharge summaries. The system organizes documents by category before saving them in either cloud storage or local databases which include metadata information about each document such as upload date and document type and patient ID.

Working:
- Files are uploaded through a form with input validation.
- Each file is tagged with metadata and stored in a structured directory or database.
- Redundant files are checked using hash matching to prevent duplication.

C. Point-Based Assistance Engine
A unique feature of the system, this engine assigns points to documents or requests based on urgency, document type, and user behavior. Higher-point tasks are prioritized on the admin and doctor dashboards for quick attention.

Working:
- A scoring algorithm assigns points (e.g., Lab Report = 10, Emergency Note = 50).
- A task queue prioritizes high-point items for faster processing.
- The system dynamically updates the queue as new documents are uploaded.

D. Search and Retrieval System
This component enables users to search for documents using multiple filters such as date, type, doctor's name, or keywords. Advanced search capabilities are provided using full-text indexing and query optimization.

Working:
- Search queries are processed through an indexed database (e.g., Elasticsearch or SQL-based).
- Results are sorted by relevance and user access rights.
- Pagination and preview features are included for ease of access.

E. Notification and Alert System
The system sends real-time notifications and alerts to users for critical updates such as new document uploads, appointment reminders, and system actions.

Working:
- Notification events are triggered by system actions (e.g., document upload).
- Users are alerted via email, SMS, or in-app popups.
- A scheduler component handles recurring alerts.

F. Security and Compliance Layer
This component ensures that all operations within the system adhere to medical data privacy regulations such as HIPAA and GDPR.

Working:
- All document uploads are encrypted during transmission (HTTPS/SSL).
- Access logs and audit trails are maintained for all user activities.
- Sensitive information is masked or restricted based on user role.

G. Admin Dashboard

An interactive dashboard for system administrators to monitor user activity, manage uploads, oversee point queues, and generate reports.

Working:
- Displays real-time system analytics (e.g., number of uploads, active users).
- Admins can add or deactivate users and view logs.
- Includes data export functionality for reporting and compliance.

Flow Chart:

Start
↓
User Login (Admin / Doctor / Patient)
↓
Role-Based Dashboard (Based on user type)
↓
Upload / View Documents
- Doctor / Admin: Upload
- Patient: View
↓
Point Assignment Engine → Assigns urgency score
↓
Task Queue Prioritization → Sorts based on point values
↓
Document Search and Retrieval → Filters and keyword search
↓
Notifications System → Email / SMS / In-App alerts
↓
Secure Storage and Audit Logs → Encrypted storage and compliance
↓
End

V. RESULTS AND ANALYSIS

The Point Assistance System was implemented and evaluated in a simulated hospital environment involving three types of users: administrators, doctors, and patients. The primary objective of the evaluation was to assess the system's efficiency, user satisfaction, document retrieval speed, and the effectiveness of the point-based prioritization engine.

A. Document Upload and Retrieval Performance

The system was tested with over 500 simulated patient records including prescriptions, lab reports, and discharge summaries. Document retrieval time was recorded across multiple search filters (e.g., date, document type, and patient ID). The average document retrieval time was reduced to 1.4 seconds, compared to 5–8 seconds in conventional hospital information systems. This improvement is attributed to indexed search capabilities and optimized data structures.

Metric	Existing System	Point Assistance System
Avg. Upload Time (sec)	6.5	3.2
Avg. Retrieval Time (sec)	5.9	1.4
Duplicate Record Errors	High	None Detected

B. User Feedback and Usability

A usability test was conducted involving 15 users (5 from each role). The System Usability Scale (SUS) was employed to quantify user experience. The average SUS score across all user groups was 87.3, indicating a high level of satisfaction.

User Group	Avg. SUS Score
Administrators	88.0
Doctors	85.5
Patients	88.5

Participants appreciated the clear role-based interface, responsive design, and instant feedback provided by the notification system. Minimal training was required for new users to navigate the system effectively.

C. Effectiveness of the Point-Based Assistance Engine

To evaluate the priority queuing system, time-to-action metrics were collected. Urgent documents (e.g., emergency notes) assigned higher point values were processed 42% faster than lower-priority ones, proving the effectiveness of the point-based logic.

Document Type	Avg. Time-to-Action (Without Points)	Avg. Time-to-Action (With Points)
Emergency Note	12 min	7 min
Lab Report	18 min	12 min

Routine Check File	25 min	23 min

D. Security and Audit Analysis

A security audit was performed to assess compliance with HIPAA standards. All user interactions were logged in a tamper-proof audit trail, and encryption protocols were validated for both transit (HTTPS/TLS) and storage (AES-256). No data breaches or unauthorized access incidents were detected during the evaluation phase.

Summary of Findings

- Document handling operations were significantly faster and more accurate.
- Users showed high satisfaction and found the system easy to use.
- The point-based prioritization reduced delays in high-urgency cases.
- The platform adhered to modern data security and privacy standards.

VI.CALCULATIONS

To quantitatively assess the effectiveness of the Point Assistance System, a set of metrics were computed from recorded test data. The focus was on document retrieval time, user satisfaction, task prioritization efficiency, and error reduction.

A. Retrieval Time Reduction (%)

To measure improvement in document retrieval speed compared to traditional systems, the percentage reduction was calculated using:

$$\text{Retrieval Time Reduction (\%)} = ((T\_old - T\_new) / T\_old) \times 100$$

Where:

T_old = 5.9 seconds (conventional system)

T_new = 1.4 seconds (proposed system)

Retrieval Time Reduction = ((5.9 - 1.4) / 5.9) × 100 = 76.27%

The system demonstrated a 76.27% improvement in retrieval time.

B. Task Processing Time Improvement

Time-to-action was measured for different document types before and after point prioritization. For emergency notes:

Time Reduction (%) = ((T_before - T_after) / T_before) × 100

T_before = 12 minutes

T_after = 7 minutes

Time Reduction = ((12 - 7) / 12) × 100 = 41.67%

Hence, high-priority documents were handled 41.67% faster due to point-based task sorting.

C. Usability Score Index (Average)

The System Usability Scale (SUS) is based on a 100-point scale and is calculated as:

SUS Average = (Sum of all SUS scores) / Number of users

For 15 users:

SUS Average = (Sum of individual scores) / 15 = 87.3

An average SUS score of 87.3 confirms excellent usability as per industry standards.

D. Document Upload Efficiency

Reduction in upload time is calculated using:

Upload Time Reduction (%) = ((T_old - T_new) / T_old) × 100

T_old = 6.5 seconds

T_new = 3.2 seconds

Upload Time Reduction = ((6.5 - 3.2) / 6.5) × 100 = 50.77%

This indicates a 50.77% improvement in document upload performance.

Summary of Performance Metrics

Metric	Value
Document Retrieval Time Reduction	76.27%
Upload Time Reduction	50.77%
High-Priority Task Speed Boost	41.67%
Avg. SUS Usability Score	87.3 / 100

VII. IMPLEMENTATION AND TESTING

A. System Implementation

The Point Assistance System was implemented as a modular, role-based web platform using modern full-stack web technologies. The architecture was designed to ensure scalability, data security, and user accessibility across multiple devices.

1) Front-End:
The front-end was developed using HTML5, CSS3, and JavaScript, enhanced with React.js to create a responsive, user-friendly interface. Role-specific dashboards were created to offer customized functionalities for administrators, doctors, and patients.

2) Back-End:
The server-side logic was built using Node.js and Express.js, with API endpoints managing user authentication, file uploads, point assignments, and notifications. RESTful APIs ensured interoperability and modularity.

3) Database:
Patient documents and user data were stored in MongoDB, a NoSQL database optimized for document-based storage. Metadata such as timestamps, user roles, and document types were indexed for fast retrieval.

4) Security:
The system integrated JWT-based authentication and HTTPS encryption for secure user sessions and file transfers. Data access was controlled using a Role-Based Access Control (RBAC) system, aligned with HIPAA and GDPR regulations.

5) Notification System:
A lightweight notification engine was integrated using Nodemailer for email alerts and Twilio API for optional SMS communication.

6) Point-Based Prioritization Engine:
A custom-built module was used to dynamically assign point values to each uploaded document based on type, urgency, and timestamp. This queue was visible to administrators and doctors for priority handling.

B. Testing
Extensive functional and non-functional testing was conducted in a controlled simulated environment.

1) Functional Testing:
All system modules were tested for expected input-output behavior. Unit tests were written for each core function, including document upload, user login, search, and notification.

- Upload Module Accuracy: 100% success rate with 500+ test files
- Role-Based Access: Verified with 3 user types (Admin, Doctor, Patient)
- Document Search: Tested with keyword, date, and type filters

2) Usability Testing:
Fifteen users (5 per role) participated in usability testing sessions. Task completion time, error rates, and subjective feedback were collected. The average task success rate exceeded 95%, and the average user satisfaction score (based on the SUS scale) was 87.3, indicating excellent usability.

3) Performance Testing:
Stress testing was performed to validate system performance under load. The system successfully handled:

- 100 concurrent users
- 500 document uploads
- <2 second average search response time

4) Security Testing:
Penetration testing and vulnerability scanning were conducted to evaluate system resilience. OWASP Top 10 threats were used as the basis, and no critical vulnerabilities were found. Audit logs were tested for integrity and traceability.

Summary
The implementation of the Point Assistance System proved to be stable, secure, and efficient. Testing across multiple dimensions validated the system’s readiness for deployment in real-world healthcare environments. The integration of a point-based prioritization engine further enhanced operational effectiveness by enabling faster response to high-priority medical documents.

VIII. CONCLUSION

The research study describes the creation of a Point Assistance System which operates through a web-based platform to handle patient documentation. The developers created the system to solve two main problems which affect healthcare documentation systems: operational bottlenecks and security risks that target traditional and semi-digital healthcare documentation systems. The system achieves better operational performance through its combination of role-based access control and real-time document processing and point-based prioritization engine which results in faster document retrieval and better patient service.

The system achieved excellent results through its functional and usability testing and performance testing and security testing which showed both high user satisfaction and full compliance with HIPAA and GDPR data protection standards. The system showed better performance through its ability to search documents 76% faster and its ability to upload files at double speed and its quick response to critical documents by 42% which demonstrated improved system performance and stability.

The platform functions through modular architecture which enables it to expand easily while supporting future technological advancements like mobile compatibility and artificial intelligence for document tagging and EHR system integration. The system provides modern healthcare workflow solutions through its effective document management capabilities which deliver secure and simple document management for healthcare organizations that need streamlined operations.t.

IX.FUTURE SCOPE

1.*Integration with AI and Machine Learning:*
- ◦ Future systems can leverage AI to provide intelligent scheduling by predicting user preferences, optimal appointment times, and even rescheduling conflicts automatically.
- ◦ Machine learning models could analyze past appointment data to improve scheduling efficiency and personalized recommendations.

2. Voice-Activated and Multimodal Interfaces:
- ◦ Incorporation of voice assistants (e.g., Alexa, Google Assistant) for hands-free appointment booking and management.
- ◦ Use of multimodal inputs (voice, text, gesture) to make the system more accessible and user-friendly.

3. Cross-Platform and Multi-Device Synchronization:
- ◦ Enhanced synchronization across various devices (smartphones, wearables, desktops) and platforms (Google Calendar, Outlook) for seamless appointment tracking.

4. Integration with IoT and Smart Environments:
- ◦ The system could connect with IoT devices like smart home assistants and smart office systems to automate reminders and preparation for appointments.
- ◦ Real-time environment data (like traffic, weather) can be incorporated to adjust appointment times or send alerts.

5. Enhanced Security and Privacy Features:
- ◦ Implementing blockchain or advanced encryption for secure handling of sensitive appointment and personal data.
- ◦ User-controlled privacy settings and compliance with data protection laws (GDPR, HIPAA for healthcare).

6. Expanded Use Cases and Industry Integration:
- ◦ Beyond medical or business appointments, the system could be extended to sectors like education (student-teacher meetings), government services, and social events.
- ◦ Integration with CRM and ERP systems for enterprise-level scheduling and customer management.

7. Automated Follow-ups and Feedback:
- ◦ Systems could automatically send follow-up notifications, feedback surveys, or reminders for next steps after an appointment.
- ◦ Use of sentiment analysis on feedback to improve services.

8. Use of Blockchain for Transparency:
- ◦ Appointment records can be stored in a tamper-proof manner for auditability in sensitive fields such as legal or medical appointments.

9. Adaptive Scheduling Based on Real-Time Analytics:
- ◦ Systems may adapt scheduling rules dynamically based on current user workload, appointment history, and external factors.

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