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Design, Implementation, and Evaluation of a Web-Based IEC Workflow System

[1] Samrudhi Motilal Chavan, [2] Prerna Ravindra Jadhav, [3] Sakshi Santosh Patil, [4] Chaitali Vilas Phapale, [5] Dr. Jaya Suryavanshi, [6] Dhiraj Birari

[1] [2] [3] [4] [5] [6] Information Technology, MVPS's KBTCOE, Nashik, India

Corresponding Author Email: [1] samrudhi.chavan.2004@gmail.com, [2] preranarjadhav141@gmail.com, [3] sakshipatil9247@gmail.com, [4] phapalechaitali@gmail.com, [5] suryavanshi.jaya@kbtcoe.org, [6] birari.dhiraj@kbtcoe.org

Abstract*— The main functions of Institutional Ethics Committees and their US counterparts, Institutional Review Boards, are to protect ethical standards and human participants in medical research. However, many ethics review processes are done manually, scattered, and create administrative delays. This results in longer approval times and less transparency. Previous studies on digitizing ethics reviews revealed gaps that motivated us to design, implement, and evaluate a web-based workflow management system for IECs. This system aims to manage the submission, review, and approval of research proposals efficiently. The proposed system includes role-based access control, automated workflow management, digital document handling, real time status tracking, and notification systems to improve efficiency and accountability. We developed a prototype that shows the automation of the IEC process from investigator submission to reviewer evaluation and administration oversight. Validations using functional and workflow methods demonstrate that the system can significantly cut down on administrative overhead and improve turnaround times compared to traditional paper-based systems. This platform provides a modern solution for ethics reviews that is both scalable and suitable for medical research institutions.

***Index Terms*—Ethics Workflow Automation, Institutional Ethics Committee, Institutional Review Board, Research Ethics Management, Web-Based Systems.**

I. INTRODUCTION

Institutional Ethics Committees/Institutional Review Boards are responsible for ensuring that medical and health research involving human participants is conducted ethically. Ethics review is a mandatory requirement for studies involving human subjects, serving to protect participant rights, ensure informed consent, and maintain regulatory compliance [1]. With the ever-expanding biomedical and clinical research activities, IECs are called upon to review an increasing number of research proposals. Despite their critical role, ethics review processes in many institutions remain mainly manual and administratively burdensome. Traditional workflows that involve paper-based submissions, manual document handling, and offline review meetings often result in limited visibility of processes and increased timelines for approval. Empirical studies have demonstrated that these inefficiencies further contribute to substantial delays in ethics approval, impacting the initiation of research and overall productivity in research [2]. These challenges call for an increasing need for digital solutions that provide efficiency in ethics review processes without compromising the required ethical rigor and regulatory compliance. In view of this, this paper presents the design, implementation, and evaluation of a web-based IEC workflow management system that supports end-to-end ethics review processes with the intent of improving efficiency, transparency, and administrative coordination.

II. BACKGROUND AND MOTIVATION

A. Limitations of Conventional IEC and IRB Workflows

Institutional Ethics Committees traditionally rely on manual and paper-based workflows for protocol submission, reviewer assignment, and decision communication. Such processes require significant administrative coordination and often lack standardized tracking mechanisms. Prior studies have reported that manual document handling, fragmented communication, and reliance on offline meetings contribute to inefficiencies and prolonged review timelines [3]. As the volume of medical research increases, these limitations reduce the ability of IECs to process submissions in a timely and consistent manner.

In addition to delays, conventional workflows make it difficult to balance efficiency with the quality of ethical oversight. Excessive administrative burden can negatively affect reviewer focus and decision consistency, particularly in high-throughput research environments [4]. These challenges highlight the need for systematic improvements in ethics review operations.

B. Limitations of Existing Digital and Semi-Digital Approaches

To address inefficiencies in manual processes, several institutions have adopted partial digitization strategies, such as electronic forms, email-based submissions, or standalone ethics management tools. Workflow-based systems for

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managing ethical clearance have demonstrated improvements in coordination and document traceability [5]. However, many of these solutions are limited to specific stages of the review process and do not provide integrated, end-to-end support.

Empirical studies on automation indicate that while digitization can improve administrative efficiency, isolated automation efforts are insufficient to fully resolve issues related to transparency, oversight, and process integration [6]. As a result, even semi-digital systems may continue to suffer from fragmentation and limited real-time visibility.

C. Emerging Needs and Motivation for an Integrated System

The limitations of both conventional and semi-digital approaches indicate a need for a more comprehensive solution. Modern ethics review requires systems that not only digitize existing processes but also integrate workflow management, role-based access, document tracking, and administrative oversight within a single platform. An integrated system can reduce administrative burden, improve transparency, and support consistent decision-making across the ethics review lifecycle. Motivated by these needs, this work focuses on the design and implementation of a unified, web-based IEC workflow management system that addresses operational inefficiencies while preserving ethical rigor and regulatory compliance.

III. SYSTEM REQUIREMENTS AND DESIGN OBJECTIVES

The design of the proposed web-based Institutional Ethics Committee (IEC) workflow management system is driven by limitations observed in existing ethics review practices and requirements identified through prior research. Traditional IEC processes are often fragmented, manually intensive, and lack real-time visibility, resulting in administrative delays and inconsistent review experiences. To address these challenges, the proposed system aims to digitize and automate core IEC operations while maintaining ethical rigor, transparency, and regulatory compliance.

A. Functional Requirements

Based on the analysis of current IEC workflows, the system is required to support the complete lifecycle of ethics review in a structured and efficient manner. Key functional requirements include

1) *Digital Proposal Submission:* The system must enable investigators to submit research protocols, informed consent documents, and supporting materials through a unified web interface, eliminating paper-based submissions.
2) *Role-Based Access Control:* Distinct user roles—Principal Investigator, Reviewer, and Administrator—must be supported, with controlled access to system functionalities to ensure confidentiality and accountability.
3) *Automated Workflow Management:* The system should automate proposal routing, reviewer assignment, and status transitions to reduce manual intervention and processing delays.
4) *Review and Decision Management:* Reviewers must be able to access assigned proposals, submit structured feedback, and record decisions digitally, while administrators oversee and consolidate outcomes.
5) *Tracking and Notifications:* Real-time tracking of proposal status and automated notifications for deadlines, decisions, and meetings must be provided to all stakeholders.
6) *Document Management:* Secure storage, retrieval, and version control of all submitted documents must be supported to ensure traceability and audit readiness.

B. Non-Functional Requirements

In addition to functional capabilities, the system must satisfy several non-functional requirements critical for deployment in medical research environments

1) *Security and Privacy:* The system must protect sensitive research data through secure authentication, authorization mechanisms, and controlled access.
2) *Scalability:* The platform should support multiple IECs and increasing volumes of submissions without performance degradation.
3) *Usability:* The user interface must be intuitive and accessible to users with varying levels of technical expertise to encourage adoption.
4) *Reliability and Availability:* Continuous system availability and fault tolerance are essential to support timesensitive research workflows.

C. Design Objectives

Guided by these requirements, the primary design objectives of the proposed system are to reduce administrative burden, improve turnaround time, enhance transparency in ethics review, and provide a scalable foundation for future integration with institutional and regulatory systems. These objectives form the basis for the system architecture and implementation described in the subsequent section.

IV. SYSTEM ARCHITECTURE

Figure 1 illustrates the overall system architecture of the proposed web-based IEC workflow management system. The architecture follows a layered design comprising a Presentation Layer, Application Layer, and Data Layer, enabling modularity, scalability, and secure handling of ethics review processes. Communication between layers is facilitated using standard HTTP/REST interfaces.

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A. Presentation Layer

The Presentation Layer provides the primary interaction interface for system users, including Researchers, Reviewers, and Administrators. Access to the system is enabled through a web portal that can be accessed via standard client web browsers. Each user role is presented with a role-specific interface to support activities such as protocol submission, review, decision tracking, and administrative monitoring.

External components and client services may also interact with the system through RESTful APIs, allowing integration with institutional research portals or document repositories. This layer is responsible solely for user interaction and request forwarding, ensuring a clear separation from core business logic.

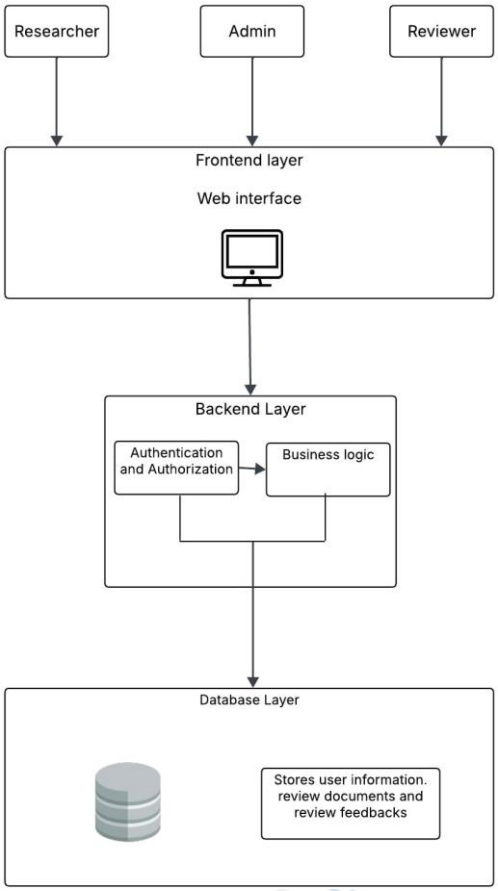

Figure 1. Overall system architecture of the proposed IEC workflow system

B. Application Layer

The Application Layer forms the core of the proposed system and hosts the Application Server, which implements the IEC workflow logic. This layer manages key operations including protocol intake, workflow routing, reviewer assignment, review consolidation, and decision generation.

Requests received from the Presentation Layer are processed through REST APIs, validated, and executed according to predefined workflow rules. The centralized business logic ensures consistency in ethics review procedures while allowing configurable parameters to adapt to institutional requirements.

C. Data Layer

The Data Layer is responsible for secure data management and system integrity. It includes services for authentication and authorization, ensuring that only authorized users can access sensitive research data based on their assigned roles. All research protocols, review comments, decisions, and audit logs are securely stored and managed within this layer using MongoDB, a NoSQL database that provides flexible schema design, high scalability, and secure data storage.

Additionally, logging and reporting components support administrative oversight, enabling traceability of actions, monitoring of review timelines, and generation of compliance reports. This layer ensures data confidentiality, accountability, and long-term record maintenance essential for ethics governance.

V. PROPOSED WEB-BASED SYSTEM

The proposed system is a role-based, web-enabled platform designed to streamline Institutional Ethics Committee (IEC) workflows by automating submission, review, and approval processes. It integrates three primary user roles: Principal Investigator (PI), Reviewer, and Administrator, each equipped with tailored dashboards and functionalities.

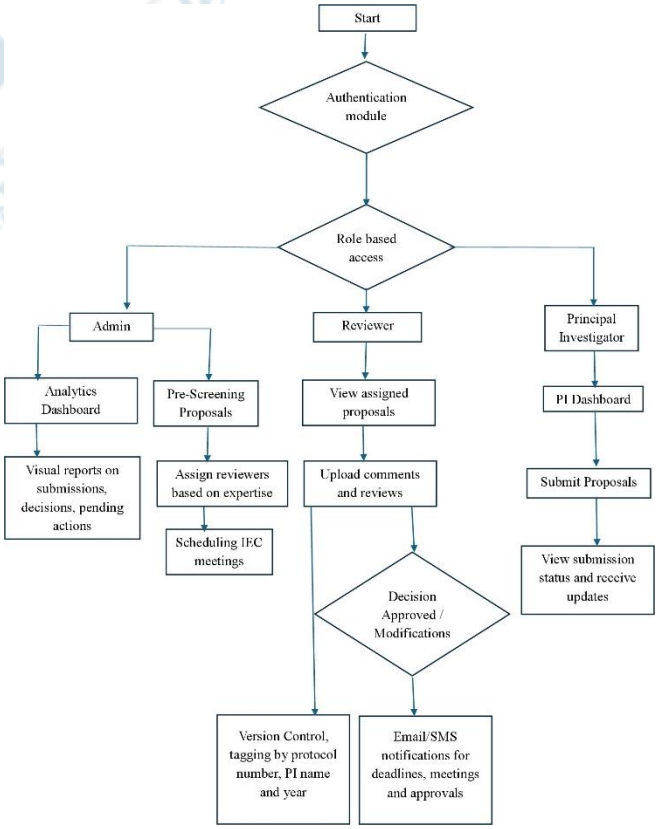

Figure 2. Flowchart illustrating the end-to-end IEC workflow

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A. Authentication and Role-Based Access

All users access the system through a secure authentication module that provides role-based access control. Once authenticated, users are directed to their respective dashboards — PI, Reviewer, or Admin — ensuring confidentiality, accountability, and compliance with institutional policies.

B. Principal Investigator (PI) Module

The PI dashboard provides investigators with an intuitive interface for proposal submission. Investigators can upload study protocols, consent forms, and supporting documents digitally. The system enables them to track submission status in real time, receive notifications, and view IEC decisions or requests for modification. This reduces administrative burden and enhances transparency for researchers.

C. Reviewer Module

The Reviewer dashboard facilitates structured and transparent evaluations. Reviewers can access assigned proposals, upload comments, and provide feedback directly within the platform. The system allows for collaborative reviewing, enabling multiple experts to share insights simultaneously. Once reviews are completed, decisions are consolidated into an "Approved/Modification Required" status, ensuring clarity for both investigators and administrators.

D. Administrator Module

The Administrator Module is responsible for overseeing the entire IEC workflow. It is designed to streamline operations and provide centralized control. The key functionalities include:

- Pre-Screening Proposals: Verifying completeness and compliance of submissions before forwarding them for review.
- Reviewer Assignment: Automatically assigning proposals to reviewers based on their expertise.
- Scheduling IEC Meetings: Coordinating and managing committee meetings efficiently with calendar integration.
- Analytics Dashboard: Generating visual reports on submissions, pending actions, and final decisions.

This centralized oversight enhances monitoring, ensures fair distribution of workload, and improves accountability across the research approval process.

VI. RESULTS AND DISCUSSION

A functional prototype of the IEC workflow system was validated through key user centric components, namely the researcher (Principal Investigator) dashboard and the digital proposal submission workflow. In the system, the researcher role corresponds to the Principal Investigator (PI), who is responsible for initiating, submitting, and tracking research proposals throughout the ethics review lifecycle.

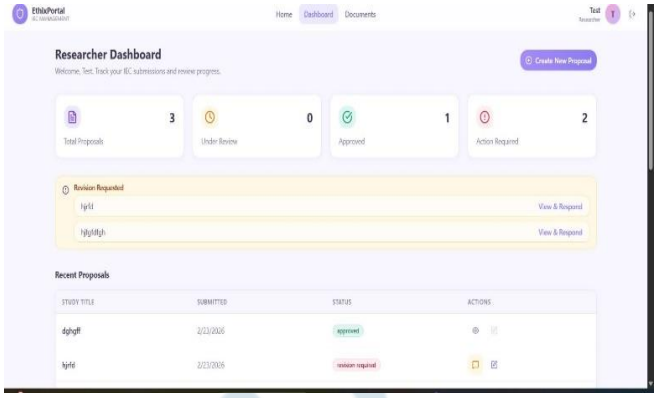

Figure 3. Researcher (Principal Investigator) dashboard showing proposal status tracking in the IEC workflow prototype

The researcher (PI) dashboard provides a consolidated view of all submitted proposals along with their current review status, such as under review, approved, or revision required. Summary indicators displaying the total number of proposals and their respective states enable quick situational awareness for

the PI. During prototype validation, the dashboard effectively demonstrated real time status tracking and centralized access to proposal information, which are typically fragmented across emails and manual records in conventional IEC processes. This centralized visibility supports improved transparency and reduces uncertainty for PIs during the ethics review process.

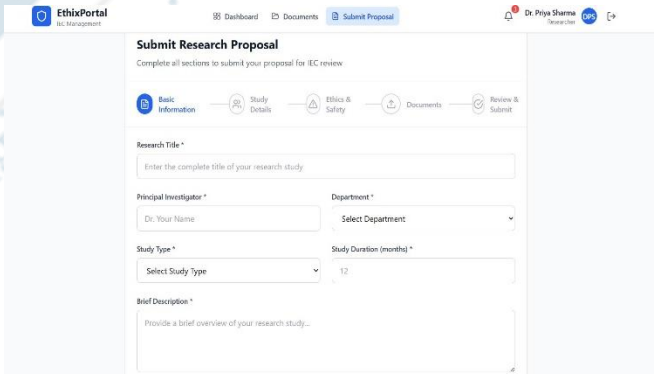

Figure 4. Multi step digital proposal submission workflow used by the Principal Investigator

The digital proposal submission workflow enables structured data entry through a multi-step form covering essential sections such as basic information, study details, ethical and safety considerations, supporting documents, and final review. The workflow is completed by the Principal Investigator (PI) and ensures submission completeness before IEC evaluation. The sequential design enforces controlled navigation, mandatory field validation, and structured data capture, thereby minimizing incomplete or inconsistent entries. Prototype testing demonstrated smooth stage transitions, reliable validation mechanisms, and stable form behavior across submission steps. These

implementation components illustrate how a web-based system can standardize proposal intake, improve traceability of review activities, and reduce manual coordination efforts. Although the system has not yet been deployed in a live institutional environment, initial testing indicates strong potential to enhance transparency, accountability, and operational efficiency. Future pilot deployment will allow empirical evaluation of usability, review turnaround time, and stakeholder satisfaction under real-world conditions.

VII. CONCLUSION AND FUTURE SCOPE

A web based prototype for managing Institutional Ethics Committee (IEC) workflows was designed and implemented to address limitations associated with manual and semi digital ethics review processes. The system demonstrates end to end digitization of key activities, including structured proposal submission and transparent status tracking for the researcher acting as the Principal Investigator (PI). The prototype validates the feasibility of supporting systematic, role based IEC operations through a unified digital platform. The implementation highlights the benefits of centralized proposal management, standardized data capture, and improved traceability across the ethics review lifecycle. Scenario based validation confirmed correct workflow execution, controlled access to sensitive

information, and consistent handling of proposal states. These outcomes indicate that the proposed system can serve as a practical foundation for modernizing IEC operations and improving transparency in research ethics governance. Future scope includes pilot deployment of the system within an institutional IEC to enable empirical evaluation of usability, review turnaround time, and user satisfaction. Additional enhancements may include support for inter institutional ethics review, analytics driven monitoring of review performance, integration with institutional research databases, and configurable workflows to accommodate diverse regulatory requirements. Extending the system with advanced notification mechanisms and reporting dashboards can further strengthen administrative oversight and decision support.

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