**PolicyCraft: Strategic and Ethical Integration of Generative AI in Higher Education**

**A Web-Based Framework for AI Policy Analysis and Recommendation**

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**Abstract**

This project develops PolicyCraft, a comprehensive web-based application designed to analyse university AI policies, extract key themes, classify institutional approaches, and generate strategic recommendations for higher education institutions navigating the integration of generative artificial intelligence. The application addresses the critical gap identified in current literature regarding the absence of theoretically grounded, comprehensive frameworks to balance GenAI's innovative potential with risks to academic integrity, equity, and institutional accountability.

The system combines Natural Language Processing (NLP) techniques, machine learning classification, and interactive visualisations to provide institutions with data-driven insights for developing ethical and strategic AI policies. Initial development has established a secure authentication framework and foundational architecture, with ongoing work focused on implementing advanced NLP analysis capabilities.

**Keywords:** Generative AI, Higher Education Policy, Natural Language Processing, Policy Analysis, Ethical AI Integration

**1. Introduction**

**1.1 Background and Context**

The rapid emergence of generative artificial intelligence tools, particularly large language models such as ChatGPT, Claude, and Google Bard, has fundamentally disrupted traditional paradigms in higher education. These technologies present unprecedented opportunities for personalised learning, automated assessment, and enhanced research capabilities, whilst simultaneously raising profound concerns about academic integrity, algorithmic bias, and equitable access to educational resources (Bobula, 2024; Chan & Hu, 2023).

Recent empirical research by Dabis and Csáki (2024) examining policy responses of 30 leading universities to generative AI challenges reveals that institutions primarily focus on four key ethical dimensions: accountability and responsibility, human agency and oversight, transparency and explainability, and inclusiveness and diversity. Their analysis demonstrates that universities predominantly adopt a "bottom-up" approach, providing instructors with flexibility to determine AI use whilst maintaining clear communication requirements.

However, as highlighted by Bond et al. (2024) in their comprehensive meta-systematic review, significant research gaps persist in AI ethics, collaboration, and methodological rigour within higher education contexts. The absence of systematic, theoretically grounded frameworks for policy development has resulted in reactive, ad-hoc responses that fail to address the complex interplay between technological innovation and educational values.

**1.2 Problem Statement**

The central problem addressed by this project is the lack of comprehensive, data-driven tools to support higher education institutions in developing strategic and ethical policies for generative AI integration. Current policy development processes rely heavily on informal consultation and reactive responses to emerging challenges, without systematic analysis of successful approaches or consideration of institutional context and stakeholder needs.

This gap is particularly significant given the rapid pace of AI development and the varying institutional contexts in which policies must operate. Universities require evidence-based guidance that considers both the technical capabilities of AI systems and the pedagogical, ethical, and governance implications of their deployment.

**1.3 Research Aims and Objectives**

This project aims to develop PolicyCraft, a web-based framework that provides higher education institutions with analytical tools and strategic guidance for ethical generative AI integration. The specific objectives are:

**Primary Objective:** To create a theoretically grounded, practical framework for ethical GenAI integration in higher education through automated policy analysis and recommendation generation.

**Secondary Objectives:**

1. To develop an NLP-powered analysis engine capable of processing and categorising university AI policies
2. To implement a classification system that identifies restrictive, permissive, and balanced policy approaches
3. To create an interactive web platform with user authentication and secure data management
4. To design a recommendation engine that generates tailored policy suggestions based on institutional context
5. To produce comparative visualisations that highlight trends and patterns across institutional approaches

**1.4 Research Questions**

The project addresses the following research questions:

**Main Research Question:** How can higher education institutions strategically adopt generative AI whilst ensuring pedagogical value, ethical responsibility, and institutional accountability?

**Sub-questions:**

1. What strategic challenges and opportunities exist for GenAI integration in teaching and assessment?
2. What ethical concerns (e.g., bias, transparency, equity) should universities prioritise in AI policies?
3. How do existing university policies conceptualise GenAI's role, and what assumptions underlie these approaches?
4. What technical and methodological approaches best support automated policy analysis and recommendation generation?

**2. Literature Review**

**2.1 Generative AI in Higher Education Context**

The integration of generative artificial intelligence in higher education represents a paradigm shift that demands careful consideration of both opportunities and challenges. Recent studies have highlighted the transformative potential of these technologies whilst identifying significant concerns regarding their implementation (Williamson & Eynon, 2020).

Barnes and Hutson (2024) emphasise the critical importance of mitigating algorithmic bias through technical solutions, diverse datasets, and strict adherence to ethical guidelines in higher education AI applications. Their comprehensive review of bias mitigation strategies demonstrates that successful AI integration requires not only technical sophistication but also institutional commitment to equity and inclusion.

The rapid adoption of tools such as ChatGPT has prompted varied institutional responses, ranging from complete prohibition to enthusiastic embrace. UNESCO (2023) guidance on AI in education emphasises the need for balanced approaches that harness the potential of these technologies whilst safeguarding educational integrity and equity.

**2.2 Policy Development and Institutional Responses**

Current research reveals significant variation in institutional approaches to AI policy development. The JISC (2023) guidelines for UK higher education provide a framework for understanding the key considerations that institutions must address, including academic integrity, data protection, and pedagogical effectiveness.

However, as noted by the 2024 EDUCAUSE AI Landscape Study, only 23% of responding institutions have established AI-related acceptable use policies, indicating a significant gap between the pace of technological development and institutional preparedness (EDUCAUSE, 2024).

**2.3 Theoretical Frameworks for AI Integration**

The theoretical foundation for this project draws upon several interconnected frameworks:

**Ethical Framework:** Building upon UNESCO's AI Ethics recommendations and BERA (2018) guidelines for educational research, emphasising transparency, accountability, and inclusive design.

**Pedagogical Framework:** Incorporating constructivist learning theory and digital literacy frameworks to ensure AI integration supports rather than supplants critical thinking and intellectual development.

**Governance Framework:** Utilising institutional theory and policy analysis frameworks to understand how organisational context influences policy development and implementation.

**2.4 Natural Language Processing and Policy Analysis**

The application of NLP techniques to policy analysis represents an emerging area of research with significant potential for supporting evidence-based policy development. Recent advances in transformer-based language models have enabled more sophisticated analysis of policy documents, including theme extraction, sentiment analysis, and comparative classification.

This project builds upon established NLP methodologies whilst addressing the specific challenges of policy document analysis in the higher education context, including varying document structures, institutional terminology, and the need for nuanced interpretation of policy intent.

**3. Methodology**

**3.1 Research Approach**

This project employs a mixed-methods approach that combines qualitative policy analysis with quantitative NLP techniques. The methodology is grounded in design science research principles, emphasising the development of practical artefacts that address real-world problems whilst contributing to theoretical understanding.

The research follows an iterative development process, with continuous refinement based on testing with real policy documents and stakeholder feedback. This approach ensures that the final system addresses practical needs whilst maintaining academic rigour.

**3.2 Data Collection and Sources**

**3.2.1 Policy Document Collection**

The project analyses AI policies from a diverse range of higher education institutions, including:

**International Universities:**

* Stanford University, MIT, Harvard University, Yale University, Princeton University, Columbia University (United States)
* Oxford University, Cambridge University, Imperial College London, UCL, King's College London, Edinburgh University (United Kingdom)

**Selection Criteria:**

* Publicly available AI or generative AI policies
* Institutional diversity (research-intensive, teaching-focused, public/private)
* Geographic representation across major English-speaking higher education systems
* Policy recency (2023-2025) to ensure relevance to current AI capabilities

**3.2.2 Data Quality and Ethical Considerations**

All policy documents used in this research are publicly available and do not contain personal or sensitive information. The analysis focuses on institutional policy positions rather than individual perspectives, ensuring compliance with ethical research guidelines (BERA, 2018).

**3.3 Technical Architecture and Implementation**

**3.3.1 System Architecture**

PolicyCraft is designed as a modular web-based application with the following core components:

**Backend Framework:** Python Flask with SQLAlchemy for database management **Authentication System:** Flask-Login with secure password hashing **NLP Engine:** spaCy and NLTK for text processing and analysis **Classification System:** Scikit-learn for machine learning-based policy categorisation **Visualisation:** Matplotlib and Plotly for interactive data presentation **Database:** SQLite for development, with MongoDB integration for production scaling

**3.3.2 NLP Processing Pipeline**

The text analysis pipeline implements the following stages:

1. **Document Preprocessing:** Text extraction from PDF/DOCX formats, cleaning, and normalisation
2. **Theme Extraction:** TF-IDF vectorisation and topic modelling to identify key policy themes
3. **Classification:** Machine learning classification of policy approaches (restrictive, permissive, balanced)
4. **Sentiment Analysis:** Assessment of policy tone and institutional stance
5. **Comparative Analysis:** Cross-institutional comparison and trend identification

**3.3.3 Security and Privacy Implementation**

The system implements security best practices including:

* User authentication with secure session management
* Database storage external to application directories
* Input validation and sanitisation
* Access control ensuring users only access their own data

**3.4 Validation and Testing Approach**

System validation employs multiple approaches:

**Technical Validation:** Unit testing of NLP components, integration testing of system modules **Content Validation:**Expert review of analysis results for accuracy and relevance **User Testing:** Evaluation with educational professionals to ensure usability and practical utility **Performance Testing:** Assessment of system performance with varying document loads

**4. System Design and Implementation**

**4.1 Architecture Overview**

PolicyCraft implements a modular, scalable architecture designed to support both individual institutional use and comparative analysis across multiple organisations. The system architecture prioritises security, usability, and extensibility.

**4.1.1 Core System Components**

**Authentication Module (src/auth/):**

* User registration and login functionality
* Secure session management with Flask-Login
* Role-based access control for different user types
* Password security with Werkzeug hashing

**NLP Processing Engine (src/nlp/):**

* Text extraction from multiple document formats
* Advanced preprocessing including cleaning and normalisation
* Theme extraction using statistical and machine learning approaches
* Policy classification with supervised learning techniques

**Web Interface (src/web/):**

* Responsive HTML5/CSS3 frontend with modern design principles
* Interactive document upload and analysis workflows
* Real-time feedback and progress indication
* Accessibility compliance with WCAG 2.1 standards

**Recommendation System (src/recommendation/):**

* Rule-based recommendation engine
* Institutional context consideration
* Template policy generation
* Customisable output formats

**Data Management (src/database/):**

* Secure database operations with user data separation
* Analysis result persistence and retrieval
* Data export functionality for institutional reporting
* Backup and recovery capabilities

**4.2 Implementation Progress**

**4.2.1 Completed Components (as of June 2025)**

**Foundation Infrastructure:**

* Complete project structure with modular organisation
* Flask web application framework with routing
* Secure authentication system with user registration/login
* Database architecture with external storage for security
* Responsive web interface with professional design

**Security Implementation:**

* User authentication with secure password hashing
* Session management with automatic expiry
* Access control preventing unauthorised data access
* Database storage external to application directory
* Input validation and sanitisation

**User Interface Development:**

* Public landing page with project information
* User registration and login forms with validation
* Authenticated user dashboard
* Document upload interface
* Error handling and user feedback systems

**4.2.2 Current Development Status**

The system currently provides a complete authentication framework and user management system. Users can register accounts, log in securely, and access personalised dashboards. The document upload functionality is implemented, with files securely associated with individual users.

**Demonstrated Capabilities:**

* Secure user registration with validation
* Professional web interface with responsive design
* File upload functionality with security controls
* User-specific data separation and access control
* Professional error handling and user feedback

**4.3 Technical Challenges and Solutions**

**4.3.1 Security Architecture**

One of the primary challenges addressed was ensuring robust security whilst maintaining usability. The solution involved implementing database storage external to the application directory, comprehensive input validation, and user-specific data separation.

**4.3.2 Scalable Modular Design**

The system architecture emphasises modularity to support future development and maintenance. Each component (authentication, NLP, visualisation) operates independently whilst maintaining clear interfaces for integration.

**5. Current Results and Evaluation**

**5.1 System Functionality Assessment**

The current implementation successfully demonstrates core system capabilities:

**Authentication System Performance:**

* User registration processing with comprehensive validation
* Secure login with session management
* Access control preventing unauthorised access
* Password security meeting current best practices

**Web Interface Usability:**

* Professional, responsive design suitable for academic users
* Intuitive navigation and clear user feedback
* Accessibility compliance for diverse user needs
* Cross-browser compatibility testing

**Security Validation:**

* Database storage external to application for enhanced security
* User data separation preventing cross-user access
* Input validation preventing malicious uploads
* Secure session management with automatic expiry

**5.2 Technical Architecture Validation**

The modular architecture has proven effective for iterative development:

**Modularity Benefits:**

* Independent component development and testing
* Clear separation of concerns facilitating maintenance
* Extensibility for future feature additions
* Code reusability across system components

**Performance Considerations:**

* Efficient database queries with proper indexing
* Responsive user interface with minimal loading times
* Scalable architecture supporting future user growth
* Resource optimisation for development and production environments

**5.3 User Experience Evaluation**

Initial testing with development users has validated key design decisions:

**Positive Feedback:**

* Professional appearance appropriate for academic institutions
* Intuitive workflow from registration through document upload
* Clear error messages and helpful user guidance
* Responsive design working effectively across devices

**Areas for Continued Development:**

* NLP processing capabilities (planned next phase)
* Interactive visualisations for analysis results
* Advanced recommendation functionality
* Batch processing for multiple documents

**6. Next Steps and Implementation Plan**

**6.1 Immediate Development Priorities**

**Phase 1: NLP Engine Implementation (June-July 2025)**

* PDF text extraction using PyPDF2 and pdfplumber libraries
* Text preprocessing and cleaning for policy documents
* Theme extraction using TF-IDF and topic modelling techniques
* Initial classification system development

**Phase 2: Machine Learning Integration (July 2025)**

* Training data preparation from collected policy documents
* Supervised learning for policy approach classification
* Validation testing with expert evaluation
* Performance optimisation and accuracy assessment

**Phase 3: Visualisation and Analytics (July-August 2025)**

* Interactive dashboard development with Plotly
* Comparative analysis visualisations
* Export functionality for institutional reporting
* Advanced analytics for trend identification

**6.2 Testing and Validation Schedule**

**Technical Testing:**

* Unit testing for individual NLP components
* Integration testing across system modules
* Performance testing with varying document loads
* Security testing for authentication and data access

**User Validation:**

* Expert review of analysis accuracy and relevance
* Usability testing with educational professionals
* Feedback collection and iterative improvement
* Documentation and user guide development

**6.3 Risk Management and Mitigation**

**Technical Risks:**

* NLP accuracy challenges: Mitigated through diverse training data and expert validation
* Performance issues: Addressed through optimisation and scalable architecture
* Integration complexity: Managed through modular design and comprehensive testing

**Timeline Risks:**

* Feature scope management: Prioritising core functionality over advanced features
* Testing schedule: Allowing adequate time for validation and refinement
* Documentation requirements: Parallel development of technical and user documentation

**7. Conclusion and Expected Contributions**

**7.1 Project Contributions to Knowledge**

PolicyCraft addresses a significant gap in current research and practice by providing a systematic, data-driven approach to AI policy development in higher education. The project contributes to both theoretical understanding and practical implementation:

**Theoretical Contributions:**

* Comprehensive framework integrating pedagogical, ethical, and governance considerations
* Methodological advancement in automated policy analysis using NLP techniques
* Evidence-based insights into institutional approaches to AI integration

**Practical Contributions:**

* Accessible web-based tool for institutional policy analysis
* Automated recommendation generation based on comparative analysis
* Scalable platform supporting both individual institutions and cross-institutional research

**7.2 Impact and Significance**

The project addresses urgent practical needs in higher education whilst contributing to broader understanding of AI governance. The systematic analysis of institutional policies provides valuable insights for both policymakers and researchers.

**Immediate Impact:**

* Support for institutions developing or revising AI policies
* Evidence-based insights into effective policy approaches
* Reduced time and resources required for policy development

**Longer-term Significance:**

* Contribution to theoretical frameworks for AI governance in education
* Foundation for ongoing research into policy effectiveness
* Model for similar tools in other sectors and contexts

**7.3 Limitations and Future Research**

**Current Limitations:**

* Analysis limited to English-language policies
* Focus on higher education context may limit transferability
* Recommendation quality dependent on training data diversity

**Future Research Opportunities:**

* Expansion to international policy contexts and languages
* Longitudinal analysis of policy evolution and effectiveness
* Extension to other educational sectors and policy domains
* Integration with institutional outcomes data for impact assessment

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**Appendices**

**Appendix A: System Architecture Diagrams**

*[Technical diagrams to be included in final version]*

**Appendix B: Policy Document Sources**

*[Complete list of institutional policies analysed]*

**Appendix C: Technical Specifications**

*[Detailed technical documentation]*

**Appendix D: User Interface Screenshots**

*[System interface documentation]*

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