

Harnessing Open Access, E-Learning, and Web Crawlers for Library Innovation using Hybrid Framework

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The rapid evolution of digital technologies necessitates a paradigm shift in library systems to enhance knowledge dissemination and user accessibility. The digital transformation of libraries is essential to address the persistent challenges of limited academic resource accessibility, outdated content management, and inefficient information retrieval. Traditional systems such as DSpace and Koha often suffer from manual updates, static metadata indexing, and low user engagement rates. The proposed method uses a hybrid framework integrating Open Access (OA) databases, E-Learning platforms, and Web Crawlers (HOEW) to catalyze library innovation and enhance knowledge dissemination. This system aims to automate resource collection, real-time content updates, and intelligent metadata management using AI and Natural Language Processing (NLP) engines. Open Access integration and web Crawlers systematically fetch academic documents and repository content, continuously enriching the library database with current information. This hybrid methodology improves resource availability, reduces average search time and enhances user satisfaction. The metadata extraction module utilized a fine-tuned Deep Learning model to achieve 92% of metadata accuracy, enabling high-precision identification of document titles, author names, keywords, and publication attributes from heterogeneous academic sources. Automated web crawlers consistently indexed a high volume of scholarly documents from open repositories which improves the crawler efficiency reaching 500 documents per hour, significantly outperforming manual indexing methods. The proposed system achieved the highest accuracy of 96.8%, significantly outperforming the Content-Based Recommender (92.5%), Collaborative Filtering (89.3%), Hybrid Recommender System (87.1%), and Keyword-Based Search (85.4%). The precision of the proposed system reached 95.4%, ensuring high relevance of retrieved content compared to other systems. The F1-Score of 96.1% and the recall value of 97.2% indicated the system efficiency in retrieving relevant information. These measurable improvements validate the hybrid system effectiveness in enhancing academic resource accessibility, retrieval efficiency, and user experience.

Keywords: *Academic resource accessibility; Automated information retrieval; Digital libraries; Open access; Web crawlers*