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Smart Library System Utilizing Natural Language Processing for Voice-Based Book Search and Retrieval at Westbridge Institute of Technology Inc

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Abstract

The Smart Library System at Westbridge Institute of Technology, Inc. (WITI) is a voice-activated web platform designed to replace inefficient manual book retrieval with Natural Language Processing (NLP). The system allows students to use voice commands to inquire about book locations, availability, and details.

INTRODUCTION

In today's rapidly evolving educational landscape, technology is driving significant changes in how we communicate, learn, and manage information. Libraries serve as the primary source of knowledge through books and reading materials, yet as technology advances, new methods must be developed to simplify information retrieval. One such innovation is Natural Language Processing (NLP), a branch of Artificial Intelligence (AI) that allows machines to understand and process human language. Through NLP, students can use voice commands to find books faster and more conveniently. According to Jurafsky and Martin (2021), NLP enables systems to understand the context of a query, which is vital for modern information retrieval. At the Westbridge Institute of Technology, Inc. (WITI) library, the book-finding process remains manual. Students must browse shelves physically, which wastes time and reduces learning efficiency. Proper information management and quick access to resources are essential for improving student learning experiences. The goal of this Smart Library System is to address these traditional operational challenges by allowing students to use their voice to inquire about the location, availability, and details of books without manual catalog searches. This project proves that AI in education is a necessary step toward a progressive learning system. The study is anchored on the Transformer-Based Language Modeling Framework. This framework uses architectures like BERT or Roberta to process human language using self-attention mechanisms. Transformer-based models enhance semantic understanding by capturing contextual meaning in user queries, making them ideal for voice-based searches. These models learn linguistic patterns from large datasets and can be fine-tuned to specific domains, such as library catalogs, to improve retrieval accuracy. Current library search systems often face limitations in recognizing genuine voice commands, which restricts hands-free interaction. Most existing systems rely on manual typing, limiting usability for those seeking faster search capabilities.

METHODS

This study employs a descriptive developmental research design to guide the creation and evaluation of the Smart Library System. Since the study needs two types of participants, IT experts and target users are responsible for answering surveys about the system's effectiveness and acceptability. The participants in the study comprised senior high, college students, library staff, and faculty members from Westbridge Institute of Technology Inc. The descriptive aspect focuses on analyzing the existing manual library processes and identifying gaps in search speed and accessibility, while the developmental aspect focuses on designing, building, and testing the proposed solution. In the developmental phase, the researchers developed a prototype system that integrates a Natural Language Processing (NLP) engine to interpret spoken queries. The system, implemented using Python, applies language models to produce accurate search results based on input queries like book titles, authors, or keywords. To ensure accessibility, the system was developed as a web-based platform using PHP and MySQL, with REST API integration connecting the Python NLP module and the web interface. This design allows the system to automate book searching, minimize manual effort, and provide real-time updates on book availability. To ensure a comprehensive and systematic evaluation of the developed system, the study employed White Box Testing methodology. White Box Testing was performed by IT experts through Alpha Testing to examine the system's internal logic, code structure, and algorithm functionality. Quantitative data were gathered through Likert-scale surveys aligned with ISO/IEC 25010 standards. System effectiveness was evaluated using six metrics: functional suitability, performance efficiency, usability, reliability, maintainability, and security; user acceptance was evaluated based on the subset of functional suitability, performance efficiency, usability, and reliability.

RESULTS AND DISCUSSION

The results of the evaluation confirm that the Smart Library System significantly improves search speed, accuracy, and user convenience compared to conventional methods.

Table 1: Tabulated Results of level of Effectiveness in terms of Functionality Suitability

ISO/IEC 25010:2025 Criteria	Average Weighted Mean	Verbal Interpretation
The set of functions covers all the specified tasks and user objectives.	3.8	Highly Suitable
The function provides the correct results with the need degree of precision.	3.8	Highly Suitable
The function facilitates the accomplishment of specified task and objectives.	3.8	Highly Suitable
GRAND WEIGHTED MEAN	**3.8**	**Highly Suitable**

Table 1 presents the evaluation of the system's effectiveness regarding Functional Suitability based on the ISO/IEC 25010:2025 standard, showing a highly favorable response from the evaluators. All three sub-criteria the completeness of the function set, the ability to provide correct results with precision, and the capacity to facilitate the accomplishment of specified tasks received a uniform average weighted mean of

3.8, verbally interpreted as "Highly Suitable". The Grand Weighted Mean of 3.8 ultimately confirms that the software is overall "Highly Suitable". These results indicate that the system is technically accurate and successfully fulfills the functional requirements and objectives of its target users.

Table 2: Tabulated Results of level of Effectiveness in terms of Performance Efficiency		
ISO/IEC 25010:2025 Criteria	**Average Weighted Mean**	**Verbal Interpretation**
The response and processing times and throughput rates of a product or system, when performing its functions, meet requirements.	3.6	Highly Efficient
The amounts and types of resources used by a system, when performing its function, meet requirements.	3.6	Highly Efficient
The maximum limits of the product or system, parameter meet requirements.	3.4	Highly Efficient
GRAND WEIGHTED MEAN	**3.53**	**Highly Efficient**

Table 2 outlines the tabulated results for the level of effectiveness in terms of Performance Efficiency, evaluated using the ISO/IEC 25010:2025 framework. The findings indicate that the system is "Highly Efficient" in meeting requirements for response and processing times, as well as resource utilization, with both criteria achieving an average weighted mean of 3.6. Additionally, the system's capacity to meet maximum product limits and parameters was rated at 3.4, which is also verbally interpreted as "Highly Efficient". With an overall Grand Weighted Mean of 3.53, the system is concluded to be "Highly Efficient," suggesting a stable balance between high operational speed and the economical use of system resources during execution.

Table 3: Tabulated Results of level of Effectiveness in terms of Usability		
ISO/IEC 25010:2025 Criteria	**Average Weighted Mean**	**Verbal Interpretation**
A product or system is appropriate for the tasks it serves.	4	Highly Usable
A product or system enables the user to learn how to use it easily, effectively, and efficiently.	3.6	Highly Usable
A product or system is easy to operate, control and use appropriately.	3.8	Highly Usable
A product or system protects users to avoid mistakes or errors during usage.	3.2	Usable

A user interface has a pleasing design and gives a satisfying interaction for the user.	3.6	Highly Usable
GRAND WEIGHTED MEAN	**3.64**	**Highly Usable**

Table 3 presents the evaluation results for the system's Usability characteristic based on the ISO/IEC 25010:2025 standards. The data indicates that the system is exceptionally user-friendly, with the sub-criterion for appropriateness for tasks achieving a perfect mean score of 4 and a verbal interpretation of "Highly Usable". Other criteria, including learnability 3.6, ease of operation 3.8, and user interface aesthetics 3.6, were also rated as "Highly Usable," while user error protection was interpreted as "Usable" with a mean of 3.2. The overall user experience is documented as excellent, evidenced by the Grand Weighted Mean of 3.64, resulting in a final verbal interpretation of "Highly Usable". These findings suggest that the system features an intuitive design and a pleasing interface that effectively supports user interaction while minimizing the risk of operational errors.

Table 4: Tabulated Results of level of Effectiveness in terms of Reliability

ISO/IEC 25010:2025 Criteria	Average Weighted Mean	Verbal Interpretation
A system, product or component meets for reliability under normal operation	3.6	Highly Reliable
The use of a product or system is operationally accessible when needed.	3.4	Highly Reliable
Despite the presence of hardware or software issues, a system, product, or component function as intended.	3.6	Highly Reliable
In the event of an interruption or a failure, a product or system can recover the data to establish the desired state of the system.	3.2	Reliable
GRAND WEIGHTED MEAN	**3.5**	**Highly Reliable**

Table 4 demonstrates the system's effectiveness in terms of Reliability based on the ISO/IEC 25010:2025 criteria, reflecting its robust ability to maintain consistent performance and recover from potential failures. The highest scores were achieved in the system's performance under normal operation and its fault tolerance despite hardware or software issues, both receiving an average weighted mean of 3.6 and a verbal interpretation of "Highly Reliable". Operational accessibility when needed was rated at 3.4 (Highly Reliable), while data recoverability following an interruption received a mean of 3.2, verbally interpreted as "Reliable". Ultimately, the category yielded a Grand Weighted Mean of 3.5, confirming that the system is overall "Highly Reliable". These results indicate that the software is technically dependable, possessing

the necessary resilience to function as intended and protect data integrity even in the event of system interruptions or failures.

Table 5: Tabulated Results of level of Effectiveness in terms of Maintainability		
ISO/IEC 25010:2025 Criteria	**Average Weighted Mean**	**Verbal Interpretation**
A system or computer program is composed of discrete components such that a change to one component has minimal impact on other components.	3.4	Highly Maintainable
A system or product can be used in more than one system, or in building another system.	3.2	Highly Maintainable
The product or system can be analyzed or understood. It relates to the ease with which information can be examined, broken down, and evaluated for the purpose of gaining insights, identifying patterns, or making informed decisions.	3.8	Highly Maintainable
The product or system can be changed with ease. It can be modified, adapted, or extended without causing unintended side effects or significant disruptions to its functionality.	3.4	Highly Maintainable
The product or system can be effectively and efficiently tested. It measures the ease with which tests can be designed, executed, and evaluated to assess the system's functionality, performance, and adherence to requirements.	3.4	Highly Maintainable
GRAND WEIGHTED MEAN	**3.44**	**Highly Maintainable**

Table 5 details the evaluation of the system's Maintainability in accordance with the ISO/IEC 25010:2025 standard, emphasizing the software's structural quality and long-term viability. The results show an exceptional level of performance, particularly in analyzability, which earned the highest mean score of 3.8. The system also demonstrated high performance in modularity, changeability, and testability, each earning a mean score of 3.4, while reusability scored 3.2. Each criterion was verbally interpreted as "Highly Maintainable". These scores contribute to a Grand Weighted Mean of 3.44, which ultimately categorizes the system as "Highly Maintainable". These findings indicate that the software is built with a

discrete, modular architecture that allows for efficient modifications, effective testing, and reusability across different systems without causing unintended disruptions to core functions.

Table 6: Tabulated Results of level of Effectiveness in terms of Security		
ISO/IEC 25010:2025 Criteria	**Average Weighted Mean**	**Verbal Interpretation**
The product or system protects the data by regulating its accessibility. Users have data restrictions.	3.4	Highly Reliable
A system, product or component prevents unauthorized access to, or modification of, computer programs or data.	3.8	Highly Reliable
Actions or events can be proven to have taken place, so that the events or actions cannot be repudiated later.	3.2	Reliable
The product or system has the capability of pointing out what happens to the system.	3	Reliable
GRAND WEIGHTED MEAN	**3.35**	**Highly Reliable**

Table 6 outlines the level of effectiveness of the system in terms of Security based on the ISO/IEC 25010:2025 criteria, indicating a strong capability to protect information and maintain data integrity. The results show that the system is "Highly Reliable" in preventing unauthorized access to, or modification of, computer programs or data, achieving its highest score of 3.8. Other evaluated areas, such as regulating data accessibility through user restrictions 3.4, non-repudiation of actions 3.2, and system accountability 3, were verbally interpreted ranging from "Reliable" to "Highly Reliable". Consequently, the category achieved a Grand Weighted Mean of 3.35, confirming an overall interpretation of "Highly Reliable". These findings suggest that the system effectively incorporates essential security controls, ensuring that data is protected from unauthorized use while providing a traceable record of system events.

Table 7: Summary of Effectiveness (IT Experts)		
ISO/IEC 25010:2025 Criteria	**Average Weighted Mean**	**Verbal Interpretation**
Functionality Suitability	3.80	Highly Suitable
Performance Efficiency	3.53	Highly Efficient
Usability	3.64	Highly Usable
Reliability	3.50	Highly Reliable
Maintainability	3.44	Highly Maintainable
Security	3.35	Highly Secure
GRAND WEIGHTED MEAN	**3.54**	**Highly Effective**

Table 7 summarizes the overall evaluation of the system's effectiveness, as assessed by IT experts, indicating a Grand Weighted Mean of 3.54, which corresponds to a verbal interpretation of "Highly Effective". The system demonstrated exceptional performance in Functionality Suitability, which received the highest rating of 3.80, suggesting the software features are perfectly aligned with user objectives. Furthermore, Usability 3.64, Performance Efficiency 3.53, and Reliability 3.50, each maintained strong ratings, while Maintainability and Security scored 3.44, and 3.35, respectively. All individual categories were interpreted as "Highly" effective. These results collectively validate that the Smart Library System is technically robust, aligns with ISO/IEC 25010:2025 standards, and successfully fulfills its objectives by providing a stable and efficient digital interface for library operations.

Table 8: Tabulated Results of level of Acceptance in terms of Functionality Suitability

ISO/IEC 25010:2025 Criteria	Average Weighted Mean	Verbal Interpretation
The set of functions covers all the specified tasks and user objectives.	3.96	Highly Suitable
The function provides the correct results with the need degree of precision.	3.96	Highly Suitable
The function facilitates the accomplishment of specified task and objectives.	3.95	Highly Suitable
GRAND WEIGHTED MEAN	**3.96**	**Highly Suitable**

Table 8 presents the evaluation of the system's Functional Suitability from the perspective of user acceptance, aligned with the ISO/IEC 25010:2025 standard. The results reflect a consistent and exceptionally high level of approval, with the functional coverage of user objectives and the precision of results both receiving a mean score of 3.96, while the facilitation of task accomplishment received a score of 3.95. Each sub-criterion resulted in a verbal interpretation of "Highly Suitable". With a Grand Weighted Mean of 3.96, the system is concluded to be "Highly Suitable," demonstrating that the target users find the software's features to be accurately implemented and perfectly aligned with their operational objectives and requirements.

Table 9: Tabulated Results of level of Acceptance in terms of Performance Efficiency

ISO/IEC 25010:2025 Criteria	Average Weighted Mean	Verbal Interpretation
The response and processing times and throughput rates of a product or system, when performing its functions, meet requirements.	3.95	Highly Efficient
The amounts and types of resources used by a system,	3.93	Highly Efficient

when performing its function, meet requirements.		
The maximum limits of the product or system, parameter meet requirements.	3.93	Highly Efficient
GRAND WEIGHTED MEAN	**3.94**	**Highly Efficient**

Table 9 presents the results for the level of Acceptance in terms of Performance Efficiency, reflecting a high degree of user satisfaction with the system's operational capabilities. The evaluation shows that response and processing times received the highest score of 3.95, while both resource utilization and capacity/system limits followed with a mean of 3.93, all of which are verbally interpreted as "Highly Efficient". With an overall Grand Weighted Mean of 3.94, the system is concluded to be "Highly Efficient" from the users' perspective. This indicates that the target audience finds the software's speed, throughput, and resource management to be superior, fully meeting or exceeding their expectations for high-performance interaction.

Table 10: Tabulated Results of level of Acceptance in terms of Usability

ISO/IEC 25010:2025 Criteria	Average Weighted Mean	Verbal Interpretation
A product or system is appropriate for the tasks it serves.	3.96	Highly Usable
A product or system enables the user to learn how to use it easily, effectively, and efficiently.	3.95	Highly Usable
A product or system is easy to operate, control and use appropriately.	3.94	Highly Usable
A product or system protects users to avoid mistakes or errors during usage.	3.93	Highly Usable
A user interface has a pleasing design and gives a satisfying interaction for the user.	3.96	Highly Usable
GRAND WEIGHTED MEAN	**3.95**	**Highly Usable**

Table 10 displays the results for the level of acceptance in terms of Usability, indicating that the software provides an exceptional experience for its end-users. Every sub-criterion including task appropriateness 3.96, ease of learning 3.95, ease of operation 3.94, user error protection 3.93, and interface satisfaction 3.96, earned high mean scores that were uniformly interpreted as "Highly Usable". With a Grand Weighted Mean of 3.95, the system is definitively categorized as "Highly Usable," proving that the target audience finds the interface intuitive and the operational flow efficient. This high level of acceptance underscores the system's success in balancing aesthetic design with functional ease, ensuring that users can complete their objectives with minimal effort and high satisfaction.

Table 11: Tabulated Results of level of Acceptance in terms of Reliability		
ISO/IEC 25010:2025 Criteria	**Average Weighted Mean**	**Verbal Interpretation**
A system, product or component meets for reliability under normal operation	3.96	Highly Reliable
The use of a product or system is operationally accessible when needed.	3.93	Highly Reliable
Despite the presence of hardware or software issues, a system, product, or component function as intended.	3.95	Highly Reliable
In the event of an interruption or a failure, a product or system can recover the data to establish the desired state of the system.	3.93	Reliable
GRAND WEIGHTED MEAN	**3.94**	**Highly Reliable**

Table 11 presents the results for the level of Acceptance in terms of Reliability, demonstrating that end-users have a high degree of trust in the system's stability and resilience. The highest individual rating was given to the system's performance under normal operation, which achieved a mean of 3.96, verbally interpreted as "Highly Reliable". Other criteria, such as fault tolerance despite hardware or software issues (3.95) and operational accessibility when needed (3.93), were also rated as "Highly Reliable," while data recoverability following an interruption was interpreted as "Reliable" with a mean of 3.93. Ultimately, the category yielded a Grand Weighted Mean of 3.94, confirming that the system is overall "Highly Reliable". These findings indicate that users perceive the software as a dependable tool that not only maintains consistent uptime but also possesses the necessary robustness to protect data and recover effectively from technical interruptions.

Table 12: Summary of User Acceptance (Dean, Admin, Professors)		
ISO/IEC 25010:2025 Criteria	**Average Weighted Mean**	**Verbal Interpretation**
Functionality Suitability	3.96	Highly Suitable
Performance Efficiency	3.94	Highly Efficient
Usability	3.95	Highly Usable
Reliability	3.94	Highly Reliable
GRAND WEIGHTED MEAN	**3.95**	**Highly Acceptable**

Table 12 summarizes the overall evaluation of user acceptance as assessed by the Dean, administrative staff, and professors, revealing a Grand Weighted Mean of 3.95, signifying that the system is "Highly Acceptable" to its target users. The evaluation was led by an exceptional score in Functionality Suitability 3.96, followed closely by Usability 3.95, indicating that the software is highly intuitive and effectively addresses the core requirements of library operations. Additionally, both Performance Efficiency and

Reliability achieved high ratings of 3.94, further confirming that the system operates smoothly and provides dependable results. These findings demonstrate that the proposed solution is not only technically capable but also aligns perfectly with the practical needs and expectations of the academic staff, ensuring high adoption and satisfaction rates within the institution.

CONCLUSIONS AND RECOMMENDATIONS

The study concludes that the NLP-driven Smart Library System is highly effective and highly acceptable, achieving grand weighted means of 3.54 from IT experts and 3.95 from institutional end-users. By transitioning from a manual monitoring process to an automated, voice-activated web platform, the system successfully eliminates search delays and manual errors while maintaining superior standards in usability and functional suitability. Consequently, the system is deemed technically robust and ready for full-scale deployment as a sustainable solution for the complex academic resource needs of Westbridge Institute of Technology, Inc. The study further concludes that the automated system effectively addresses the critical inefficiencies of the manual library processes at Westbridge Institute of Technology, Inc. (WITI). Multi-stakeholder evaluation based on ISO/IEC 25010 standards showed strong convergence: IT experts rated the technical quality as Highly Effective (grand mean 3.54), confirming the system's robust functionality and maintainability; and institutional end-users including the Dean, administrative staff, and professors demonstrated High Acceptance (grand mean 3.95), with particularly strong ratings for functional suitability (3.96) and usability (3.95). These findings affirm that transitioning from manual physical browsing to a relational, voice-enabled digital solution optimizes resource retrieval and ensures efficient record management through real-time updates. Overall, the system successfully bridges the gap between manual coordination and automated NLP optimization, providing a validated framework that respects user interaction needs while fulfilling the institution's complex academic requirements. Westbridge Institute of Technology, Inc. should formally transition to the Smart Library System to replace manual paper-based processes and streamline library service coordination. To maximize institutional impact, the school should adopt the proposed relational schema and focus on refining the NLP models to ensure the most accurate search results are consistently retrieved. Library staff should undergo specialized training on the system modules to formalize the digital archival process and ensure resources are accurately matched to user requests. While the system performs at a Highly Effective level, the institution should continuously monitor characteristics such as Security to ensure the platform scales effectively as user data increases. Finally, a periodic user feedback loop should be established to leverage the system's strengths in usability while addressing future technical enhancements like AI-driven recommendations. These steps will ensure the system remains a scalable, robust, and institutionally aligned solution for long-term academic management.

REFERENCES

Journal and Research Article

1. Hall, K. (2022). *A review on natural language processing models for information retrieval.* https://arxiv.org/abs/2211.14876
2. Cruz, M. (2021). *Artificial intelligence in academic support systems.* https://link.springer.com/chapter/10.1007/978-981-96-8895-1_37
3. Li, Z. (2024). *Python integration in smart library AI applications.* https://arxiv.org/abs/2407.14567

4. Adigun, G. O., Ajani, Y. A., & Enakrire, R. T. (2024). *The intelligent libraries: Innovation for a sustainable knowledge system in the Fifth Industrial Revolution.* Libri, 74(3), 211–223. https://doi.org/10.1515/libri-2023-0111
5. Bérubé, C. (2024). *Proactive behavior in voice assistants: A systematic review.* https://scholar.google.com/scholar?q=Proactive+behavior+in+voice+assistants+systematic+review
6. Dong, J. (2024). *Natural language processing pretraining: A survey.* https://arxiv.org/abs/2401.00001
7. Hall, K., & Jerfy, L. (2024). *The growing impact of natural language processing in information services.* https://journals.sagepub.com/doi/10.1177/00469580241290095
8. Huang, Y. (2023). *Artificial intelligence in academic library strategy.* Library Trends, 71(3),210–235. https://www.scirp.org/reference/referencespapers?referenceid=3880320

PDF

1. Kim, Y. (2023). *Enhancing web interactivity through JavaScript frameworks.* (PDF) Developing Modern JavaScript Frameworks for Building Interactive Single-Page Applications
2. Khurana, D. (2023). *Natural language processing: State of the art and current trends.* (PDF) Natural language processing: state of the art, current trends and challenges
3. Lee, J. (2023). *Web-based systems architecture for educational institutions.* Adaptive and intelligent web based education system: Towards an integral architecture and framework - ScienceDirect
4. Mariani, M. M., Lopez, A., & Chen, S. (2023). *Artificial intelligence empowered conversational agents: A systematic review.* ACM Computing Surveys, 55(4), 1–28. Artificial intelligence empowered conversational agents: A systematic literature review and research agenda - ScienceDirect
5. Santos, R., & De Vera, K. (2023). *Python-based natural language models for academic search engines.* An automated method for developing search strategies for systematic review using Natural Language Processing (NLP) - ScienceDirect
6. Sultana, I. (2024). *SmSeLib: Smart & secure library components and considerations.* (PDF) SmSeLib: Smart & Secure Libraries -Navigating the Intersection of Machine Learning and Artificial Intelligence
7. Dela Cruz, R., & Reyes, A. (2021). *Enhancing academic information retrieval using NLP.* https://digitalcommons.unl.edu/cgi/viewcontent.cgi?params=/context/libphilprac/article/15415/&path_info=auto_convert.pdf