FEYZİYE SCHOOLS FOUNDATION

IŞIK UNIVERSITY

Methodology

Instructor: Dr. Gülsüm Çiğdem ÇAVDAROĞLU

Bilgesu ÇAKIR

Nov, 2025

Table of Contents

TVC 3

Technological Domains 3

Literature Review 3

Refined Problem Definition 5

Problem and Solution Tree 5

Root Causes 6

Consequences 6

Solution Tree 7

Root Solutions 7

Expected Positive Outcomes 8

Work Package Methodology 9

WP1: System Architecture, Process Design, And Core Infrastructure Development 9

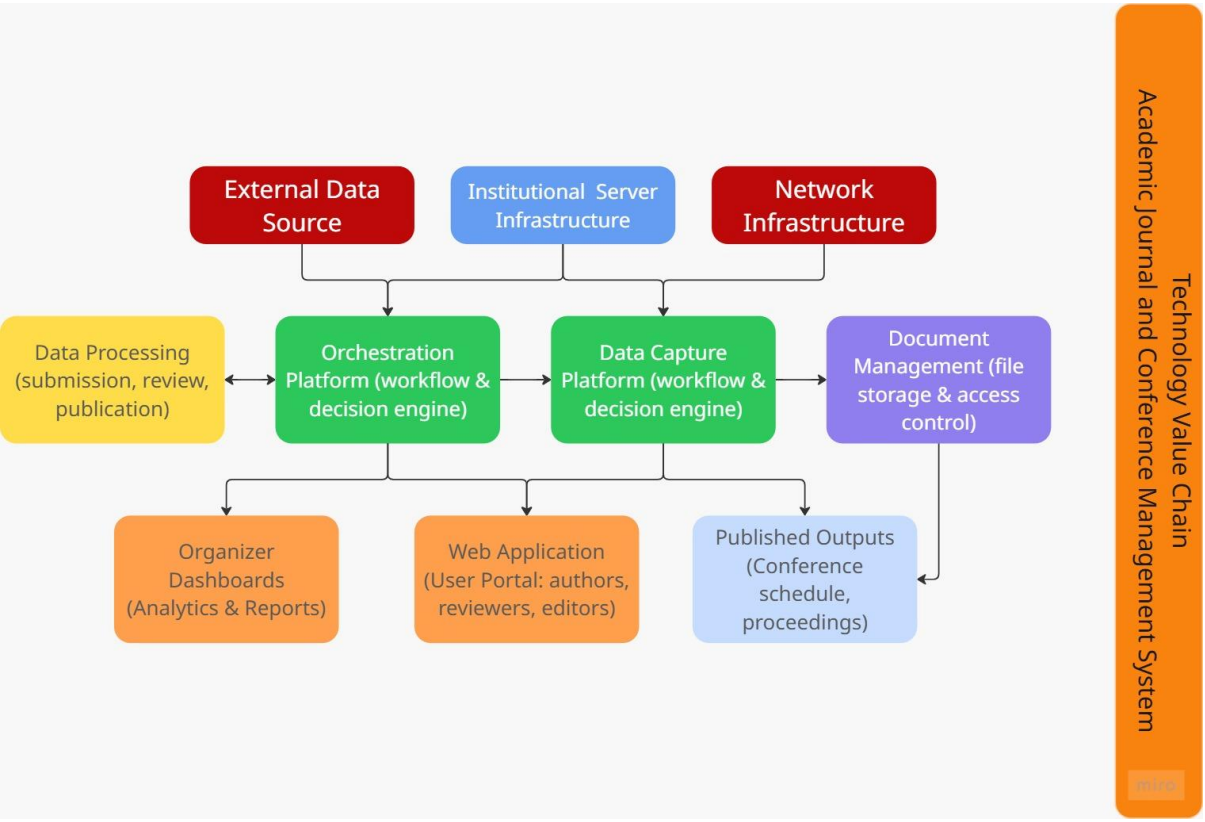
WP2: Referee Assignment Engine And Process Automation 10

WP3: User Interface, Accessibility, And Performance Evaluation 11

WP4: System Integration, Pilot Implementation, and Final Product Development 12

References 15

TVC



Technological Domains

This project focuses on microservice architecture, BPMN 2.0-based process modelling,

automatic reviewer matching algorithms, text processing and similarity analysis, accessibility standards (WCAG 2.2), and usability testing.

The literature indicates that microservice architecture offers scalability, security, and flexibility; BPMN based validation methods reduce process errors; NLP based reviewer assignment models increase matching accuracy; and WCAG compliance improves user experience. Therefore, all selected methods are consistent with current scientific trends in the technology fields.

Literature Review

Microservice architecture is increasingly being used to enhance efficiency and scalability on academic platforms [1]. This structure offers personalized experiences through recommendation systems based on user interests and participation history, thereby accelerating processes [1]. Microservice-based approaches have also been evaluated in studies comparing different solutions in the field of workflow management. These analyses have shown that features such as flexibility and event-based triggering improve system performance [2]. Service

networks developed to enable microservices to support different processing patterns provide significant improvements in transition times and processing times by integrating elements such as authentication, authorization, and monitoring [3]. Research conducted on the security dimension has compiled commonly used security practices in microservice systems based on data obtained from open source projects and practitioner surveys; it has revealed that API gateways, service-based identity management, and zero-trust principles are effective [4]. Furthermore, systems providing authentication and access control through a single API gateway in edge computing environments have been developed; this approach has been found to simplify management and centralize security policies [5]. These studies generally demonstrate that microservice architecture provides a robust infrastructure for academic platforms in terms of scalability, security, and integrated service management.

Research in the field of business process management focuses on testing and validating process models. As a result, it aims to ensure that BPMN structures work reliable in complex processes [6]. Systematic literature reviews conducted in this context show that BPMN testing methods are classified, model validation and verification techniques are analysed, and the scope of existing tools is determined [6]. Subsequently, research addressing the management of process variants with model-driven approaches has revealed that managing BPMN-based process families with a formal metamodel and model transformation tools reduces configuration errors and increases learnability [7]. Similarly, multi-layered scientific workflow engines compliant with the BPMN 2.0 standard, process execution engine, BPMN model engine, and scientific flow engine have been developed. These have provided scalable and extendable architectures [8]. In an experimental study on the timely execution of processes, personalized email reminders were found to increase the likelihood of participants completing tasks on time. This effect was reported to be measured as a 14% improvement [9].

In the context of process and expert assignment systems, research has initially focused on automating the referee-article matching process in conference management systems. For example, one of the first studies proposed a system architecture that matched articles with reviewers' competencies through a keyword taxonomy, which is still widely used today, taking into account not only exact matches but also semantic similarities in similarity measurements [11]. Then, it was shown that the referee assignment process could be speeded up using “automatic topic identification” techniques, by automatically extracting topics from article titles 6 and abstracts and defining referees' expertise from their publication histories [12]. Then, referee-article matching algorithms from 1992 to 2022 were systematically evaluated; the increasing importance of automatic assignment techniques in the literature, the diversification of matching criteria, and approaches to optimization problems were identified [13]. Moving on to the dimension of security and misconduct, it was observed that “collusion rings” (groups of reviewers who review each other's articles) formed through the offers reviewers made for articles could manipulate the assignment system, while existing detection tools were unable to effectively uncover these rings [15]. When all these studies are evaluated together, it is seen that referee-assignment processes are undergoing an evolution ranging from architecture to automation and from automation to fraud detection [11-15].

The usability of academic systems was first addressed through tests conducted on web-based journal and conference management systems. For example, one study identified nine main usability problem areas in the system based on feedback from authors, reviewers, and publishers during user tests conducted for an electronic journal management system [16]. Then,

in terms of accessibility, a guideline scheme prepared within the scope of international standards (World Wide Web Consortium (W3C) accessibility guideline 2.2) emphasizes the requirement to ensure the accessibility of systems and content by disabled users [17]. A user survey study on the usability of multilingual websites also revealed significant differences in user satisfaction and task completion time between different language versions [18]. Furthermore, the user experience (UX) and usability of online peer review tools were evaluated; reviews based on teacher and student profiles identified areas for improvement in both tools [19]. Finally, regional library websites were assessed for accessibility, and it was reported that these sites had various shortcomings in terms of access level and compatibility [20]. When these studies are evaluated together, it is seen that the areas of usability and accessibility are becoming increasingly important for academic process management, journal/conference management systems, and institutional web portals [16-20].

Refined Problem Definition

Academic journal and conference processes are multi-stage structures consisting of application, referee assignment, evaluation, revision, and decision steps. Since these processes are carried out in different systems in most institutions, problems such as time loss, increased workload, difficulty in monitoring, and inconsistency in the process arise.

Although the literature indicates that microservice architecture improves the performance of academic platforms in terms of flexibility, scalability, and security, existing systems do not widely use this approach [1–5]. Similarly, testing and validating BPMN-based workflows supports the correct functioning of complex processes; however, existing platforms do not sufficiently implement these methods [6–10].

Studies on the referee assignment process show that automatic topic extraction, similarity analysis, optimization, and accuracy-enhancing algorithms improve referee-article matching [11–15]. Nevertheless, manual assignment is still largely used in real systems, which can lead to errors, inappropriate matches, and biased results.

Various studies have revealed that usability and accessibility issues are prevalent on academic platforms, with serious shortcomings in navigation, feedback mechanisms, and compliance with WCAG standards [16–20].

Therefore, the fundamental problem can be defined as follows:

Academic journal and conference processes are slow, difficult to monitor, and produce inconsistent results because they lack an integrated, secure, automated, and accessible structure.

Problem and Solution Tree

Academic journal and conference processes are fragmented, slow, and difficult to track.

Root Causes

1. Architectural Reasons

• There is no integrated structure due to processes being executed on different systems.

• The flexibility, scalability, and security provided by microservice architecture are not sufficiently utilized in existing systems [1–5].

• Applications such as API Gateway and centralized authentication are lacking.

2. Workflow-Related Causes

• The processes of application → referee invitation → evaluation → decision are not modelled using standards such as BPMN 2.0.

• Process errors and delays cannot be detected because BPMN testing and validation methods are not applied [6–10].

• Automatic reminder, triggering, and time control mechanisms are inadequate.

3. Reasons Related to Reviewer Assignment

• Reviewer-article matching is largely done manually.

• Automatic topic extraction, similarity measurement, and optimization-based methods are not used [11–14].

• Protective controls against academic misconduct such as conflicts of interest and "collusion rings" are not implemented [15].

4. Usability and Accessibility Reasons

• The system's navigation structure, feedback, and user guidance are weak [16, 19].

• Accessibility features compliant with WCAG 2.2 standards are lacking [17, 20].

• There are inconsistencies in meaning, terminology, and structure in multilingual interfaces [18].

Consequences

Operational Outcomes

• Review processes are taking longer, and decision times are being delayed.

• The workload of editors and reviewers is increasing.

• It is not possible to track which stage of the process is being completed.

Quality and Fairness Outcomes

• Incorrect or unbalanced reviewer assignments may occur.

• Referee abuses cannot be detected.

• The quality and consistency of evaluations are declining.

User Experience Outcomes

• Authors cannot clearly see the progress of the process.

• Referees and editors are struggling to complete their tasks.

• Accessibility and usability issues lead to dissatisfaction.

Organizational Outcomes

• Alignment with digital transformation goals is not being achieved.

• The capacity to develop local/cloud-based academic systems is limited.

• Scalability and sustainability issues are emerging.

Solution Tree

To design a secure, automated, and accessible system that integrates academic application, peer review, and decision-making processes on a single platform.

Root Solutions

1. Architectural Solutions

• Establishing a microservices-based architecture

• Centralizing authentication, authorization, and monitoring with API Gateway + service mesh

• Creating a scalable and secure infrastructure [1–5]

2. Workflow Solutions

• Model all processes using BPMN 2.0

• Detect process errors early using BPMN testing/validation methods [6–10]

• Adding timers, automatic reminders, and status notifications

3. Referee Assignment Solutions

• Using automatic topic extraction, text similarity, and expertise analysis

• Developing referee assignment algorithms based on optimization and fairness criteria [11–14]

• Adding conflict of interest and collusion ring detection mechanisms [15]

4. Usability and Accessibility Solutions

• Identifying interface weaknesses through user testing [16,19]

• Ensuring full compliance with WCAG 2.2 standards [17,20]

• Standardizing terminology in multilingual interfaces [18]

Expected Positive Outcomes

Operational

• Processes are shortened, reducing the workload for editors and reviewers.

• The application–review–decision cycle becomes regular and traceable.

Quality and Fairness

• More accurate reviewer assignments are made.

• Detecting abuses becomes easier.

• Process integrity increases.

User Experience

• Authors see the process more clearly.

• Reviewers complete their tasks more easily.

• The interface becomes accessible to everyone.

Institutional

• Digital transformation goals are supported.

• The potential for developing local/cloud-based academic systems is strengthened.

• The platform becomes more sustainable and scalable.

Work Package Methodology

WP1: System Architecture, Process Design, And Core Infrastructure Development

Description:

This work package forms the foundation of the project. The necessary architecture and BPMN-based process designs for integrating submission, referee assignment, evaluation, and decision processes into a single digital platform are developed at this stage. The literature indicates that microservice-based academic platforms provide scalability, security, and process flexibility. Therefore, WP1 aims to establish the system's entire methodology on a solid foundation.

Goal:

To define the technical and structural infrastructure of the platform and establish processes within a standard model.

Objectives:

Obj-1: Prepare BPMN 2.0 process models covering submission–reviewer–evaluation flows.

Obj-2: Separate system components according to microservice logic.

Obj-3: Create a basic data model and API drafts.

Obj-4: Develop a core structure defining security, access control, and roles.

Tasks:

T1.1 – Requirements Analysis: Functional requirements for the roles of author, editor, reviewer, and administrator are gathered.

T1.2 – BPMN Process Modelling: The submission, reviewer assignment, evaluation, decision, and notification processes are modelled.

T1.3 – Microservice Architecture Design: Components such as identity management, submission service, reviewer service, and notification service are decomposed.

T1.4 – Data Model Design: Schemas are created for data entities such as articles, reviewers, evaluations, users, and notifications.

T1.5 – API Drafts and Security Layer: The API gateway structure, access roles, and authentication steps are defined.

Deliverables:

D1.1 – System Requirements Document (DOC)

D1.2 – BPMN 2.0 Process Diagrams (Model Set)

D1.3 – Microservices Architecture Design File (Technical document)

D1.4 – Data Model & API Drafts (Technical output)

WP Relationship:

WP1 forms the fundamental infrastructure of the project. The referee assignment and process automation to be developed in WP2 are based on these designs. The interface and performance evaluation in WP3 also uses the model and data structures defined in WP1.

WP2: Referee Assignment Engine And Process Automation

Description:

This work package covers the development of automated assignment methods that match articles with suitable referees. The literature indicates that referee assignment processes should be conducted based on criteria such as keywords, expertise, workload, and conflict checks. This WP aims to create an automation structure that takes all these criteria into account.

Goal:

To make the referee assignment process objective, fast, and measurable.

Objectives:

Obj-1: Develop a matching method that measures article–referee similarity.

Obj-2: Integrate workload, conflict of interest (COI), and suitability parameters into the system.

Obj-3: Automate the matching engine to work in line with BPMN processes.

Obj-4: Measure the accuracy of the algorithm through pilot tests.

Tasks:

T2.1 – Text Preprocessing & Keyword Extraction: Thematic analysis is performed on titles and abstracts.

T2.2 – Referee Expertise Profile Extraction: Referees' field tags and past publication information are processed.

T2.3 – Matching Algorithm Development: Similarity measurement, workload optimization, and conflict control are integrated.

T2.4 – Validation and Pilot Tests: Consistency and performance tests are performed on a sample submission pool.

T2.5 – Process Automation Integration: The assignment engine is connected to BPMN models and automatic notification flows are created.

Deliverables:

D2.1 – Referee Assignment Algorithm (Model)

D2.2 – Expertise & Keyword Dataset

D2.3 – Pilot Test and Validation Report (DOC)

D2.4 – Process Automation Flows (BPMN process set)

WP Relationship:

WP2 is based on the architectural and process models defined in WP1. The user interface in WP3 displays the matching output produced by WP2 and provides users with control capabilities.

WP3: User Interface, Accessibility, And Performance Evaluation

Description:

This work package includes interface design and evaluation tests that ensure the platform is user-friendly, accessible, and performs efficiently. The literature indicates that usability and accessibility issues are common in academic process management systems. Therefore, WP3 focuses on improving the user experience.

Goal:

To develop an easy-to-use, accessible, and fast-performing platform interface.

Objectives:

Obj-1: Create simple and understandable interfaces suitable for the roles of author, reviewer, and editor.

Obj-2: Ensure compliance with accessibility standards (WCAG 2.2).

Obj-3: Measure interaction performance through user testing.

Obj-4: Perform performance evaluation through system load testing.

Tasks:

T3.1 – UI/UX Design: Prototypes are prepared for submission, review, evaluation, and decision screens.

T3.2 – Accessibility Testing: Contrast, navigation, labelling, and keyboard access are tested according to WCAG criteria.

T3.3 – Usability Testing: User task scenarios, completion times, and errors are measured.

T3.4 – Performance & Load Testing: Response times, latency, and error rates under load are evaluated.

T3.5 – Final Improvements: Interface optimization is performed based on test results.

Deliverables:

D3.1 – UI/UX Prototypes (Screen Set)

D3.2 – Accessibility Evaluation Report (DOC)

D3.3 – Usability Test Report (DOC)

D3.4 – Performance Analysis Report (DOC)

WP Relationship:

WP3 is the layer that presents the architecture created in WP1 and the matching engine developed in WP2 to the user. The outputs of both WPs are processed in the WP3 interface, and user feedback is evaluated to improve the overall quality of the system.

WP4: System Integration, Pilot Implementation, and Final Product Development

Description:

This work package covers the integration of components developed in all previous work packages into a single integrated platform. The architectural structure, referee assignment

engine, and user interface modules are integrated with each other. The system is then piloted, and its performance and functionality are evaluated based on real user scenarios. This phase is when the final output of the project is concretely realized and turned into a working product.

Objective:

To create a functioning academic management system by integrating all developed modules and to validate the final product by conducting a pilot implementation of the system.

Goals:

Obj-1: Integrate all components developed in WP1, WP2, and WP3 into a single platform.

Obj-2: Verify that the system functions consistently.

Obj-3: Conduct usage tests with pilot user groups (authors, editors, reviewers).

Obj-4: Implement final improvements based on pilot results and prepare the final product.

Tasks:

T4.1 – Module Integration: The data model, API, referee assignment engine, and interface screens are connected to each other.

T4.2 – End-to-End System Tests: Submission creation, referee assignment, evaluation, and decision flows are tested end-to-end.

T4.3 – Pilot User Testing: The system is tested with a small group of designated users (e.g., authors, reviewers, editors) and feedback is collected.

T4.4 – Bug Fixing and Final Optimization: Improvements are made to performance, process flows, and the interface based on pilot results.

T4.5 – Final Product Preparation: A publishable, documented, and usable version is created.

Deliverables:

D4.1 – Integrated Working System (Beta Version)

D4.2 – End-to-End Test Results Report (DOC)

D4.3 – Pilot Usage Feedback Report (DOC)

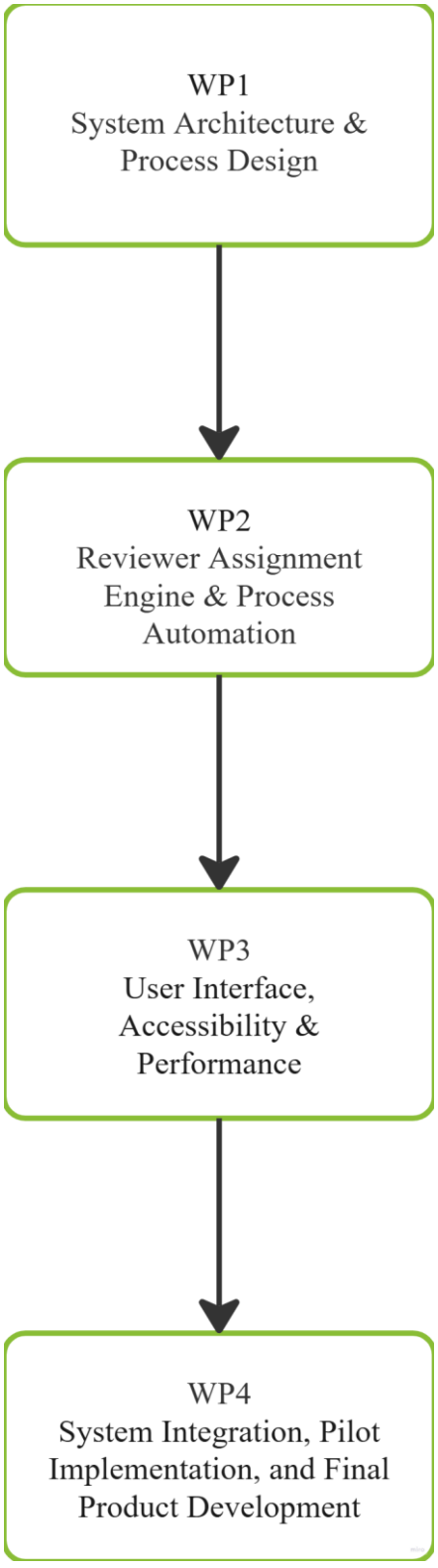
D4.4 – Final Improvements and Final Product Version (Release Package)

D4.5 – Final Product Documentation (User manual + technical explanations)

WP Relationship:

WP4 is the stage where the outputs of all previous work packages are combined.

The basic architecture of WP1, the referee assignment engine of WP2, and the user interface and usability outputs of WP3 are fully integrated in this WP and turned into a working product.



References

[1] Yang, B., Liu, H., Xiong, X., Zhu, S., Tolba, A., & Zhang, X. (2023). A big data platform for international academic conferences based on microservice framework. Electronics, 12(5), 1182. https://doi.org/10.3390/electronics12051182

[2] Represa, J. G., Larrinaga, F., Varga, P., Ochoa, W., Perez, A., Kozma, D., & Delsing, J. (2023). Investigation of microservice-based workflow management solutions for industrial automation. Applied Sciences, 13(3), 1835. https://doi.org/10.3390/app13031835

[3] Nicolas-Plata, A., Gonzalez-Compean, J. L., & Sosa-Sosa, V. J. (2024). A service mesh approach to integrate processing patterns into microservices applications. Cluster Computing, 27, 7417–7438. https://doi.org/10.1007/s10586-024-04342-5

[4] Rezaei Nasab, A., Khomh, F., & Adams, B. (2021). An empirical study of security practices for microservices systems. arXiv:2112.14927. https://arxiv.org/abs/2112.14927

[5] Xu, R., Jin, W., & Kim, D. (2019). Microservice security agent based on API gateway in edge computing. Sensors, 19(22), 4905. https://doi.org/10.3390/s19224905

[6] Bano, M., Ramzan, M., & Ikram, A. (2023). A literature review on techniques for BPMN testing and formal verification. Business Process Management Journal, 29(8), 66–90. https://www.emerald.com/bpmj/article/29/8/133/258196/

[7] García-Borgoñón, L., et al. (2022). Model-driven management of BPMN-based business process Software and Systems https://link.springer.com/article/10.1007/s10270-022-00985-3

[8] Wang, X., & Zhang, Y. (2024). A scientific workflow engine design and implementation (BPMN 2.0 compliant). In EAI (pp. 1–7). https://eudl.eu/pdf/10.4108/eai.15-3-2024.2346547

[9] Bälter, O., et al. (2023). Effect of personalized email-based reminders on participants' timeliness: A randomized study. https://formative.jmir.org/2023/1/e43977 JMIR Formative Research, 7, e43977.

[10] Lin, Y., & Chen, Z. (2024). A hybrid BPMN–DMN framework for secure inter organizational workflows. arXiv:2412.01196. https://arxiv.org/html/2412.01196v1

[11] Kalmukov, Y. (2011). Architecture of a conference management system providing advanced paper assignment features. IJCA, 34(3), 51–59. https://arxiv.org/abs/1111.6934

[12] Ferilli, S., et al. (2006). Automatic topics identification for reviewer assignment. In LNCS. https://link.springer.com/chapter/10.1007/11779568_78

[13] Zhao, X., et al. (2022). Reviewer assignment algorithms for peer review automation.

IP&M, 59(6), 102991. https://www.sciencedirect.com/science/article/pii/S0306457322001388

[14] Karimzadehgan, M., et al. (2012). Integer linear programming for constrained multi-aspect expertise matching in reviewer https://pmc.ncbi.nlm.nih.gov/articles/PMC3375698/ assignment.

[15] Shibber, A., et al. (2024). On the detection of reviewer-author collusion rings from bidding data. arXiv:2402.07860. https://arxiv.org/abs/2402.07860

[16] Hasan, L. R., & Abuelrub, E. (2013). Usability Testing for IAJIT OpenConf JMS. Journal of Software, 8(2), (PDF) Usability Testing for IAJIT OpenConf Journal Management System

[17] W3C Accessibility Guidelines Working Group. (2023/2024). WCAG 2.2. W3C Recommendation. https://www.w3.org/TR/WCAG22/

[18] Miraz, M., Excell, P., Maaruf, M., & Maarof, M. (2013). Multilingual website usability analysis on an international user survey. https://www.researchgate.net/publication/259864612

[19] Azevedo, R., Alves, C., & Pereira, R. (2022). Analysing usability and UX in peer review tools. In Proceedings of the 14th International Conference on Computer Supported Education (CSEDU 2022) (pp. 363–370). https://www.scitepress.org/Papers/2022/110675/110675.pdf

[20] Hristov, R. (2024). Accessibility evaluation of the websites of the regional libraries in Bulgaria. New Perspectives in Science Education (Conference Proceedings). https://conference.pixel-online.net/files/npse/ed0014/FP/0146-SNEE6937-FP-NPSE14.pdf