

A hierarchical scholar expertise information system based on publication profiles and research records: a case in Universitas Diponegoro

Eko Didik Widiyanto¹, Hadiyanto², Teddy Mantoro³, Raka Sindu Wardoyo⁴,
Muhamad Irham Maulana¹

¹Department of Computer Engineering, Faculty of Engineering, Universitas Diponegoro, Semarang, Indonesia

²School of Postgraduate, Universitas Diponegoro, Semarang, Indonesia

³Faculty of Science and Technology, Sampoerna University, Jakarta, Indonesia

⁴Institute for Research and Community Service, Universitas Diponegoro, Semarang, Indonesia

Article Info

Article history:

Received Sep 17, 2024

Revised May 28, 2026

Accepted Jun 27, 2026

Keywords:

Campus competitive advantage

Research productivity

Scholar information system

Science and technology index

University reputation

ABSTRACT

One factor that boosts the reputation of higher education institutions (HEIs) in gaining competitive advantage is the research productivity of their scholars, including at Diponegoro University (Undip). However, existing studies focus on metrics and their measurement but lack discussion of systems for leveraging these metrics to promote these scholars' expertise. This study proposes a scholars' expertise information system at Undip based on their publications and research track records to bridge information between the campus and outside parties, namely industry, government, and society. It provides expertise searching and browsing facilities in Dewey's hierarchy of subjects and the institutional structure hierarchy. Scholar publications and research data are retrieved using the science and technology index application program interface (SINTA API). The collected data included lecturer profiles, study programs, SINTA subjects, articles, research, community service, intellectual property rights (IPR), and books. It has been fully deployed and adopted online, presenting the expertise of Undip scholars based on their publications and research records. The finding shows that all pages perform well, with an average GTmetrix B grade and a performance score of 91%, a structure score of 88%, and a 1.8s loading time. With all the functionalities and performances of the system, this study contributes to developing an information system model to promote the expertise of university scholars, primarily based on their publications and research.

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Corresponding Author:

Eko Didik Widiyanto

Department of Computer Engineering, Faculty of Engineering, Universitas Diponegoro

Prof. Sudarto st., Semarang, Central Java 50275, Indonesia

Email: didik@live.undip.ac.id

1. INTRODUCTION

Globalization, ranking, and limited funding availability have created a competitive environment for higher education institutions (HEIs) [1]. The university's reputation has a significant and positive influence in gaining a sustainable competitive advantage, including student enrollment, funding sources and support, and broader access to the labor market [2]. Research productivity affects the university's reputation, including the number of articles published in high-ranking journals and the number of citations they obtain [3]–[6]. Research productivity requires commitment from campus institutions and stakeholders to achieve excellence in research

processes and results [7]. From the HEI perspective, campus stakeholders are all internal and external parties who influence and are affected by university actions, behaviors, and policies [8], [9].

The influence of this global ranking requires HEIs to meet performance indicators, develop performance-based appraisal systems, and implement changes to obtain a world-class university reputation [10], [11]. Publication and announcement of ranking results at national and global levels have also shaped opinions that influence policy-making, academic behavior, and stakeholder opinion on university performance [12], including in Indonesia [13], [14]. As one of the stakeholders in developing HEIs in Indonesia, the Directorate General of Higher Education (DGHE) in the Ministry of Education and Culture of the Republic of Indonesia has established a strategy to strengthen the quality and relevance of higher education to increase the number of world-class universities [15].

DGHE has established a policy for assessing lecturers' credit according to their academic qualifications and field of knowledge, one of which is based on the publication of scientific papers in journals [16]. These journals fall into four categories: national journals, accredited national journals, international journals, and reputable international journals. Furthermore, one measure of performance in realizing the strategy for strengthening HEIs, both state and private universities, is the number of lecturers' publications, their citations, and the scientific productivity of institutions in reputable international journals or conferences, especially those indexed in Scopus and Web of Science (WoS) [17]. The number of research publications for an institution, especially in Scopus, becomes a weight in university rankings by world university ranking agencies, such as Webometrics [18]. Hence, increasing research publications becomes a priority strategy for most HEIs.

Publication of research and scientific articles from these lecturers needs to be further promoted on the university website so that other parties, namely industry, government, and society, can obtain information about lecturers and their expertise from its online official resource [19]. Riyanto *et al.* [20] conducted a web-based mapping of national expertise in Indonesia. Input data from researchers and their expertise came from the Indonesian Institute of Sciences (LIPI) in Excel format and converted to structured query language (SQL). Saaludin *et al.* [6] improved lecturers' evaluation scores by using AHP to obtain the weightage of each criterion evaluation. Expertise mapping has also been carried out for other purposes, including selecting a thesis supervisor, using various algorithms, such as decision tree classification and analytical hierarchy process [21], [22].

Existing studies focus on metrics and their measurement but lack a system for leveraging these metrics to improve the expertise of these academics on their websites, as Saleh *et al.* [19] suggested. Therefore, this study proposes a web-based information system that provides a hierarchy of institutions and scholars' expertise in a HEIs, namely Diponegoro University (Undip), using publication and research data from the science and technology index database (SINTA) [23]. Besides promoting scholars' expertise like Salman [24], this developed system can also be used to measure university research performance [13], [25] and improve university brand [26].

2. METHOD

This study developed an Undip scholars' expertise information system (EIS) and deployed the system on an operational server. It provides data on scholars based on their scientific publications and research track records in a hierarchy of the institution and scholars' expertise. The application ran on an Ubuntu server with 2x2.2 GHz CPU processors and 2GB of memory and was implemented using Laravel 8.83.27, Bootstrap 4.0.0-Beta, PHP 7.4.33, and MySQL 8.0.31. The constraints in this system are the server specifications provided by the university's IT manager, including Linux Ubuntu operating system (OS), Apache webserver, PHP, and MySQL database. Using the Laravel and Bootstrap frameworks is not a constraint for this system and is based on our programming preference to meet the functional specifications.

Scholars' publications and research data are collected from SINTA [23]. The application program interface (API) provides access to the SINTA server using Laravel Job Batching. It allows sending a group of jobs to a queue to be executed in parallel for more efficient data retrieval. Data fetched from SINTA included profiles of lecturers, study programs, SINTA subjects, articles from Scopus, Garuda, Google Scholar, and WoS, research, community service, intellectual property right (IPR), and books. Initially, we collected 1609 scholar data and stored them in the MySQL database for further processing. We used scholar affiliations to map scholars based on 14 faculties/schools and 148 academic programs in Undip. Furthermore, this study used the Dewey decimal code to determine expertise based on subject mapping owned by scholars [27], [28]. It provides a classification system according to a hierarchy of decimal principles that divides all fields of knowledge.

The application has been deployed on the operational server at <https://kepakaran.apps.undip.ac.id>. We conducted functional testing to ensure the functionality of all pages, including searching and indexing the lecturer database and their expertise and representing the lecturer publication profile with performance graphics. Unlike using the subjective user acceptance analysis as in [29], [30], to ensure the reliability and efficiency of the EIS, we also conducted performance tests using GTmetrix on all public pages [31]. These

tests grade pages on how fast they perform in loading, interactivity, and visual stability. This grade is a weighted average of the performance and structure scores with a 60:40 composition. The performance score shows how well the page performs from a user perspective. It uses five key weighting metrics: first contentful paint (FCP), speed index, largest contentful paint (LCP), total blocking time (TBT), and cumulative layout shift (CLS). The structure score shows how well the page is built for optimal performance. We use these grades and scores to validate the system's performance and ability to provide a seamless user experience, as used in [32]–[34]. Moreover, utilizing the Statcounter website, we investigated the impact of EIS based on its average monthly view and visitors in the last 12 months. This tool can provide valuable insights for website owners to understand user behavior and improve performance [33], [35].

3. RESULTS AND DISCUSSION

The EIS system is a unique online tool on the official university website that facilitates expert connections. It offers comprehensive data on Undip lecturers' profiles, publications, and research track records in the hierarchical order of their affiliations and expertise. This centralized and structured expertise data can be easily accessed by users, enabling them to find experts at Undip based on their specific fields of interest. Moreover, it is a potent promotional tool for those seeking collaboration with the university's professional experts. Figure 1 shows a use-case diagram describing the behavior of the system. The system involves three categories of users: administrators, lecturers, and public users. Administrators are actors who can process data and are classified as university admins, faculty admins, and department admins. The public user is an actor who can access and view the homepage and the available menus. Each admin has their respective roles and rights when accessing the admin page inside login. The university admins can manage the profiles and accounts of all faculties, departments, lecturers, and the about page, ensuring the information is accurate and up-to-date. Faculty admins can manage faculty profiles and accounts, department profiles and accounts in the faculty, and lecturer accounts and profiles in the faculty. Department admins can manage department profiles and accounts and lecturer accounts and profiles in the department. Lecturers can manage their accounts and profiles. Meanwhile, public users can visit and access the menus available on the homepage, including a list of experts, a list of lecturers, and the about page. They can view lecturer profiles by selecting from the list of lecturers or their departments.

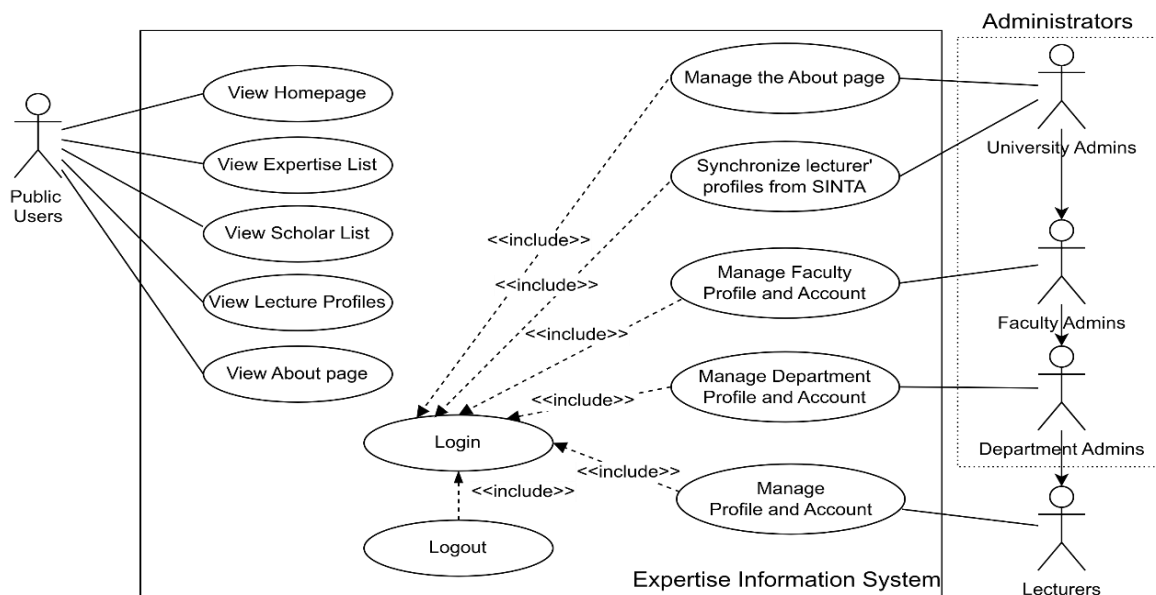


Figure 1. Use-case diagram of the EIS system

The EIS user-friendly interface presents data on lecturers and researchers in a clear hierarchical structure based on scientific publications and research records. It provides easy-to-use search and browse functions for scholars' data, presenting complete expertise and profiles with a brief performance graphic. The main page is intuitively organized, consisting of the homepage, the expertise pages, and the scholars' profile pages based on their affiliations. Figure 2 shows the menu and page hierarchy. It collects 1,609

scholar profiles, including publications, books, IPRs, research, and community service activities. Profiles can be browsed and indexed through the hierarchy of areas of expertise and their affiliations. The areas of expertise display the arrangement of 10 parent areas and their children using the Dewey classification. Affiliations display the hierarchy of 14 faculties/schools/institutions and 148 academic programs at Undip. It provides search facilities using scholar or expertise keywords on the main page and all pages with their respective scopes.

Data modeling in Figure 3 shows the relationship between data used in the EIS system as an entity relationship diagram (ERD). ERD is used to model complex data structures and relationships that define the main table and connect tables and their attributes with data types and lengths, primary keys, foreign keys, and cardinality. EIS uses 19 main and eight connecting tables to implement the system's functionality.

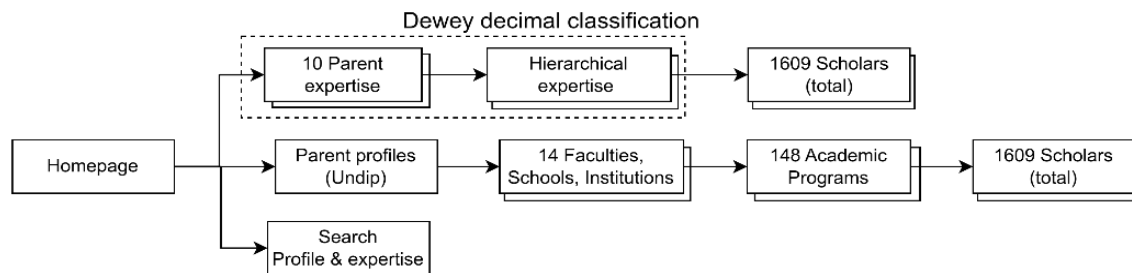


Figure 2. Menu and page hierarchy



Figure 3. Data modeling using entity relationship diagram (ERD)

Figure 4 shows the implementation of the main pages of EIS. The homepage in Figure 4(a) displays four menus: expertise, profiles, about, and login. The page also displays the 5 top subjects and scholars based on the number of their publications. The expertise page displays scholars hierarchically and alphabetically grouped based on their fields of expertise, as shown in Figures 4(b) and 4(c), respectively. The profiles page displays scholars grouped by faculty or study program hierarchically and alphabetically by scholar name, as shown in Figures 4(d) and 4(e), respectively. A list of 5 featured scholars and expertise is also displayed in the sidebar. The scholar page in Figure 4(f) displays his/her biography, publications, IPR, books, research,

and community service. The spider graph on the page shows the Scopus publications profile based on their documents' quartile. This page also shows connections of other scholars involved in publication collaborations.

This EIS system has been operating online at <https://kepakaran.apps.undip.ac.id>. The test results of its performance using GTmetrix and its impact using Statcounter are shown in Figure 5. GTmetrix produces an A grade for the homepage with a performance score of 95% and a structure of 92%, as in Figure 5(a). It shows that the access speed performance of this page is excellent in terms of loading time, interactivity, and visual stability. This grade reflects an excellent web page experience in terms of front-end structure and actual performance experienced by users. The longest time to display elements on the page (largest contentful paint, LCP) is 1.2s, and to process the code script (total blocking time, TBT) is 0s. The optimality value of the displayed page layout (cumulative layout shift, CLS) is 0.01. These results indicate that accessing the homepage will provide a good user experience, with an LCP value of less than 1.2s, TBT of less than 0.15s, and CLS of less than 0.1 [31]. The system impact metrics are shown by the number of views and unique visitors, as in Figure 5(b). The system received an average of 14.6 K monthly views and 7.0 K monthly visitors in one year, respectively.

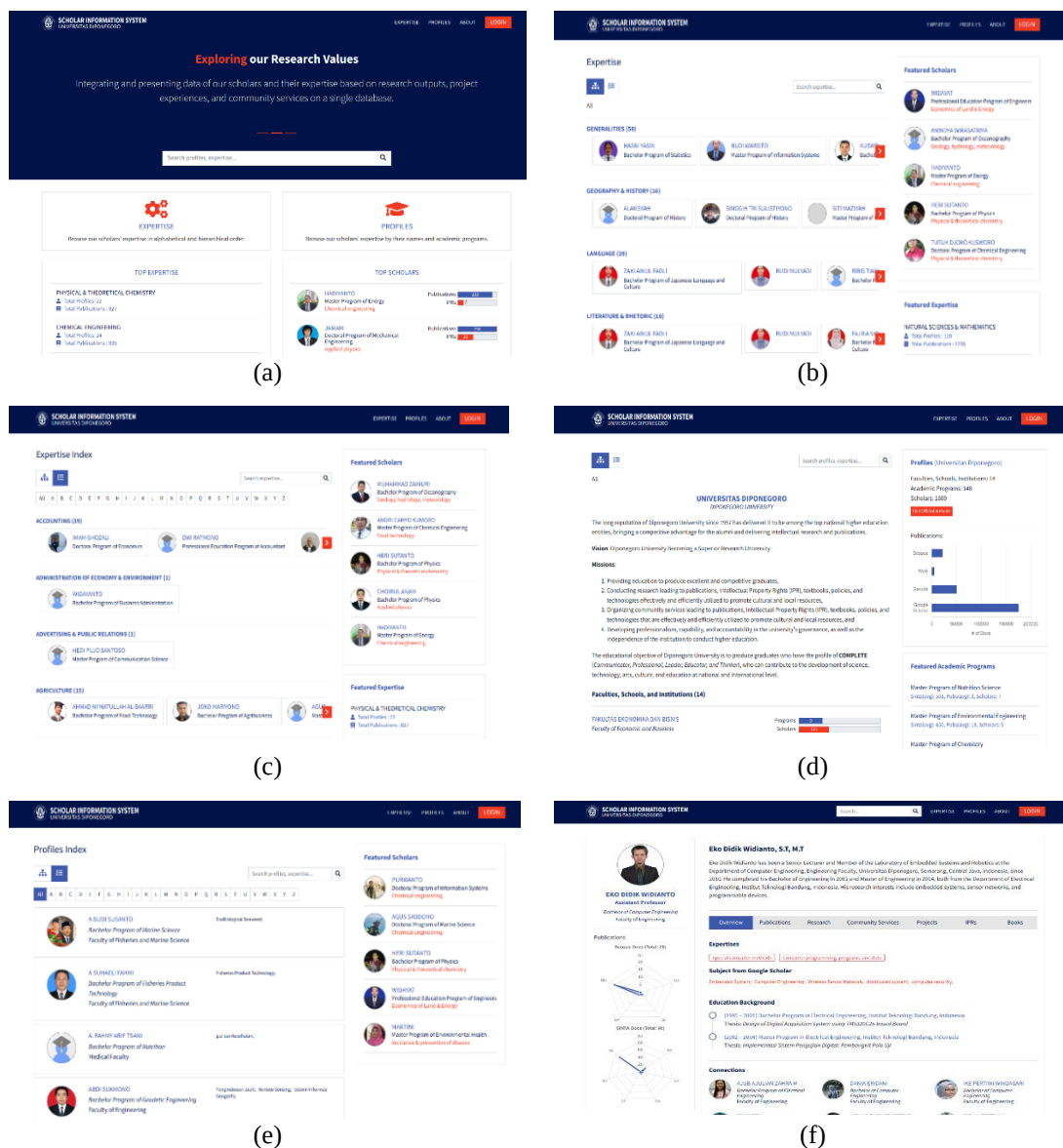
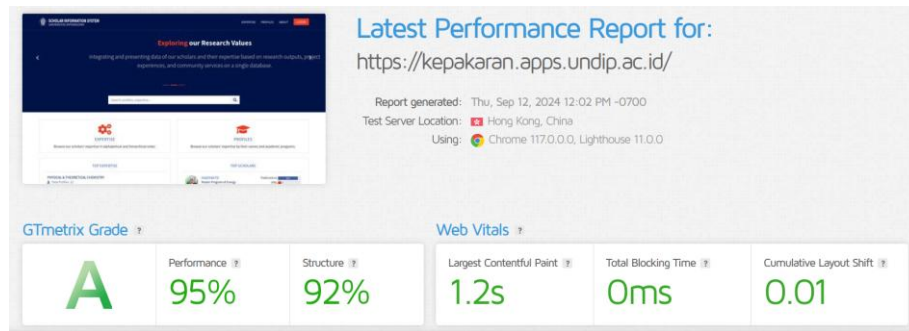
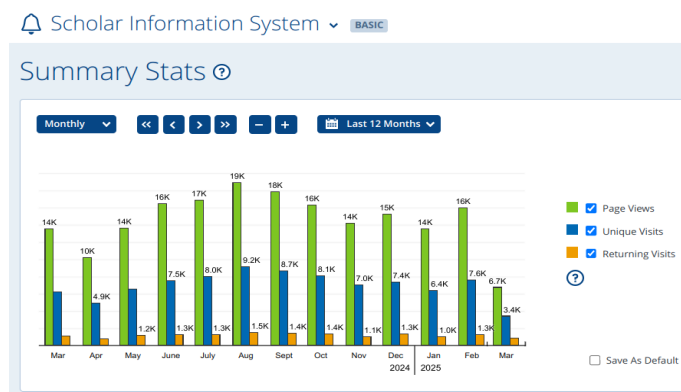


Figure 4. Main pages implementation: (a) homepage, (b) expertise page by subjects' hierarchy, (c) expertise page by subject index, (d) profiles page by affiliation hierarchy, (e) profiles pages by scholar index, and (f) a scholar profile page

Table 1 details the performance testing results on all EIS main pages using GTmetrix. Almost all pages are A grade with performance and structure scores above 90%. The worst grade is the expertise page, both hierarchically and alphabetically, with grades D and C, respectively, with loading times of 6.8s and 3s. The expertise page gets the worst performance and structure scores of 49% and 77%. Its worst TBT time is 0.589s. This performance is because the expertise page has an excess document object model (DOM) size of 7,250 elements [36]. However, the average EIS page grade is B, which is a good performance. It has performance and structure scores of 91% and 88%. The average full-page loading time is 1.8s. We demonstrated that this EIS has a good user experience [31], as [34] with Google's page speed.



(a)



(b)

Figure 5. The EIS performance and impact: (a) using GTmetrix on the homepage and (b) statcounter monthly views and unique visitors to the website

Table 1. The EIS functionality and performance

No	Page name	Page route	Functionality	GTmetrix		Web vitals				Page load (s)
				Grade	PS (%)	SS (%)	LCP (s)	TBT (s)	CLS	
1.	Homepage	/	Success	A	95	92	1.2	0	0.01	1.9
2.	Expertise (hierarchical)	/expertise	Success	D	49	77	2.3	0.589	0.23	6.8
3.	Parent expertise	/expertise/categorical/E0	Success	B	89	85	1.1	0.210	0.04	1.9
4.	Child expertise	/expertise/categorical/E0/SE000	Success	A	95	86	1.1	0.105	0.07	1.5
5.	Grandchild expertise	/expertise/categorical/E0/SE000/004	Success	A	95	91	1.1	0	0.07	1.2
6.	Expertise (alphabetical)	/expertise/alphabetical	Success	C	71	82	1.3	0.264	0.25	3.0
7.	Scholars (Root Institution)	/lecturers	Success	A	97	92	1.1	0.034	0.02	1.2
8.	Scholars (Faculty)	/lecturers/list/faculty/4	Success	A	92	91	1.4	0	0.01	1.6
9.	Scholars (Program)	/lecturers/list/faculty/4/62201	Success	A	92	91	1.4	0	0.01	1.5
10.	Scholars (alphabetical)	/lecturers/alphabetical	Success	A	98	91	0.989	0	0.01	1.1
11.	Overview profile	/lecturers/profile/<id>/overview	Success	A	96	90	1.1	0	0	1.3
12.	Publication profile	/lecturers/profile/<id>/publications	Success	A	98	90	0.968	0.018	0.01	1.2
13.	Research profile	/lecturers/profile/<id>/research	Success	A	98	89	0.975	0.030	0.01	1.1
14.	Comm. Service profile	/lecturers/profile/<id>/com_services	Success	A	97	91	1.0	0.055	0	1.2
15.	IPR profile	/lecturers/profile/<id>/iprs	Success	A	92	90	1.4	0.009	0	1.5
16.	Books profile	/lecturers/profile/<id>/books	Success	A	97	89	1.1	0.001	0	1.1

PS: performance score, SS: structure score, LCP: largest contentful paint in s, TBT: total blocking time in ms, CLS: cumulative layout shift

These results indicate that the developed EIS system has functioned and performed well. The significant number of views and unique visitors shows that the system has received visitors' attention. The finding shows that universities can use this EIS model to leverage their scholars' research productivity and promote their expertise [20], [24]. However, the results of these tests may vary depending on several factors, including the time and location of the user during the test [32]. Also, this system still manually maps scholars and their expertise, so further research can implement AI to automatically classify scholars' expertise based on their publication and research metadata records [37]–[39].

Moreover, there are still pages in the EIS that need performance improvements [40], [41], especially the expertise page with large DOM elements, such as implementing React Java-script front-end [42] and Redis cache in the back-end server [43], [44]. This user experience testing may also be done automatically to identify web operations periodically and provide recommendations to overcome performance bottlenecks and improve website quality [45]. Since this study focuses more on system performance to provide user experience, like [29] with user acceptance testing and [30] with usability testing, both of which only focus on potential users, we conducted tests to measure loading speed, interactivity, and visual stability of each website page. Usability and performance testing can be integrated to optimize the website to provide a seamless and efficient user experience, ensuring higher satisfaction and engagement [34], [46].

4. CONCLUSION

The scholar information system has been fully developed and deployed online at <https://kepakaran.apps.undip.ac.id>. It is fully operational and presents the expertise of Undip Scholars based on their publications in hierarchical and alphabetical expertise and affiliations. All pages have an average B grade, with a performance score of 91%, a structure score of 88%, and a 1.8s loading time. The average monthly number of views and visitors to the website of 14.6K and 7.0K, respectively, shows that the system has positively impacted the promotion of Undip scholars' expertise. With these regards, this web-based system can be a model for promoting the expertise of university scholars, primarily based on their publications and research.

ACKNOWLEDGMENTS

We thank the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia for providing the SINTA API of Undip authors' metadata. We also thank Wisnu Adi Pramono and Daniel Alvaro Sormin from the Department of Computer Engineering, Diponegoro University (Undip), who helped us develop this application.

REFERENCES

- [1] G. Miotto, C. Del-Castillo-Feito, and A. Blanco-González, "Reputation and legitimacy: key factors for higher education institutions' sustained competitive advantage," *Journal of Business Research*, vol. 112, pp. 342–353, May 2020, doi: 10.1016/j.jbusres.2019.11.076.
- [2] M. Amado Mateus and F. Juárez Acosta, "Reputation in higher education: a systematic review," *Frontiers in Education*, vol. 7, Jun. 2022, doi: 10.3389/feduc.2022.925117.
- [3] B. L. Delgado-Márquez, M. Á. Escudero-Torres, and N. E. Hurtado-Torres, "Being highly internationalised strengthens your reputation: an empirical investigation of top higher education institutions," *Higher Education*, vol. 66, no. 5, pp. 619–633, Nov. 2013, doi: 10.1007/s10734-013-9626-8.
- [4] C.-K. (Karl) Huang *et al.*, "Comparison of bibliographic data sources: implications for the robustness of university rankings," *Quantitative Science Studies*, vol. 1, no. 2, pp. 445–478, Jun. 2020, doi: 10.1162/qss_a_00031.
- [5] J. D. Linton, R. Tierney, and S. T. Walsh, "Publish or perish: how are research and reputation related?," *Serials Review*, vol. 37, no. 4, pp. 244–257, Dec. 2011, doi: 10.1080/00987913.2011.10765398.
- [6] N. Saaludin, M. H. Ismail, B. Che Mat, and S. Harun, "Improving lecturers' evaluation score by using analytic hierarchy process (AHP): a case at universiti kuala lumpur," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 15, no. 1, pp. 391–398, Jul. 2019, doi: 10.11591/ijeecs.v15.i1.pp391-398.
- [7] D. Vogler, "Analyzing reputation of Swiss universities on Twitter—the role of stakeholders, content and sources," *Corporate Communications: An International Journal*, vol. 25, no. 3, pp. 429–445, May 2020, doi: 10.1108/CCIJ-04-2019-0043.
- [8] J. Burrows, "Going beyond labels: a framework for profiling institutional stakeholders," *Contemporary Education*, vol. 70, no. 4, p. 5, 1999, [Online]. Available: <http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=3116623&site=ehost-live>
- [9] J. Kettunen, "Stakeholder relationships in higher education," *Tertiary Education and Management*, vol. 21, no. 1, pp. 56–65, Jan. 2015, doi: 10.1080/13583883.2014.997277.
- [10] M. Marques and J. J. W. Powell, "Ratings, rankings, research evaluation: how do schools of education behave strategically within stratified UK higher education?," *Higher Education*, vol. 79, no. 5, pp. 829–846, May 2020, doi: 10.1007/s10734-019-00440-1.
- [11] E. Janavi and S. Abdi, "Faculty members' performance appraisal system: a bibliometric analysis of the scientific literature," *International Journal of Information Science and Management*, vol. 22, no. 3, pp. 63–83, 2024, doi: 10.22034/ijism.2024.2013962.1281.
- [12] E. Hazelkorn and A. Gibson, "Global science, national research, and the question of university rankings," *Palgrave Communications*, vol. 3, no. 1, p. 21, Nov. 2017, doi: 10.1057/s41599-017-0011-6.

- [13] A. I. Hermanu, D. Sari, M. C. Sondari, and M. Dimiyati, "Is it necessary to evaluate university research performance instrument? Evidence from Indonesia," *Cogent Social Sciences*, vol. 8, no. 1, Dec. 2022, doi: 10.1080/23311886.2022.2069210.
- [14] B. M. Sukoco *et al.*, "Stakeholder pressure to obtain world-class status among Indonesian universities," *Higher Education*, vol. 82, no. 3, pp. 561–581, Sep. 2021, doi: 10.1007/s10734-020-00667-3.
- [15] Directorate General of Higher Education, "Rencana strategis Direktorat Jenderal Pendidikan Tinggi 2020-2024 (Strategic plan of the Directorate General of Higher Education 2020-2024)." Ministry of Education and Culture of Indonesia, 2020.
- [16] Directorate General of Science and Technology Resources and Higher Education, "Pedoman Operasional penilaian angka kredit kenaikan jabatan akademik/pangkat dosen (Operational guidelines for assessing credit points for academic promotion/lecturer ranks)." Ministry of Research Technology and Higher Education, Jakarta, 2019.
- [17] Directorate General of Higher Education, "Buku panduan indikator kinerja utama perguruan tinggi negeri (handbook of key performance indicators of state universities)." Ministry of Education and Culture of Indonesia, Jakarta, 2021.
- [18] Webometrics, "Methodology," Webometrics. Accessed: Sep. 12, 2024. [Online]. Available: <https://www.webometrics.info/en/Methodology>.
- [19] A. H. Saleh, R. C. M. Yusoff, N. A. A. Bakar, and R. Ibrahim, "Systematic literature review on university website quality," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 25, no. 1, pp. 511–520, Jan. 2022, doi: 10.11591/ijeecs.v25.i1.pp511-520.
- [20] S. Riyanto, Lukman, and H. Subagyo, "Sistem informasi direktori kepakaran nasional berbasis web sebagai sarana knowledge management (Web-based national expertise directory information system as a knowledge management tool)," *Konferensi Teknologi Informasi dan Komunikasi untuk Indonesia*, pp. 306–311, 2011.
- [21] Yuanyuan Fan, Ana Evangelista, and Hadi Harb, "An automated thesis supervisor allocation process using machine learning," *Global Journal of Engineering Education*, vol. 23, no. 1, pp. 20–30, 2021.
- [22] S. Faudzi, S. Abdul-Rahman, R. A. Rahman, J. Zulkepli, and A. Bargiela, "Optimizing the preference of student-lecturer allocation problem using analytical hierarchy process and integer programming," *Journal of Engineering Science and Technology*, vol. 15, no. 1, pp. 261–275, 2020.
- [23] Sinta, "Affiliations." Accessed: Sep. 12, 2024. [Online]. Available: <https://sinta.kemdiktisaintek.go.id/affiliations?page=6>
- [24] O. Salman, "Promoting Diversity in Academic Research Communities through Multivariate Expert Recommendation," University of Arkansas, 2021.
- [25] M. Dimiyati *et al.*, "Research strength index to identify the performance of research universities: the case of Indonesia," *Journal of Science and Technology Policy Management*, vol. 14, no. 3, pp. 547–562, Apr. 2023, doi: 10.1108/JSTPM-06-2020-0096.
- [26] X. Yaping, N. T. T. Huong, N. H. Nam, P. D. Quyet, C. T. Khanh, and D. T. H. Anh, "University brand: a systematic literature review," *Heliyon*, vol. 9, no. 6, p. e16825, Jun. 2023, doi: 10.1016/j.heliyon.2023.e16825.
- [27] M. Dewey, *A classification and subject index, for cataloguing and arranging the books and pamphlets of a library*. Amherst, MA, USA, 1876.
- [28] OCLC, "Introduction to the Dewey decimal classification." Accessed: Sep. 12, 2024. [Online]. Available: <https://www.oclc.org/content/dam/oclc/dewey/versions/print/intro.pdf>
- [29] R. Fiati, W. Widowati, and D. Mutiara Kusumo Nugraheni, "Service quality model analysis on the acceptance of information system users' behavior," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 30, no. 1, pp. 444–450, Apr. 2023, doi: 10.11591/ijeecs.v30.i1.pp444-450.
- [30] I. Mahmud, F. Sadia, M. Rahman, S. Ahmed, and D. Islam, "Web usability test in 60 seconds: a theoretical foundation and empirical test," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 17, no. 1, pp. 398–403, 2019, doi: 10.11591/ijeecs.v17.i1.pp398-403.
- [31] GTmetrix, "GTmetrix features." Accessed: Sep. 12, 2024. [Online]. Available: <https://gtmetrix.com/features.html>
- [32] R. Mission, "Web service performance analysis using the GTMetrix web monitoring tool," *Journal of Innovative Technology Convergence*, vol. 3, no. 1, pp. 1–8, Jun. 2021, doi: 10.69478/JITC2021v3n1a01.
- [33] A. M. Almatrafi and Z. H. Alharbi, "The impact of web analytics tools on the performance of small and medium enterprises," *Engineering, Technology and Applied Science Research*, vol. 13, no. 5, pp. 11753–11762, 2023, doi: 10.48084/etasr.6261.
- [34] E. Budiman, M. Wati, D. Indra, D. Moeis, and M. Jamil, "QoE and QoS evaluation for academic portal in private higher education institution," in *2018 International Conference on Computer Engineering, Network and Intelligent Multimedia (CENIM)*, IEEE, Nov. 2018, pp. 94–99, doi: 10.1109/CENIM.2018.8710977.
- [35] P. Chokrasamesiri and T. Senivongse, "User engagement analytics based on web contents," in *Studies in Computational Intelligence*, vol. 656, R. Lee, Ed., Cham: Springer, 2016, pp. 73–87, doi: 10.1007/978-3-319-40171-3_6.
- [36] M. Kinnunen, "Evaluating and improving web performance using free-to-use tools," University of Oulu, 2020.
- [37] M. Kragelj and M. Kljajić Borštnar, "Automatic classification of older electronic texts into the universal decimal classification–UDC," *Journal of Documentation*, vol. 77, no. 3, pp. 755–776, Apr. 2021, doi: 10.1108/JD-06-2020-0092.
- [38] O. Suominen, J. Inkinen, and M. Lehtinen, "Annif and Finto AI: developing and implementing automated subject indexing," *JLIS.it*, vol. 13, no. 1, pp. 265–282, 2022, doi: 10.4403/jlis.it-12740.
- [39] K. Golub, O. Suominen, A. T. Mohammed, H. Aagaard, and O. Osterman, "Automated Dewey decimal classification of Swedish library metadata using Annif software," *Journal of Documentation*, vol. 80, no. 5, pp. 1057–1079, Sep. 2024, doi: 10.1108/JD-01-2022-0026.
- [40] W. Liu, X. Yang, H. Lin, Z. Li, and F. Qian, "Fusing speed index during web page loading," in *Abstract Proceedings of the 2022 ACM SIGMETRICS/IFIP PERFORMANCE Joint International Conference on Measurement and Modeling of Computer Systems*, New York, NY, USA: ACM, Jun. 2022, pp. 45–46, doi: 10.1145/3489048.3522663.
- [41] J. van Riet, I. Malavolta, and T. A. Ghaleb, "Optimize along the way: an industrial case study on web performance," *Journal of Systems and Software*, vol. 198, p. 111593, Apr. 2023, doi: 10.1016/j.jss.2022.111593.
- [42] M. Levlin, "DOM benchmark comparison of the front-end JavaScript frameworks React, Angular, Vue, and Svelte," Åbo Akademi University, 2020.
- [43] M. V. Privalov and M. V. Stupina, "Improving web-oriented information systems efficiency using Redis caching mechanisms," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 33, no. 3, pp. 1667–1675, Mar. 2024, doi: 10.11591/ijeecs.v33.i3.pp1667-1675.
- [44] G. Hasslinger, M. Okhovatzadeh, K. Ntougias, F. Hasslinger, and O. Hohlfeld, "An overview of analysis methods and evaluation results for caching strategies," *Computer Networks*, vol. 228, p. 109583, Jun. 2023, doi: 10.1016/j.comnet.2023.109583.
- [45] A. Namoun, A. Alrehaili, and A. Tufail, "A review of automated website usability evaluation tools: research issues and challenges," in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, vol. 12779, M. M. Soares, E. Rosenzweig, and A. Marcus, Eds., Cham: Springer, 2021, pp. 292–311, doi: 10.1007/978-3-030-78221-4_20.
- [46] A. Qasrawi, S. VicunaPolo, and R. Qasrawi, "User experience and performance evaluation of Palestinian universities websites," in *2021 International Conference on Promising Electronic Technologies (ICPET)*, IEEE, Nov. 2021, pp. 73–77, doi: 10.1109/ICPET53277.2021.00019.

BIOGRAPHIES OF AUTHORS



Eko Didik Widiyanto    has been a senior lecturer and member of the Laboratory of Embedded Systems and Robotics at the Department of Computer Engineering, Engineering Faculty, Universitas Diponegoro, Semarang, Central Java, Indonesia, since 2010. He completed his bachelor of Engineering in 2001 and Master of Engineering in 2014, both from the Department of Electrical Engineering, Institut Teknologi Bandung, Indonesia. His research interests include embedded systems, sensor networks, and programmable devices. He has published more than 20 papers in international journals and conferences. His publications have been cited over 110 times for an H index of 6. He can be contacted at email: didik@live.undip.ac.id.



Prof. Dr. Ir. Hadiyanto S.T., M.Sc., IPU    is an outstanding lecturer at the Department of Chemical Engineering, Engineering Faculty, Universitas Diponegoro and School of Postgraduate, Universitas Diponegoro. He proved this by winning 3rd place as a 2013 National Level Outstanding Lecturer. In the same year he also won 1st place as an Outstanding Lecturer at the Diponegoro University (Undip) Level and at the Faculty of Engineering Level. Due to his achievements and perseverance, he received the highest academic title as professor of the Faculty of Engineering and was inaugurated on November 30 2017. He currently works at Biomass and Renewable Energy Group (CBIORE). His research focuses are food processing, bioprocessing, microalgae, environment, and bioenergy. He can be contacted at email: hadiyanto@lecturer.undip.ac.id and hadiyanto@che.undip.ac.id.



Prof. Teddy Mantoro, M.Sc., Ph.D.    is currently with Sampoerna University. He holds a Ph.D., an M.Sc., and a B.Sc., all in Computer Science. He was awarded a Ph.D. from Department of Computer Science, the Australian National University (ANU), Canberra, the capital city of Australia, and he received a master degree from Department of Computer Science, School of Advanced Technologies, the Asian Institute of Technology, Bangkok, the capital city of Thailand. His research interests focus on Intelligent Environment, pervasive/ubiquitous computing, context aware computing, mobile computing, information security, and wireless sensor network. He has published 177+ conference/journal papers (151 papers in Scopus, h-index=11), 4 Computer Science books and more than 20-chapter books which published in USA, Indonesia, Malaysia and Germany. To date, he served on committees and review boards for more than 90 International conferences. He is also a senior member of IEEE and he was the managing editor for the International Journal of Mobile Computing and Multimedia Communications (IJMCMC) (Feb 2010-Sept 2014), and editor for 3 other journals. He can be contacted at email: teddy.mantoro@sampoernauniversity.ac.id.



Raka Sindu Wardoyo    completed his B.Comp. in 2021 at the Informatics Department of the Faculty of Science and Mathematics, Universitas Diponegoro. He is currently with the Institute for Research and Community Services, Universitas Diponegoro. He has extensive experience and expertise in information systems and database development. He can be contacted at email: rakasinduardoyo@live.undip.ac.id.



Muhamad Irham Maulana    completed his B. Eng in 2023 at the Computer Engineering Department of the Engineering Faculty, Universitas Diponegoro. He has a lot of experience and expertise in front-end development. He can be contacted at email: muhamadirhammaulana@alumni.undip.ac.id.