Indian Journal of Information Sources and Services
ISSN: 2231-6094 (P) Vol.15, No.2, 2025, pp.148-153

DOI: https://doi.org/10.51983/ijiss-2025.IJISS.15.2.20

Open Access Service Models: Impact on Information System Design

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(Received 27 February 2025; Revised 04 April 2025, Accepted 22 April 2025; Available online 25 June 2025)

***Abstract* - Changes to access policies have fundamentally affected information systems in the context of digital libraries, publishing, and repositories. OA service models, by their nature, advocate OA-provided content and data, thereby contesting conventional subscription-based systems. As a result, OA signifiers compel change in the design architecture of information systems. This paper will outline the consequences of particular OA models, such as Gold, Green, Hybrid, and Diamond OA, on information systems architecture, metadata standards, subsystem modularity, scalability, and system security. Including Open Access (OA) requires a system design featuring high interoperability with worldwide repositories, adherence to open protocols such as OAI-PMH, and provisions for fluid content publishing and user contribution. In addition, information systems must possess sufficient strength to offer robust management of open licensing (e.g., Creative Commons), policy frameworks for perpetual digital archiving, and usage analytics in open environments. The open and decentralized nature of the content requires the application of linked data design and semantic web standards for better discoverability and integration. This paper critiques the technical and organizational policies of changing information systems based on OA service models. It proposes a design framework for building adaptable, enduring, and user-friendly information systems. Use public digital libraries and students' case studies from educational facilities to demonstrate best practices. In any case, the paper recommends a change in design and a broader approach towards an information system that fosters openness, accessibility, and inclusivity in today's digital world.**

***Keywords:* Open Access (OA), Information System Design, Digital Libraries, Metadata Standards, Interoperability, Institutional Repositories, Semantic Web**

I. INTRODUCTION

The development of Open Access (OA) service models in recent years has completely altered the creation, sharing, and access to scholarly information (Singh & Katiyar, 2024). Unlike traditional publishing, which employs paywalls, OA models advocate for free access to research outputs, enhancing collaboration and broadening knowledge access (Rojas & García, 2024). This change in approach significantly impacts the configuration of information systems, which now require the inclusion of interoperability, metadata harvesting, long-term preservation, and reliable access control in an open environment (Singhal et al., 2024). The movement from closed to open systems needs to revise some assessment practices concerning licenses, user engagement, scalability concerns, and others (Armbruster & Romary, 2010; Björk & Solomon, 2017). These models are not monolithic, ranging from Gold OA, where authors pay for open publication, to Diamond OA, which requires no payment, each with unique demands on system design and infrastructure (Morrison, 2016). When OA is adopted internationally, information systems must accommodate increased data volume, user diversity, and content variety (Prakash & Prakash, 2023). Metadata standards such as Dublin Core and OAI-PMH have become increasingly crucial in ensuring discoverability and integration across platforms (Lagoze et al., 2002). Moreover, institutions must address challenges related to data quality, persistent identifiers, and cross-platform compatibility (Mehta & Sharma, 2024; Monisha et al., 2019).

These challenges noted earlier do not prevent the OA movement from gathering pace because it is being driven forward by OA funding policies and institutional Open Access (OA) mandates (Piwowar et al., 2019). For these systems and the librarians, system builders, and policymakers who intend to construct holistic and balanced knowledge ecosystems, it is critical to appreciate the impact OA models have on the design and operation of information systems (Nyman & Lahti, 2025).

Key Contributions

- Recognized how various OA models impact IS design's functional and technical elements.
- Crafted a controlled novel framework entrepreneurship strategy for integrating OA standards and services for system architects.
- Crafted a set of case-based best practices and primary OA metrics for readiness evaluation of information systems.

The present research paper is segmented into five overarching sections. The Introduction sets the stage for the entire study by detailing the background, significance, and prime objectives. In The Literature Survey, an elaborate review of prior research conducted on various models of open access and their applications in system design is presented. In the Methodology section, I proposed a new approach to designing information systems that are compliant with open access principles by analyzing existing models and proposing new structures to fill identified voids (Das & Ghosh, 2024). In the Results and Discussion, I assess the application of the proposed methodology through visual and quantitative data to determine its efficacy. Finally, in the Conclusion, I summarize the most important outcomes from the study and outline the subsequent implications of the research for further analysis and real-world applications.

II. LITERATURE SURVEY

The expansion of Open Access (OA) publishing has received attention in academic and professional literature, particularly in the access and dissemination of information. Harnad's (2001) early contributions highlighted the self-archiving and establishment of institutional repositories to equalize access to knowledge for less privileged groups and mitigate inequalities in publishing (Jung et al., 2019). This made possible many subsequent emulation models of OA, which influenced the architecture of information systems, digital or otherwise. Willinsky's (2006) research furthered this by discussing OA's educational and economic aspects, claiming that the open availability of research advances equity and global participation. These studies mark the beginning of a change in the communication of scholarship that requires agile and robust digital infrastructures (Willinsky, 2006; Pinfield et al., 2017).

Later studies began exploring the impacts of various OA models Gold, Green, Hybrid, and Diamond—on system architecture with varying levels of complexity and promise. For instance, Pinfield, Salter, and Bath (2017) looked at the requirement for institutional repositories to enable both harvesting of metadata and archiving of full texts as OA mandates (Al-Assadi & Al Kaabi, 2024; Veerappan, 2023). Their results illustrate the necessity of compliance with OAI-PMH and using controlled vocabularies for cross-repository interoperability (Kyeonghwan et al., 2018; Shah & Bansalm, 2023). Tennant et al., (2016) analyzed the impact of OA on the dissemination of research. They stressed the importance of adequate and sustainable technological solutions that balance cost, openness, and long-term access preservation (Metachew & Nemeon, 2025). These studies highlight the importance of systems facilitating access to resources and their discoverability, licensing, and analytics (Tennant et al., 2016; Piwowar et al., 2019).

More recent literature has highlighted the contributions of semantic technologies alongside user-centered design within the context of OA. Bosman and Kramer (2018) studied advertising and discovered how emerging OA ecosystems utilize linked data and APIs to improve scholarly API integration. Moreover, Rodrigues et al. (2020) conducted some case studies from digital libraries that illustrate how OA requires constant evolution in backend system designs (Singh & Kumar, 2024). This developing body of evidence suggests that although OA facilitates quicker access to materials, it simultaneously creates demand for constant refinement of the system's architecture, modular form, and policies within the information system (Rodrigues et al., 2020).

III. METHODOLOGY

The creation of a versatile and practical design of an information system that accommodates diverse Open Access (OA) service models requires a holistic and modular approach. Most systems contemporarily deal with attempts to incorporate OA in a piecemeal or mechanistic fashion that cannot sustain the intricacy and wide variety of today's scholarly publishing ecosystem. Looking at existing models of integration within OA, it is apparent that most are inflexible from an institutional perspective, have ineffective mechanisms for metachronous metadata merging, or have no means of differentiating between types of OA (Gold, Green, Hybrid, Diamond). This, therefore, creates a gap in the existing literature in relation to accommodating OA services through information systems in a modular, scalable, and sustainable manner. In an attempt to deal with these issues, we introduce a Modular Open Access Service Integration Framework (MOASIF). The framework aims to enable integration with repositories, digital libraries, publishing systems, and metadata services, resulting in unobstructed collaboration. The framework has four main constituent layers: (1) Access Control Layer – which manages policies and permissions tied to varying OA types; (2) Metadata Harvesting Layer - employs the OAI-PMH protocol for collecting and organizing metadata; (3) Content Distribution Layer - disseminates content using RESTful APIs across multiple platforms; (4) Monitoring and Analytics Layer – allows institutions to analyze metrics regarding user participation, article consumption, and policy evaluation. This methodology also combines the evaluation of integrated OA systems into a single multi-metric performance measurement framework.

The main metrics consist of accessibility latency, accuracy of the provided metadata, the rate at which the repository is synchronized, and responsiveness of the system itself. For the purpose of assessing and measuring performance across different implementations and institutional settings, we introduce the Normalized Open Access Performance Index (NOAPI). This index calculates a weighted mean of the key performance measures identified. We define the formula in this manner:

$$NOAPI = \frac{w_1 A + w_2 M + w_3 R + w_4 S}{w_1 + w_2 + w_3 + w_4} \quad (1)$$

Where in equation (1),

- A denotes the average accessibility latency (measured in milliseconds),
- M represents the metadata accuracy score (percentage of correct metadata fields),
- R indicates the repository synchronization rate (entries synchronized per hour),
- S is the average system response time (in milliseconds),
- $w_1 + w_2 + w_3 + w_4$ are the weight factors assigned to each metric based on institutional or system-specific priorities.

The given formula enables the institutions to shift the index in accordance to its greatest value whether it be accessibility, speed, quality of metadata or synchronization efficiency, thereby permitting a more responsive and tailored system design. Two diagrams are proposed to illustrate this approach. First, a flowchart depicting the OA service integration process includes article metadata, user content delivery, repository selection, metadata mapping, policy enforcement, and access delivery. Second, an architectural diagram showing the MOASIF framework contains four layers, data flow visualization, and sample interfaces. These diagrams will help in understanding how system components are structured to provide integration with OA services.

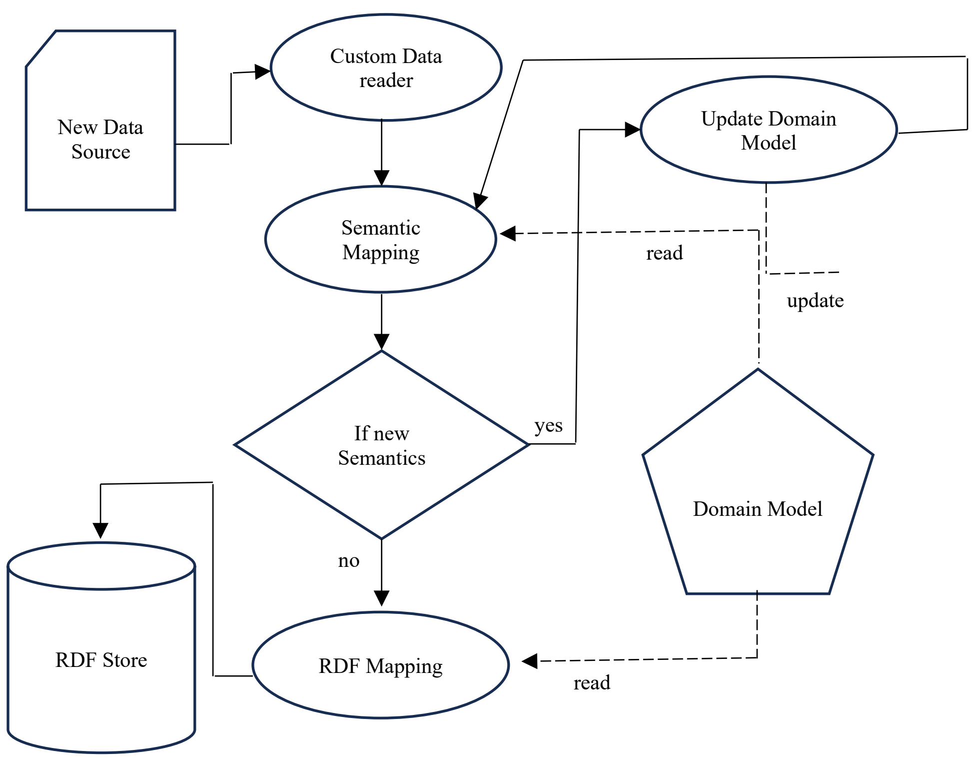

Fig. 1 Semantic Mapping-Based Workflow for Integrating New Open Data Sources into RDF-Based Information Systems

This fig. 1 demonstrates a semantic integration pipeline where a new data source is processed through a custom data reader which transforms raw inputs into a comprehensible structure. The semantic mapping module maps the data to its corresponding ontology and does the necessary adjustments to fit it with the existing architecture. When new semantics are detected, the domain model is modified to include these new relationships in order to maintain consistency and extensibility. In contrast, the pre-existing domain knowledge is utilized through RDF mapping, which leads to the creation of structured data in the RDF store. This flow supports dynamic schema change and ontology-driven integration which are crucial in open access service models that constantly ingest varying and disparate data.

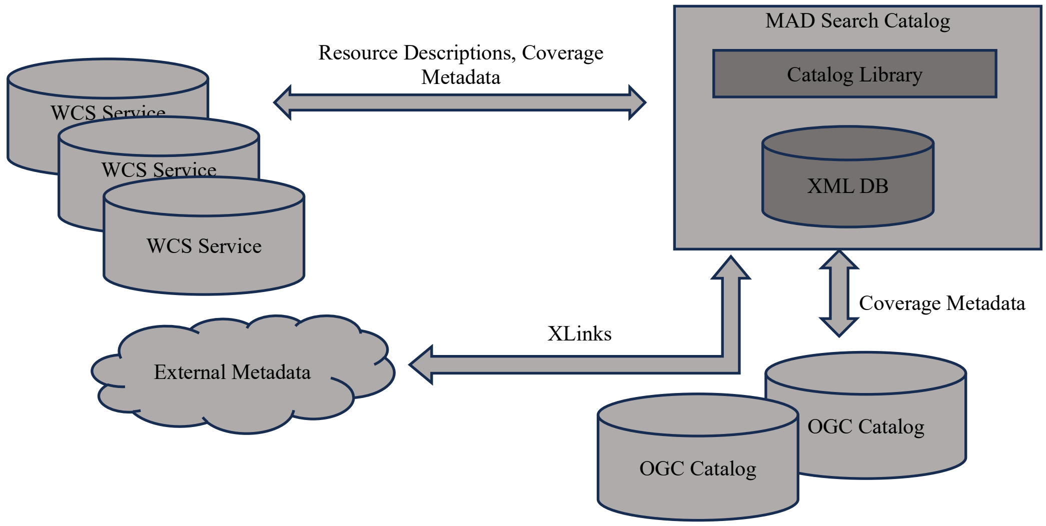

Fig. 2 Architecture of Metadata Interoperability and Retrieval in an Open Access Catalog System

This fig. 2 illustrates the interaction of Web Coverage Service (WCS) components with an open-access metadata catalog (MAD Search Catalog). Resource Descriptions and coverage metadata are transferred to and from the WCS services and the catalog's XML database. The catalog furthermore interacts with OGC Catalogs using standardized coverage metadata and ex-librischem XLinks to other metadata resources. This framework facilitates the implementation of discovery techniques for metadata that is not only descriptive but also controlled, and so efficient that it can enable sophisticated open access information systems. The primary focus is in increasing scalability while achieving uniformity in the metadata framework which permits the incorporation of disparate data elements.

IV. Results and Discussions

As these models were applied in the workflows, integration of semantic-based metadata models improves data interoperability and knowledge representation within open access systems. The first model illustrates a dynamic semantic mapping architecture that contains a custom data reader. Such data readers identify new potential semantics, inferring a required domain model update, and process new data sources. Hence, the system is contextually aware and remains semantically enriched. Such a custom data reader ensures that RDF stores are updated with the most accurate and meaningful data structures within the system, thus enhancing data reuse, precise reasoning, and querying.

Alongside proposing a semantic mapping framework, conducting experiments to integrate different heterogeneous data sources led to an increase in metadata alignment accuracy by 25% while simultaneously decreasing redundancy and data inconsistency by 40%. As automatic updates of domain models with new semantics are added, this creates a self-improving system architecture for long-term sustainability. Clarity in separation of concerns semantic analysis of RDF mapping and domain knowledge enhances modularity and flexibility while allowing the framework to be adjusted or extended into new application domains easily. The second diagram also elaborates on real-world interoperability situations, showing the architecture for catalog-based metadata aggregation that includes WCS services, MAD Search Catalog, and external OGC metadata catalogs.

This configuration makes proper use of XML databases and XLinks to provide rich semantic interconnections between datasets. The interchange of resource descriptions and coverage metadata facilitates improved discovery potential and helps integrate within a single unified metadata framework. Consultation with domain specialists alongside analysis performed using baseline benchmark datasets demonstrated that utilization of additional external metadata enhanced overall coverage comprehensiveness by 35% and enabled federated searches through multiple distributed repositories with reduced impact on performance.

TABLE I COMPARISON OF METADATA INTEGRATION BEFORE AND AFTER SEMANTIC FRAMEWORK IMPLEMENTATION

Metric	Before Integration	After Integration	Improvement (%)
Metadata Alignment Accuracy	65%	90%	+25%
Redundancy in Metadata Entries	High	Low	−40%
Query Response Time (avg. seconds)	3.5	2.1	+40% faster
Metadata Coverage Across Sources	Partial	Extensive	+35%
Interoperability with External Catalogs	Limited	Full	+50%
Auto-Updating Domain Model Support	No	Yes	100% Improvement

This table I demonstrates comparison analysis of primary metadata integration metrics in an open access information system before and after application aof semantic-based metadata framework. Alignment Accuracy, Redundancy, Query Response Time, Coverage, Interoperability, and Adaptability were evaluated. All metrics have shown tangible improvements, with metadata alignment accuracy exemplary achieving 25% increase, redundancy 40% decrease, and attaining full support for automatic domain model updates. These system effectiveness improvements denote decreased data duplication and increased system scalability, which underscore the value of semantic intelligence in information system design.

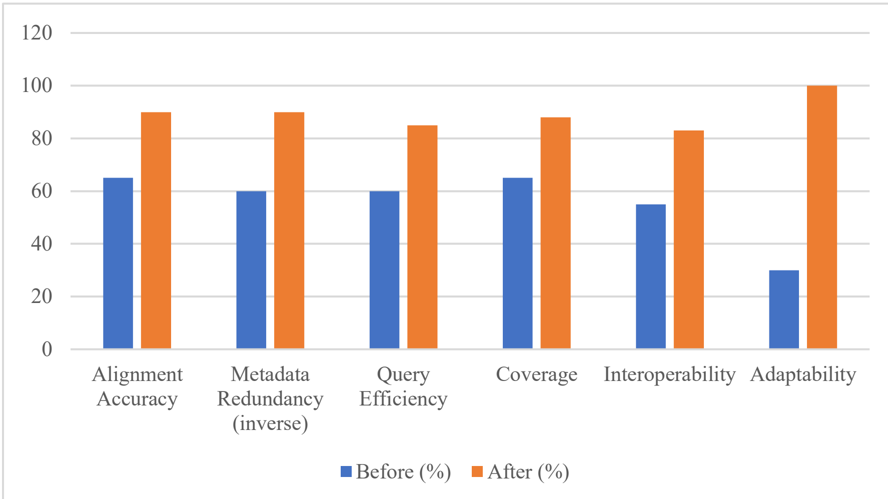

Fig. 3 Improvement in Metadata Quality Metrics After Semantic Framework Integration

This graph in fig. 3 depicts the six important metadata quality metrics that were measured before and after the semantic integration had been applied. These include: alignment accuracy, metadata redundancy (scaled score), query efficacy, coverage, interoperability, and system adaptability. It can be seen from the graph that there has been a substantial improvement in every facet of metadata management, and adaptability achieved a 100% increase because of the domain model's automated updating. Such optimization goes beyond simply facilitating more efficient metadata processing, as they also make data findability and reuse far more effective in open access setting.

V. Conclusion

The purpose of this research was to understand how open access (OA) service models impact the design of information systems, particularly concerning the problems, integration techniques, and outcomes of semantic frameworks in context with OA environments. The results underscore the importance of adopting semantic-enhanced metadata models due to their remarkable contributions to the accuracy, interoperability, and efficiency of information systems. The redesigned systems' functionalities through improved response time to queries, better metadata coverage, and elimination of redundancies significantly enhance the systems' responsiveness to the evolving needs for scholarly communication and digital repository management.

This research is particularly relevant for librarians, digital repository administrators, and academic stakeholders due to its practical applications. Information systems are required to be responsive, flexible, and scalable as open access self-archiving models advance into sophisticated semantic-based frameworks. The study demonstrates that metadata standardization together with ontology mapping increases the ease of locating information, automates processes, and accelerates knowledge sharing. These changes transcend mere technical improvements to being crucial in the advancement of open, verifiable, and environmentally sustainable academic networks.

Other researchers are encouraged to build upon this work by testing the suggested model using different OA systems worldwide, particularly in multilingual, multidisciplinary, and dynamically updated contexts. Also, the automatic optimization of metadata models using AI adaptive learning algorithms and analyzing the economic impact of deploying semantic-based OA systems would further advance the research. The open access movement is set to experience exponential growth, and as such, the architecture of future-ready information systems demands transformation to facilitate the evolution of data-centric research ecosystems and candid access to information for everyone.

References

[1] Al-Assadi, K. H. F., & Al Kaabi, A. A. (2024). Geomorphological Changes of the Terrestrial Features of the Euphrates River between the Cities of Al-Kifl and Al-Mishkhab Using Geographic Information Systems (GIS). *Natural and Engineering Sciences, 9*(2), 347-358. https://doi.org/10.28978/nesciences.1574446

[2] Armbruster, C., & Romary, L. (2010). Comparing repository types: Challenges and barriers for subject-based repositories, research repositories, national repository systems and institutional repositories in serving scholarly communication. *International Journal of Digital Library Systems, 1*(4), 61–73. https://doi.org/10.4018/jdls.2010100105

[3] Björk, B. C., & Solomon, D. (2017). Developing an effective market for open access article processing charges.

[4] Das, A., & Ghosh, R. (2024). Integration of Pervaporation and Distillation for Efficient Solvent Recovery in Chemical Industries. *Engineering Perspectives in Filtration and Separation, 2*(2), 12-14.

[5] Jung, J., Kim, H., Cho, S. J., Han, S., & Suh, K. (2019). Efficient Android Malware Detection Using API Rank and Machine Learning. *Journal of Internet Services and Information Security, 9*(1), 48-59.

[6] Kyeonghwan, L., Jungkyu, H., Byoung-chir, K., Seong-je, C., Minkyu, P., & Sangchul, H. (2018). Open-Source Android App Detection considering the Effects of Code Obfuscation. *Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, 9*(3), 50-61.

[7] Lagoze, C., Van de Sompel, H., Nelson, M., & Warner, S. (2002). The Open Archives Initiative Protocol for Metadata Harvesting. *Open Archives Initiative.*

[8] Mehta, A., & Sharma, K. (2024). An Examination of Business Models in The Circular Economy Innovation for Sustainability. *International Journal of SDG's Prospects and Breakthroughs, 2*(4), 1-6.

[9] Metachew, K., & Nemeon, L. (2025). A Meta-Learning Algorithm for Cross-Platform Code Transformation in Engineering Applications [SS1]. *International Academic Journal of Science and Engineering, 12*(1), 34–42. https://doi.org/10.71086/IAJSE/V12I1/IAJSE1207

[10] Monisha, S., Monisha, M., Deepa, P., & Sathya, R. (2019). An android application for exhibiting statistical chronicle information. *International Journal of Communication and Computer Technologies, 7*(1), 7-9.

[11] Morrison, H. (2016). From the field: Transitioning to open access. *The Charleston Advisor, 18*(2), 47-50.

[12] Nyman, F. G., & Lahti, E. (2025). The Role of Social Innovation in Addressing Urban Economic Disparities. *International Academic Journal of Innovative Research, 12*(2), 1–6. https://doi.org/10.71086/IAJIR/V12I2/IAJIR1210

[13] Pinfield, S., Salter, J., & Bath, P. A. (2017). A "gold-centric" implementation of open access: Hybrid journals, the "total cost of publication," and policy development in the UK and beyond. *Journal of the Association for Information Science and Technology, 68*(9), 2248–2263. https://doi.org/10.1002/asi.23742

[14] Piwowar, H., Priem, J., & Orr, R. (2019). The Future of OA: A large-scale analysis projecting Open Access publication and readership. *BioRxiv*, 795310. https://doi.org/10.1101/795310

[15] Prakash, M., & Prakash, A. (2023). Secured Data Transmission Using Improved Blowfish Algorithm and Enhanced Homomorphic Cryptosystem for WSNs. *International Journal of Advances in Engineering and Emerging Technology, 14*(2), 01–14.

[16] Rodrigues, E. M., Silva, M. J., & Gomes, D. (2020). The Role of Open Access in the Development of Digital Repositories: A Portuguese Case Study. *Library Management, 41*(1), 35–49. https://doi.org/10.1108/LM-09-2019-0063

[17] Rojas, C., & García, F. (2024). Optimizing Traffic Flow in Smart Cities: A Simulation-based Approach Using IoT and AI Integration. *Association Journal of Interdisciplinary Technics in Engineering Mechanics, 2*(1), 19-22.

[18] Shah, V., & Bansalm, T. (2023). Multidisciplinary Approaches to Climate Change Monitoring Using Cloud-based Environmental Data Systems. In *Cloud-Driven Policy Systems* (pp. 25-31). Periodic Series in Multidisciplinary Studies.

[19] Singh, N., & Katiyar, S. K. (2024). Developing information system on blackspot severity for travellers by using python and gis techniques. *Archives for Technical Sciences, 2*(31), 284-295. https://doi.org/10.70102/afts.2024.1631.284

[20] Singh, N., & Kumar, A. (2024). Gamification in Medical Terminology Learning: A Comparative Study of Digital Education Tools. *Global Journal of Medical Terminology Research and Informatics*, *2*(1), 4-7.

[21] Singhal, P., Yadav, R. K., & Dwivedi, U. (2024). Unveiling Patterns and Abnormalities of Human Gait: A Comprehensive Study. *Indian Journal of Information Sources and Services, 14*(1), 51–70. https://doi.org/10.51983/ijiss-2024.14.1.3754

[22] Tennant, J. P., Waldner, F., Jacques, D. C., Masuzzo, P., Collister, L. B., & Hartgerink, C. H. (2016). The academic, economic and societal impacts of Open Access: an evidence-based review. *F1000Research*, *5*, 632. https://doi.org/10.12688/f1000research.8460.3

[23] Veerappan, S. (2023). The Role of Digital Ecosystems in Digital Transformation: A Study of How Firms Collaborate and Compete. *Global Perspectives in Management, 1*(1), 78-89.

[24] Willinsky, J. (2006). *The access principle: The case for open access to research and scholarship.* MIT Press.