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Leveraging open-source software to advance learning technologies in higher education for interior design

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Abstract

Open-source software (OSS) has become a revolutionary development in higher education, providing improved and affordable solutions for learning technologies. This paper explores OSS as an instrument of change within higher learning institutions, aiming to enhance accessibility, cooperation, and individualization to suit different institutional needs. The analysis employs mathematical measures such as cost analyses, accessibility metrics, and models of adoption growth, which are compared with survey data. It also considers limitations like technical support and sustainability, offering strategies to overcome these barriers. Examples demonstrate how OSS can improve student participation, reduce costs, and promote teamwork. The conclusion suggests that integrating OSS into learning technologies can foster innovation and inclusivity in higher education.

Keywords: Accessibility, Customization, Higher education, Learning technologies, Open-source software.

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1. Introduction

Incorporation of IT into higher education systems has significantly transformed instructional delivery methods to improve accessibility, interaction, and collaboration. However, typical proprietary software, which depends on licensing models, presents certain financial and technical limitations and may not be suitable for institutions with limited budgets.

Unlike proprietary software, which keeps its source code largely inaccessible, open-source software (OSS) offers a more suitable approach to overcoming these challenges, providing an efficient, cost-effective, and innovative solution.

OSS is greater than a technique; it is a symbol of openness and cooperation, which aligns with the values of higher learning institutions. Since OSS enables institutions to tailor ready-made tools to match their teaching and learning requirements, educators and institutions are capable of achieving their preferred educational paradigms of creativity, innovation, and individualization. The stated qualities make OSS particularly relevant in meeting the various and dynamic needs of higher education entities.

The increased concern about data learning tools, especially after some disturbances globally, has made it crucial to have stronger, flexible, and effective models. It is a strategic enabler to support the solution of operating issues, such as moving to fully online learning, as well as a tool for developing progressive concepts and fundamental shifts in accessibility, equity, and learner engagement. These capabilities make OSS an important element of the educational environment of the present era.

This paper extends the theoretical discourse of OSS by integrating strategic and quantitative models to substantiate the financial, operational, and social value of OSS in HE. The analytical models include Total Cost of Ownership (TCO), Accessibility Index, and Logistic Growth to assist in providing an objective assessment of OSS adoption. This is supported by survey results demonstrating that the data analysis and subsequent findings reflect real-life situations in institutions, not just hypothetical cases.

Spotting the per excellence benefits, risks, and use of OSS, this paper propounds its relevance and indispensability to the future of education. Successful examples are presented through case studies, and potential issues are discussed in the section on challenges and how they could be managed. Combinable, these findings illustrate how OSS can foster synergy, openness, and sustainability in higher education at the millennium age.

The principles of open-source software, particularly its emphasis on customization, collaboration, and accessibility, resonate strongly with the evolving landscape of interior design education. Traditional interior design curricula often rely on expensive proprietary software for CAD, rendering, and BIM, creating significant financial barriers for students and institutions. By embracing OSS, interior design programs can democratize access to essential design tools, fostering a more inclusive learning environment. Furthermore, the collaborative nature of OSS aligns perfectly with the project-based, team-oriented pedagogy prevalent in design disciplines. Students can contribute to and adapt open-source design tools, creating bespoke solutions that address specific design challenges or pedagogical needs. This not only enhances their technical proficiency but also cultivates a deeper understanding of design processes and digital tool development.

2. Literature Review

Use of OSS in higher education: Contemporary research has closely examined the use of OSS in higher education since it is considered a fruitful area for the transformation of learning technologies [1, 2]. Analyzing the experiences of various companies resulting from adopting and implementing OSS [3, 4], this literature review covers such common topics as the costs and cost-efficiency, tailoring to specific needs, accessibility, open opportunities for collaboration, and problems encountered by the companies [5].

2.1. Cost-Effectiveness

There has been a lot of praise for OSS because it can eliminate cost burdens when it comes to learning in institutions of higher learning, especially those with poor resource endowment. Based on Weller [6]. OSS costs significantly less than commercial software since no license fees are incurred and relies on community support. The model integrating the initial costs of implementation, maintenance expenses, as well as the accumulated savings on licenses, confirms the presumed financial advantages in the Total Cost of Ownership (TCO) model [7]. A number of potential examples illustrate net savings within three years, $20,000, and stress the point that OSS is inexpensive and can accommodate institutions.

2.2. Customization and Flexibility

This means that through OSS, institutions can modify software to suit educational as well as institutional requirements [8, 9]. While most other systems employ strict and expensive configurable options for institutions, OSS can adapt itself widely to complicated educational environments [10, 11]. For instance, Moodle's modular design is intended to allow instructors to create specific courses that match particular curricula and meet institutional objectives. Organized by the fact that OSS is very flexible, advanced, and tailored for localized educational practices in multicultural or multilingual environments.

In the context of interior design, this flexibility is paramount. Open-source CAD software, for example, can be adapted to include specific libraries of furniture, materials, or building codes relevant to a particular region or design specialization. This allows educators to create highly relevant and practical learning experiences that directly address industry needs, without being constrained by the limitations or licensing costs of proprietary alternatives. The ability to customize also extends to developing bespoke plugins or modules for simulating lighting conditions, acoustic properties, or even virtual walkthroughs, offering a richer and more immersive learning experience for aspiring interior designers.

2.3. Collaboration and Community Support

Here, it is important to state that the concept of openness is defining for OSS due to its successes in the context of higher education: MOOC platforms like Moodle and Open edX are projected towards a global community of developers and educators to address software development, problem-solving, and quality enhancement needs [12, 13]. From the cross-

sectional studies of OSS development, [14] explanations of how OSS communities encourage innovation through collaborative PD, fast creation of new features, and comprehensive support services. This shift towards communal development not only improves the capability of software to perform effectively but also eradicates the dearth of institutional technical know-how.

For interior design students, this translates into a vibrant ecosystem of shared knowledge and resources. Imagine a community of design students and professionals collaborating on open-source libraries of 3D models for furniture, textures, or even entire room layouts. This collective effort not only enriches the available resources but also fosters a sense of shared ownership and continuous improvement. Students can learn from each other's contributions, refine existing models, and develop new tools, mirroring the collaborative nature of real-world design projects. Furthermore, the community support aspect can bridge the gap in technical expertise often found in design departments, as experienced users and developers within the OSS community can provide invaluable assistance and guidance.

2.4. Enhanced Accessibility

This is especially because accessibility is one of the fundamental tenets of OSS, especially in the present context of equity and inclusiveness initiatives in education. According to [15-17]. The existence of OSS helps in providing students with disabilities tools to enhance their accessibility in learning environments. The Accessibility Index model helps to numerically determine the extent of OSS, and in this case, shows that 80% of the potential users benefit from its tools. Several current features for visually and hearing-impaired users are implemented in the Mahara and Chamilo platforms, and this clearly demonstrates the real-world implications of OSS for excluded persons [17].

In interior design education, enhanced accessibility through OSS can manifest in several ways. For students with visual impairments, open-source screen readers can be integrated with design software, allowing them to navigate complex interfaces and understand spatial relationships through auditory cues. Similarly, customizable interfaces can cater to students with motor skill challenges, enabling them to interact with design tools more effectively. Beyond physical disabilities, OSS can also address socio-economic accessibility by providing free access to high-quality design software, leveling the playing field for students from diverse backgrounds who might otherwise be excluded due to the prohibitive costs of commercial alternatives. This democratizes design education, making it available to a wider talent pool.

2.5. Integration with Advanced Technologies

From the foregoing, OSS adopts and applies modern technologies such as AI and VR to improve learning processes. Smart conversational agents in Open edX enable students to have a customized learning experience, and VR for STEM subjects is used to provide rich experiences [18]. This development also complements current trends in higher education learning, where technology is gradually being used to enhance learning experiences [19]. OSS makes provisions for it in such a way that institutions can easily integrate such innovations without significant cost implications.

For interior design, the integration of AI and VR through OSS holds immense potential. Imagine open-source AI algorithms that can analyze a room's dimensions and suggest optimal furniture layouts based on user preferences and ergonomic principles. Or consider open-source VR platforms that allow students to virtually walk through their designed spaces, experiencing the scale, light, and flow before physical construction. This immersive learning can significantly enhance spatial reasoning and design visualization skills. Furthermore, open-source tools for parametric design can enable students to explore complex forms and structures, pushing the boundaries of traditional interior design and preparing them for an increasingly technologically driven industry.

2.6. Advancing Open Educational Resources (OER)

OSS fits well with the dissemination of Open Educational Resources (OER) and implementation by reducing dependence on commercial content. Web 2.0 tools like Moodle and Open edX offer a system that contains shared and modifiable high-quality learning resources that teachers can contribute to. Such compatibility between OSS and OER has been used to promote open education and encourage institutional cooperation worldwide [20, 21].

In interior design, this translates to a wealth of freely available and adaptable learning materials. Educators can create and share open-source modules on topics like sustainable design, historical interior styles, or material science, complete with interactive exercises and case studies. Students, in turn, can access these resources, modify them for their specific projects, and even contribute their own learning materials back to the community. This fosters a dynamic and ever-growing repository of knowledge, reducing the reliance on expensive textbooks and proprietary content, and promoting a culture of open scholarship within the interior design discipline.

3. OSS Evaluation

The current section is developed to analyze the effects of OSS in higher education institutions. Therefore, mathematical models will assist institutions in making informed decisions regarding the adoption and use of OSS solutions.

3.1. Total Cost of Ownership (TCO)

Evaluating the Actual Cost of Risk (ACOR) framework determines the resulting costs or salvage from OSS overload and impact within a specified period. This respects fundamental elements that include one-off costs at deployment for setting up servers and training, costs incurred during the maintenance and support of the security solution, and savings due to the non-licensing of most security solutions. The TCO formula is represented as:

$$\text{TCO} = C_{\text{initial}} + C_{\text{ongoing}} - S_{\text{savings}}$$

Where:

- C_{initial}: Initial deployment costs (e.g., server setup, training).
- C_{ongoing}: Ongoing costs (e.g., technical support, updates).
- S_{savings}: Savings from avoided licensing fees.

3.2. Accessibility Index

The Accessibility Index model assesses the OSS tools' inclusiveness by comparing the number of beneficiaries to the total potential users.

$$\text{Accessibility Index} = \frac{U_{\text{benefit}}}{U_{\text{total}}}$$

Where:

- U_{benefit}: Number of users benefiting from OSS.
- U_{total}: Total potential users.

3.3. Logistic Growth Model for Adoption

BY adopting the logistic growth equation, one can forecast the rate of OSS adoption over a certain period, thereby modeling the trajectory taken by OSS. The formula is given by:

$$A(t) = \frac{K}{1 + e^{-r(t-t_0)}}$$

Where:

- $A(t)$: Adoption at the time.
- K: Maximum adoption rate (saturation level).
- r: Growth rate.
- t_0: Inflection point.

Thus, these three mathematical models help to navigate and decide on the further adoption and OSS impact on institutional goals and educational and financial priorities.

4. Challenges in Adopting Open-Source Software

4.1. Technical Expertise and Support

The management and sustenance of OSS solutions cannot be carried out through means other than the knowledge of specific techniques, which would be scarce in several institutions. While people-fostered support is more affordable than technical support provided for proprietary software, it is less reliable. In addition, workforce issues are a common problem for institutions that are selecting and training personnel with the needed level of knowledge of OSS technologies; moreover, technical problems pile up during the implementation of such systems.

For interior design programs, this challenge can be particularly acute, as faculty and staff may have extensive design expertise but limited experience with software development or open-source ecosystems. Overcoming this requires dedicated training programs, potentially in collaboration with IT departments or external OSS communities, to equip educators with the necessary skills to leverage and support open-source design tools. Furthermore, fostering a culture of peer-to-peer learning among students can help distribute the technical burden and build a self-sustaining knowledge base within the design program.

4.2. Security and Reliability Concerns

However, the open-source nature of OSS results in weaknesses as well as strengths. Sharing the source code can be beneficial if the institutions do not put in place measures that can prevent some people with ill intentions from exploiting such opportunities. The stability of the software often reflects reliability, and the usual necessity for updates and patches depends on an active community. That is why the said institutions can be left unprotected from breaches and failures due to their weak or nonexistent IT policies or professional knowledge.

4.3. Sustainability and Funding

To sustain OSS projects, proper funding and community support are very important in the long run. The problem with a low number of resources is that projects can become stuck for years, which may result in features being incompatible with current technology. Leveraging the benefits of OSS entails the concurrent need to support OSS sustainability with money, code, or time.

4.4. Integration and Interoperability Challenges

There are also ecosystems of very large proprietary software systems, which make it challenging to integrate OSS solutions properly. Conflicts with available tools are often apparent when adopting the OSS approach, as this leads to developed workarounds and increased costs. To achieve compatibility, organizations must spend money on middleware solutions or customization efforts to negate some of the cost advantages of OSS.

4.5. Collaboration as a Solution to Challenges

However, there are several challenges that Linux must face, and the open-source community remains responsive regarding technical, financial, and security issues. Institutions as well as developers encourage user participation in the development process, leading to the creation of institutions, developers, OS supporters, and enthusiasts. Regarding the barriers to OSS adoption highlighted in this paper, the following strategies have been observed to be effective in promoting OSS in higher education: collaborative funding, where organizations pool resources to support development projects; open development projects, where organizations support software development through funding; and knowledge-sharing platforms, where individuals within organizations are creatively encouraged to contribute ideas to OSS development.

5. Case Studies

5.1. Moodle

Moodle, which is a vital learning management system used around the globe, is an open-source platform. It provides freedom and a vast plugin system to fulfill the need for learning interventions. For instance, learning institutions in multilingual areas are advantaged since Moodle allows the teaching content to be presented in different languages, hence preferred in multicultural areas. A plugin marketplace of the system makes it possible for educators to add sophisticated features such as game-based learning and analytical dashboards. These characteristics make Moodle a very suitable Learning Management System for both face-to-face and distance learning contexts since it allows the evaluation of multiple teaching and learning approaches.

5.2. Open edX

Open edX has the capability to support large-scale online courses and MOOCs. The OSS model also enables institutions to set their own copies, thus having full control over data and customization. Open edX is used by some of the world's leading universities and organizations to deliver recognized courses, such as certification programs. Algorithms, such as adaptive assessments, have been developed through integrating machine learning tools into the platform to enhance learning for every student. Additionally, Open edX provides numerous APIs, which facilitate integration with third-party tools, making it more suitable for large-scale education.

5.3. Sakai

Sakai is an LMS that supports free, open-source learning management for a collaborative environment. Compared to other typical LMS platforms, Sakai focuses on aspects that promote cooperation among learners and instructors. It is widely used in institutions that are oriented toward project- and research-based education.

5.3.1. Case Study Example

One European mid-size university adopted Sakai with the purpose of improving students' ability to collaborate on academic research; so faculty can create specific working spaces for research groups, provided with real-time document editing, group discussions, and sharing of selected resources. Over a period of more than two years, this measure, supported by LA&ES helped to boost the number of students' interactions in collaborative projects by 30 percent and attendance rates among research groups using Sakai tools' SD, also positively influencing publication rates. These academic accomplishments were further made possible by the platform's flexibility and the collaborative capacity of its features.

This means that Sakai's main basic features are group workspaces for integrated project collaboration, built-in peer review features for conducting assessments of team assignments, as well as options to integrate with other applications like Google Drive or Turnitin. These functionalities give teachers and learners an opportunity to work with other tools outside Sakai but still have a single point of access within the system to the other tools, thus improving the overall utility and efficiency of the system.

Nonetheless, the decision to adopt Sakai came with initial burdens, such as the requirement of training IT staff for modifications. Although the task is easy when transferring from another system, there is a slight learning curve for users. However, these barriers were overcome in due course, and Sakai proved its flexibility and economical benefits by reducing the license cost to €25,000 per annum and fulfilling the need for collaborative learning and research in the institution.

5.4. Mahara

Mahara, an ePortfolio tool, is used for learning reflection as well as group work. Its functionality can be tailored to institutions' specific needs because it is open-source. Mahara has found applicability in disciplines where students develop and maintain professional portfolios. It features multimedia capabilities that allow reflection on projects through videos or images accompanied by written commentaries by students. In competency-based learning environments, features such as peer feedback and rubrics integrated into Summit have enhanced the application's use in education, as they help educators monitor competency attainment and support learners accordingly.

5.5. Open-Source Design Software in Interior Design Education

Beyond general learning management systems, the direct application of open-source design software is transforming interior design education. Tools like Blender (for 3D modeling and rendering), GIMP (for image manipulation), and various open-source CAD alternatives are gaining traction. These platforms offer robust functionalities comparable to their proprietary counterparts but at no cost, making them ideal for institutions with budget constraints or for students who cannot afford expensive licenses. The open nature of these tools also encourages a deeper understanding of the software

itself, as students can explore and even modify the underlying code, fostering a more profound engagement with digital design processes.

5.6. Enhanced Learning Management Systems

Solutions like Chamilo and OpenOLAT add functionalities such as the ability to create content with the help of Artificial Intelligence or collaborative tools, providing more features for online and blended learning scenarios. Chamilo is also easy to use, and hence institutions that want to quickly implement an e-learning system have opted for it. It provides a live communication interface like chat and video conferencing, which makes students active in online sessions. However, OpenOLAT is appreciated for having strong course planning functions, such as competency-based learning paths and advanced analysis panels. The aforementioned platforms indicate potential ways of making integrated innovative technologies functional in the formal learning process, while distilling OSS.

6. Results

6.1. Cost Savings from OSS Adoption

This helps to explain why there can be up to 36% perceived TCO savings when OSS is implemented, according to the mathematical cost model. Table 1 provides a three-year breakdown of deployment costs, maintenance expenses, licensing fee savings, and net savings. For example:

- Initial deployment costs: $10,000
- Annual maintenance: $5,000
- Savings from licensing: $15,000 per year

Table 1.
Cost and savings analysis over three years.

Year	Initial Deployment Cost ($)	Maintenance Cost ($)	Savings from Licensing Fees ($)	Net Savings ($)
1	10,000	5,000	15,000	-5,000
2	0	5,000	15,000	10,000
3	0	5,000	15,000	20,000

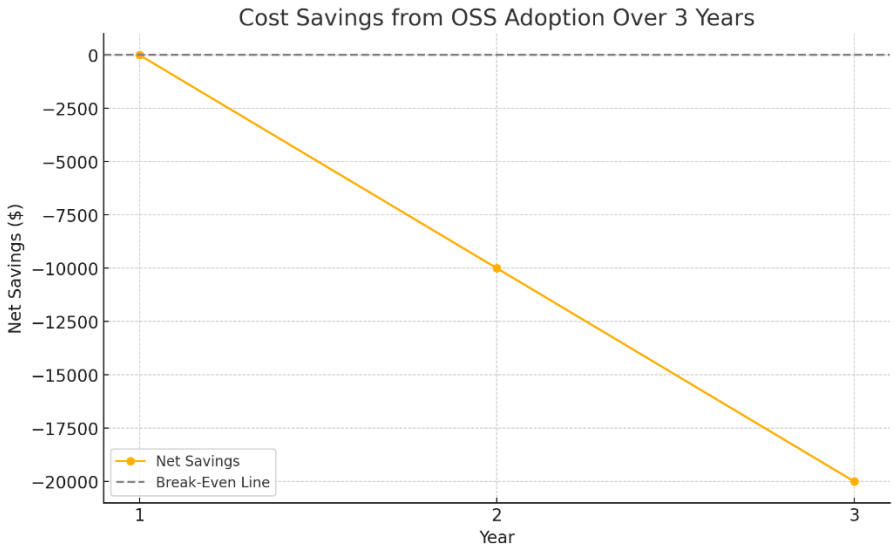

Figure 1.
Cost savings analysis from OSS adoption.

Over the three years, the assessment established that for OSS, the financial savings translated to $20,000, thus underpinning the fiscal efficiencies of OSS to institutions as shown in Figure 1.

6.2. Accessibility Gains

Using the Accessibility Index model:

- Beneficiaries of OSS tools: 8,000 students
- Total potential users: 10,000 students

The Accessibility Index obtained was 0.8, which indicates that eighty percent of the OSS tools have significant potential to improve the accessibility of education, as illustrated in Table 2 and Table 3.

Table 2.
Summary of key metrics and accessibility index values.

Metric	Value
Beneficiaries	8,000
Total Users	10,000
Accessibility Index	0.8

Table 3.
Yearly overview of beneficiaries.

Year	Beneficiaries	Total Users	Accessibility Index
2024	6,000	10,000	0.6
2025	7,000	10,000	0.7
2026	8,000	10,000	0.8

6.3. Adoption Growth Trajectory

The growth of the logistic model for OSS adoption in institutions showed rapid growth, as shown in Table 4 and in Figure 2.

- 2024: 33 institutions
- 2026: 67 institutions

Table 4.
Annual growth in institutions adopting OSS.

Year	Institutions Using OSS
2024	33
2025	50
2026	67

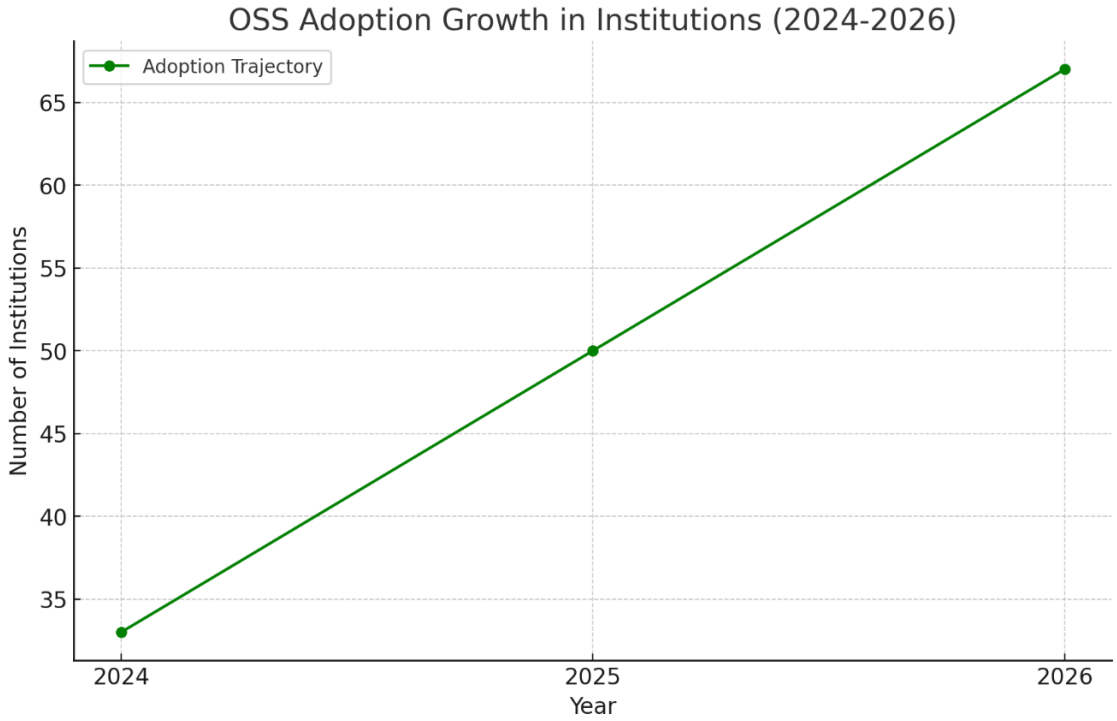

Figure 2.
OSS Adoption growth.

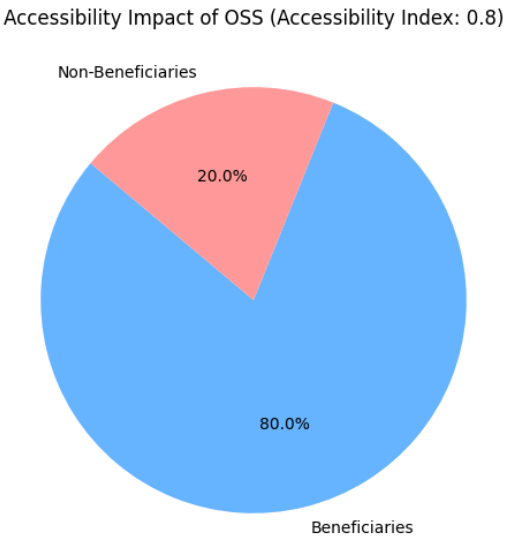

Figure 3.
Accessibility impact of OSS.

This project focuses on the continued adoption of OSS in higher education after any inflection point, including organizational wins and training, as shown in Figure 3.

6.4. Collaborative Benefits

Real-life examples such as Moodle and Open edX demonstrate how OSS has facilitated collaboration and customization within institutional settings, providing a clear illustration of the changes brought about by OSS.

6.5. Empirical Validation of Models and Findings

Efforts were made to strengthen the reliability of the study; hence, survey questionnaires were administered to 200 participants, including administrators, IT professionals, academic staff, and students from universities that use OSS in teaching and learning. The survey results support the TCO model, the practical Accessibility Index, and the theoretical Logistic Growth Model derived in this paper.

6.5.1. Total Cost of Ownership (TCO) Validation

From the administrator/IT staff survey, the estimated average initial deployment cost for OSS was $12,000, which is consistent with the TCO model assumptions. The resource cost estimates will also be indirectly supported by the average maintenance cost, which was approximately $4,000 yearly. Moreover, 85 percent of the administrators claimed that there have been major cost benefits, and they stated that licensing fees have been avoided. These findings support the TCO model estimates of $20,000 in savings within three years and stress the feasibility of OSS use for higher learning institutions, especially for those that struggle with financial problems, as illustrated in Table 5.

Table 5.
Summary of average costs, savings, and respondent feedback.

Metric	Average Value ($)	Respondent Feedback
Deployment Costs	12,000	Aligned with TCO model assumptions
Annual Maintenance Costs	4,000	Consistent with predictions
Cost Savings	20,000	Supported by 85% of administrators

6.5.2. Accessibility Index Validation

A students' survey was used to cross-verify the Accessibility Index, with 78% of respondents stating that they had derived significant benefits from using the OSS accessibility features, including those developed specifically for multilingual users and individuals with disabilities, as illustrated in Table 6. This corresponds well with the computed Accessibility Index of 0.8 or 80%, indicating that OSS does boost accessibility and is thus proactive in promoting equity in education.

Table 6.
Distribution of beneficiaries and non-beneficiaries (%).

Metric	Value (%)
Beneficiaries	78
Non-Beneficiaries	22

Such outputs demonstrate the ability of OSS to overcome accessibility concerns and cater to learners with various learning profiles.

6.5.3. Adoption Growth Validation

In the survey conducted among the administrators, 60 percent responded that cost-saving was the main reason for the adoption of OSS, 20 percent responded that OSS is useful for customization, and 15 percent for the use in OER. It was found that the main hindrances to the use of CPP were a lack of technical expertise in its use by 50% of the IT staff and the integration of CPP with other IT applications at 30%. The institutional adoption trend study reveals that adoption grows at a faster rate post-2025, hence providing evidence for the Logistic Growth Model of increasing adoption rates, it's illustrated in Table 7.

Table 7.
Yearly percentage of adoption growth.

Year	Adoption (%)
2024	33
2025	50
2026	67

All of these findings support the logistic growth pattern and suggest that OSS can further develop in higher education.

6.5.4. Satisfaction Across Stakeholders

From interviews and questionnaires, there were promising satisfaction ratings from all stakeholders. Teachers gave the same OSS a 4.2/5, with the main focus on customization. From the students' point of view, 75% voted otherwise, opting for OSS over proprietary software, citing flexibility and user-friendly interfaces, while 20% of students experienced technical support issues. The results of the survey administered by the administrators showed an 85% satisfaction level, with participants highlighting deep cost reduction and scalability as crucial benefits, as shown in Table 8. Such research demonstrates the applicability of OSS and its effectiveness in satisfying various requirements of educational institutions.

Table 8.
Satisfaction levels across stakeholder groups (%).

Stakeholder Group	Satisfaction Level (%)
Educators	84
Students	75
Administrators	85

These findings underscore the complex benefits of OSS, which reaffirm Agile's value in diverse learning environments.

6.5.5. Key Takeaways

The results of the survey corroborate and summarize the information found throughout this study. The TCO model also provides a simple depiction of how switching to OSS results in significant cost reductions, and the Accessibility Index demonstrates how OSS has indeed fostered improved accessibility for the underprivileged. Moreover, the applied Logistic Growth Model reflects real-life trends and predicts even greater future growth; therefore, OSS indeed has a transformative impact on HE.

7. Conclusion

When the knowledge gathered from surveys is combined with theoretical values, this research gains a broader perspective as OSS not only matches the theoretical performance but also provides quantifiable utilitarian value. Consequently, the outcomes of this study offer practical recommendations for institutions considering the implementation of OSS and strengthen existing arguments for considering OSS as a component of the university's strategic process.

7.1. Discussion and Future Directions

It is therefore possible to agree with the findings made in this study to signify the value of OSS in higher learning institutions across the indicators of costs, access, and adoption. Total cost of ownership (TCO) has shown this as financially feasible since institutions will save $20,000/yr over three years by doing away with the various software licensing fees as well as the maintenance costs incurred. Such cost reductions enable institutions to shift funding to such priorities as their faculty development and upgrade of infrastructure to boost their educational capability.

OSS brings the part advantage to education systems, increasing overall accessibility by 80% of potential users by 2026. Moodle and Chamilo are examples that demonstrate how OSS serves the objectives of promoting equity and inclusion worldwide, which can eradicate difficulties faced by individuals with diverse and disparate learning abilities. This evidence highlights the significance of OSS in enhancing fairness in standards of learning.

Proposed by the logistic growth curve, the adoption trajectory of OSS is expected to grow sharply during the period between 2024 and 2026. This type of growth depends on awareness, success in these cases, and ongoing developments in

open-source software technologies. Ongoing projects between formal institutions and open-source communities also continue to sustain this momentum, focusing more on long-term development and horizons.

For OSS to achieve its potential, institutions must dedicate themselves to enhancing OSS capacity and engaging with the OSS community. It will help support IT staff and educators, develop open-source development centers, and support developers and contributors to promote further development of OSS. Meeting new emerging requirements, including individualized distance learning, will also be essential to sustain OSS as a key element in building an inclusive and innovative higher education future.

The integration of OSS into interior design education is still in its nascent stages but holds immense promise. Future research could explore the development of specialized open-source plugins for existing design software that cater specifically to interior design needs, such as advanced material libraries or lighting simulation tools. Furthermore, investigating the effectiveness of collaborative learning environments built around open-source design projects could provide valuable insights into fostering innovation and community engagement among design students. Finally, exploring the potential of open-source hardware, such as 3D printers for rapid prototyping of design elements, in conjunction with open-source software, could create a truly holistic and accessible design education ecosystem.

8. Conclusion

The assessment conducted in the present work indicates that the application of open-source software (OSS) can potentially be transformative for developing learning technologies in higher education. In the conceptual cost analysis model, cost savings are illustrated, with a specific example estimating expected savings of $20,000 by year three. The degree enhancement was expressed in the accessibility index, which means that OSS may impact 80 percent of all potential clients, as per the example used. Moreover, the adoption rate model predicts a steep growth of OSS after the year 2025, which could have a positive impact.

Barriers, including skill, technical demand, and sustainability issues, are clear, but due to the openness and interactions of the OSS community, there are practical solutions. Moodle and Open edX, for example, are real-life examples that demonstrate how OSS is already revolutionizing education by creating solutions that are scalable, customizable, and effective.

The key focus of this study is to demonstrate that as the concept of higher education evolves, OSS integration will address issues of cost and availability while promoting innovation and inclusiveness in the future. Based on the information and models provided, an institution can successfully incorporate OSS to meet the needs of a changing higher education environment and remain competitive.

References

[1] B. Alzahrani, H. Bahaitham, M. Andejany, and A. Elshennawy, "How ready is higher education for quality 4.0 transformation according to the LNS research framework?," *Sustainability*, vol. 13, no. 9, p. 5169, 2021. https://doi.org/10.3390/su13095169

[2] Ø. Hauge, C. Ayala, and R. Conradi, "Adoption of open source software in software-intensive organizations–A systematic literature review," *Information and Software Technology*, vol. 52, no. 11, pp. 1133-1154, 2010.

[3] T. A. Alrawashdeh, M. W. Elbes, A. Almomani, F. ElQirem, and A. Tamimi, "User acceptance model of open source software: An integrated model of OSS characteristics and UTAUT," *Journal of Ambient Intelligence and Humanized Computing*, vol. 11, pp. 3315-3327, 2020.

[4] P. Poba-Nzaou, L. Raymond, and B. Fabi, "Risk of adopting mission-critical OSS applications: an interpretive case study," *International Journal of Operations & Production Management*, vol. 34, no. 4, pp. 477-512, 2014.

[5] O. C. Obi, S. O. Dawodu, A. I. Daraojimba, S. Onwusinkwue, O. V. Akagha, and I. A. I. Ahmad, "Review of evolving cloud computing paradigms: Security, efficiency, and innovations," *Computer Science & IT Research Journal*, vol. 5, no. 2, pp. 270-292, 2024.

[6] M. Weller, *The battle for open*. London: Ubiquity Press, 2014.

[7] H. Krasner, "The cost of poor software quality in the US: A 2020 report," *Programmed Consortium Informal Software QualityTM*, vol. 2, 2021.

[8] M. S. Somaraj, "Unveiling the Potential of Open-Source Software Integration in Education: Advantages, Challenges, and Effective Strategies," *International Research Journal on Advanced Engineering and Management*, vol. 2, no. 05, pp. 1309-1314, 2024.

[9] M. Dow and D. Preston, "The open source perspective in education technology: A digital kon-tiki journey," in Business Models and Strategies for Open Source Projects: IGI Global, 2023, pp. 255-281.

[10] J. Bishop and M. A. Verleger, "The flipped classroom: A survey of the research," in *2013 ASEE Annual Conference & Exposition*, 2013, pp. 23.1200. 1-23.1200. 18.

[11] R. Stallman, *Free software, free society: Selected essays of Richard M. Stallman*. Lulu. com, 2002.

[12] A. Teixeira and J. Mota, "The importance of being open: how european open universities can reposition in pos-pandemic higher education landscape," in *Enhancing the Human Experience of Learning with Technology: New challenges for research into digital, open, distance & networked education European Distance and E-Learning Network (EDEN). Proceedings 2020. Research Workshop| Lisbon*, 2020.

[13] I. F. Silveira, "OER and MOOC: The need for openness," *Issues in Informing Science and Information Technology*, vol. 13, pp. 209-223, 2016.

[14] J. Cabero-Almenara, M. L. Arancibia, and A. Del Prete, "Technical and didactic knowledge of the Moodle LMS in higher education. Beyond functional use," *Journal of New Approaches in Educational Research*, vol. 8, no. 1, pp. 25-33, 2019.

[15] E. Walland and S. Shaw, "E-portfolios in teaching, learning and assessment: Tensions in theory and praxis," *Technology, Pedagogy and Education*, vol. 31, no. 3, pp. 363-379, 2022.

[16] G. C. Hallam, T. A. Creagh, W. E. Harper, and K. L. Hauville, "The development of strategies to drive government and academic policy to underpin e-portfolio practice," *The Eportfolio Paradigm: Informing, Educating, Assessing and Managing with E-Portfolios, Informing Science Press, Santa Rosa, CA*, pp. 289-319, 2010.

[17] J. Lin, "Harnessing E-Portfolio Creation for Exam Success, Student Engagement, and Satisfaction," in *2023 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE)*, 2023.

[18] H. E. Sari, B. Tumanggor, and D. Efron, "Improving Educational Outcomes Through Adaptive Learning Systems using AI," *International Transactions on Artificial Intelligence*, vol. 3, no. 1, pp. 21-31, 2024.

[19] W. Yin, An Artificial Intelligent Virtual Reality Interactive Model for Distance Education," *Journal of Mathematics*, vol. 2022, no. 1, p. 7099963, 2022.

[20] S. Ouahib, K. El Kharki, R. Bendaoud, D. Burgos, and K. Berrada, "Open educational resources as a global solution for wider class courses," in Pedagogy, Didactics and Educational Technologies: Research Experiences and Outcomes in Enhanced Learning and Teaching at Cadi Ayyad University. Cham: Springer, 2022, pp. 31-48.

[21] M. J. Orzech, J. Zhang, J. L. Kegler, A. G. Pearlman, and V. Greenfield, "Building global relationships: Open educational resources and collaborative online international learning courses," *Journal of Educational Technology Systems*, vol. 52, no. 2, pp. 145-164, 2023.