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A Road Map for Sustainable Open Educational Resource Initiatives in Higher Education

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Abstract: Open Educational Resources (OER) present significant advantages, such as cost savings, addressing economic inequality, enhancing access to quality education, and supporting lifelong learning. These advantages became even more apparent during the emergency remote teaching period, emphasizing their importance and anticipating their increased relevance in the era of general artificial intelligence. Despite these benefits and recognized needs, OER initiatives face a sustainability problem. While studies have examined factors affecting OER sustainability, there is a lack of research on practical strategies that emerge from actual implementation, as well as on evaluating the effectiveness of these strategies. This study aims to identify strategies within the 3M (macro, meso, and micro) framework to support sustainable OER initiatives in higher education. Adopting a design-based research method, this study primarily collected qualitative data from relevant stakeholders through focus groups and interviews. The study identified 20 main and 21 sub-strategies for sustaining OER initiatives in higher education. The micro level includes strategies in the context of the course or platform and the meso level in the context of the institution. The macro level, which represents strategies that are more difficult and time-consuming to implement, includes strategies that interact with the institution and outside the institution. This study offers novel insights and recommendations for policymakers, administrators, practitioners, and researchers.

Keywords: open educational resources, sustainability, sustainable OER, 3M framework, higher education

Highlights

What is already known about this topic:

- OER sustainability is multidimensional, involving both the continuous creation and sharing of open content and its ongoing use and reuse.
- Despite various models, concrete strategies for the long-term sustainability of OER initiatives remain limited.

What this paper contributes:

- This paper identifies strategies for OER sustainability across institutional, platform, and resource dimensions, structured according to the 3M framework (macro, meso, micro levels).
- OER sustainability requires a holistic approach that simultaneously implements strategies at all levels (macro, meso, and micro) in a mutually supportive way.

Implications for theory, practice, and/or policy:

- The study extends OER sustainability literature by illustrating how strategies interact across macro, meso, and micro levels.
- Educational institutions and platforms can enhance sustainability by coordinating OER strategies across institutional, platform, and resource levels.
- Policymakers can develop policies to support the integration of OER into education based on the identified strategies.

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Introduction

Based on the philosophy that knowledge is a social resource, OER (Downes, 2007) is defined as free educational resources available for everyone to use (Butcher, 2015). It offers advantages such as reducing the cost of accessing educational materials, accessing quality educational resources (Gisip et al., 2024), and supporting personalized learning (Wynants & Dennis, 2022). However, despite their advantages, OER initiatives face sustainability challenges (Wang, 2019). OER sustainability is explained by several factors such as OER awareness (Bozkurt, 2019), quality (Tang, 2020), accreditation approaches (McGreal, 2017), and discoverability (Otto & Kerres, 2022). Some models and frameworks can be evaluated within OER sustainability. Huttner et al. (2018) propose a framework that highlights the sustainability of OER across the stages of development, distribution, use and revision. The Connexions model links sustainability to brand value, content, community and usability (Dholakia, 2006). Meanwhile, Abeywardena (2017) emphasises mindset, capacity building, licensing and technology, and Desrochers (2019) stresses infrastructure, resources and culture. Arinto et al. (2017) outline access, participation, and empowerment, while Tlili et al. (2023) identify ten models that rely on funding, networks, services and community contributions.

OER sustainability is critical in the context of the Fifth Industrial Revolution. Characterized by collaboration between humans and smart machines to enhance mass personalization and efficiency (Taj & Jhanjhi, 2022), the Fifth Industrial Revolution is often described as the Age of Sustainability (Kim, 2025). It aims to advance environmental, social, and economic sustainability (Kim, 2025). Environmental sustainability focuses on integrating eco-friendly technologies into production processes. In this context, OER help reduce paper consumption by promoting the use of digital content over printed materials. Moreover, their reusable and shareable nature helps minimize resource waste. Economically, OER lowers educational costs and supports budget efficiency, thus aligning with economic sustainability goals. Social sustainability emphasizes a human-centered approach to the dissemination of technology across society. Accordingly, OER supports equal access to education by offering free and inclusive learning opportunities for all (Lumadi, 2025). As emphasized by UNESCO (2019), the development of strategies to support the creation, use, and sharing of OER is essential to ensuring inclusive, high-quality education and lifelong learning opportunities for all.

Despite its commitment to accessibility, inclusivity and equality in education, OER sustainability is hampered by various factors, including a deficiency awareness regarding open sharing (Ofoegbu et al., 2021), a lack of institutional OER adoption (Luo et al., 2020; Menzli et al., 2022), lack of time to develop or share OER (Marin et al., 2022), and financing needs (Tlili et al., 2023). Given the factors discussed, OER initiatives demonstrate limited sustainability over the long term (Aksoy et al., 2025). Accordingly, it is essential to develop strategies supporting OER initiatives' long-term sustainability. Current frameworks and models tend to address OER from specific perspectives; for example, Huttner et al. (2018) focus on content, while Cox and Trotter (2017) focus on institutional and instructor adoption. Despite growing awareness, there is a lack of comprehensive approaches that examine the sustainability of an OER initiative from multiple perspectives. This research aims to identify strategies for OER sustainability through the lens of the 3M framework, offering a structured contribution to both theory and practice. Our research question was as follows:

- What are strategies for OER initiatives' sustainability?

Literature Review

Open Educational Resources

Openness is defined as transparency and freedom of content or systems (Baker, 2016). In education, openness encompasses not only dimensions such as teaching, curriculum design, textbooks, research, policy, and academic strategy (Wiley & Green, 2016), but also the development and implementation of

new educational practices that benefit society as a whole (Rossini, 2016). The concept of OER, first introduced by UNESCO in 2002, is defined as “educational materials and resources that are freely and openly available to anyone who wants them, and that also allow for combining, developing, and republishing under specific licensing conditions” (UNESCO, 2002, p. 24). OER initiatives aim to reduce regional educational inequalities (Luo et al., 2020). OER offers the advantages of reducing the cost of accessing materials, providing students with easy access to different resources (Fischer et al., 2015), and ensuring equal opportunities (Lumadi, 2025). The OER constitutes a potentially significant set of resources for promoting inclusive and democratic education, characterised by cross-disciplinary collaboration and cultural diversity (Bulathwela et al., 2024). In its 2030 Agenda for Sustainable Development, UNESCO calls on educational institutions to provide inclusive, accessible, and high-quality resources for all learners within their specific contexts (UNESCO, 2016, p. 20).

Sustainability of OER

Sustainability in OER is considered to have two dimensions. The first is the sustainability of the production and sharing of content; the second is the sustainability of users' use and reuse of content (Wiley, 2007). Some frameworks and models within the literature have addressed OER's sustainability, acceptability, and adaptations. Huttner et al. (2018) presents a framework focusing on sustainable OER, emphasizing development, distribution, use, and revision dimensions. In the development stage, they highlight the importance of preparing metadata, creating standardized resources, planning courses, and ensuring resource accessibility. The distribution stage involves instructor adoption, sharing with institutions, and making resources available online. The stage of use emphasizes classroom application, providing feedback to developers and facilitating technology-supported interaction and evaluation. The review stage involves updating content and teaching methods based on innovations while considering individual learners' needs and providing additional support when necessary (Huttner et al., 2018). The “Connexions” project, conducted by Rice University, presents a sustainability model for programs offering OER. According to this model, the sustainability of OER is influenced by brand value, content quality and quantity, user community, and site usability (Dholakia, 2006). Abeywardena's (2017) framework focuses on mindset shifts, capacity building, open licensing adoption, and technology infrastructure integration within academic institutions. Desrochers (2019) diverges by highlighting infrastructural, resource allocation, and cultural aspects, demonstrating infrastructure's pivotal role in guideline establishment, resource management, and cultural integration to sustain OER. Arinto et al. (2017) offers three stages that reflect OER engagement: access, participation, and empowerment in the context of social inclusion. Cox and Trotter (2017) present a layered structure that focuses on the acceptance of OER within the educator and institutional context. This structure involves various factors, including access, permission, awareness, capacity, availability, and volition. Tlili et al. (2023) extensively reviewed sustainability models for OER and identified ten sustainability models. These models include institutional funding, participation in OER networks, public funding, donations, sponsorship, offering paid services, selling user data, producing OER on demand, individual author contributions, and community-based approaches. A common feature shared by these models is their focus on ensuring the long-term sustainability of OER by providing various financial means. According to Papadakis et al. (2023), the success of open education initiatives can be enhanced through computer simulations that simplify complex topics, artificial intelligence technologies that tailor learning experiences, and data-driven management processes that systematically improve educational quality.

A comprehensive review of the extant literature reveals that the sustainability of OER initiatives is dependent on numerous factors, including funding (Tlili et al., 2023), OER awareness (Bozkurt, 2019), lecturer and institutional adoption (Cox and Trotter, 2017), incentive mechanisms (Breems & Doll, 2023), institutional support (Lumadi, 2025), quality (Tang, 2020), and engagement (Arinto et al., 2017). However, there remains a gap in the literature regarding concrete strategies for achieving sustainability. Wiley et al. (2016) emphasized the need for studies to support the creation and publication of

sustainable OER in universities, stating that universities without OER sustainability models have difficulties producing and sustaining OER use.

Ecological Systems Theory and 3M Framework (Macro, Meso, Micro)

Ecological Systems Theory delineates the reciprocal relationship and harmony between humans and their environment. It posits that the environment encompasses not only an individual's immediate surroundings but also the broader social contexts in which these surroundings are situated. Accordingly, the ecological environment is conceptualized as a topological structure comprising nested systems, such as the microsystem, mesosystem, exosystem, and macrosystem. The microsystem involves an individual's direct interactions within immediate settings (e.g., home, school, workplace). The mesosystem captures the connections among these settings, while the exosystem comprises external structures that indirectly affect the individual. The macrosystem encompasses overarching cultural, economic, social, educational, legal, and political systems (Bronfenbrenner, 1977). At the macro-level, ODDE involves systems and theories at the national, regional, and global levels; at the meso-level, it encompasses management, organization, and technology within educational institutions; and at the micro-level, it focuses on teaching and learning among individual learners and teachers in ODDE. This study employs a design-based research approach and the 3M framework (macro, meso, micro) to identify strategies for OER sustainability. The 3M framework was chosen for its strong alignment with the focus of the study and for its capacity to offer a contextually grounded, multi-level analytical structure.

Methodology

Design-based research methodology was used in the study because it is process-oriented in addressing real-life problems, facilitates collaboration between the researcher and participants, and offers flexibility. According to Wang and Hannafin (2005), it is a systematic and flexible research method that follows a cyclical process of analysis, design, development, and implementation with the collaboration of researchers and participants to improve educational practices in their real environment.

Both qualitative and quantitative data can be collected in design-based research (Collins et al., 2004). The primary source of data in this study was qualitative, gathered from relevant stakeholders through focus groups and interviews.

The research was conducted in the context of a public university in Türkiye. Within the scope of digital transformation, the university is involved in many different types of OER projects, such as OpenCourseWare, massive open online course (MOOC), e-book, open science article, and e-exhibition (Bozkurt et al., 2022). The research strategies were executed within the university's OER platforms.
This study received ethical approval from the relevant university's Ethics Committee for Social and Human Sciences to collect data from participants. All participants were informed of the aims and scope of the research and gave their written informed consent before participating. In accordance with ethical guidelines, all personal data were anonymised to protect participant confidentiality.

Study Group

The data sources of the study consisted of OER platforms setup team (n=6), administrators (n=2), strategy team (n=6), other OER entrepreneurs (n=4) and platform data. Purposeful sampling was employed to select information-rich cases aligned with the study's objectives (Palinkas et al., 2015). The strategy team plays a key role in developing, executing, and assessing strategies. Participants took part in the study voluntarily and were thoroughly informed in advance about its aims, procedures, and confidentiality measures. The interviews were conducted between January 2021 and October 2022. Information about the participants in the study is presented in Table 1.

Table 1. Research participant information

	Participant	Gender	Academic Title		Qualities
Strategy Team	ST1	Male	Prof.	Expertise Area	Having conducted academic studies in the field of OER and working as an OER implementer
	ST2	Female	Assoc. Prof.		
	ST3	Male	Asst. Prof.		
	ST4	Female	Asst. Prof.		
	ST5	Female	Lecturer with Ph.D.		
	ST6	Male	Lecturer		
Setup Team	K1	Male	Lecturer		
	K2	Male	Lecturer		
	K3	Female	Asst. Prof.		
	K4	Female	Lecturer with Ph.D.		
	K5	Male	Prof.		
	K6	Male	Asst. Prof.		
Administrators	A1	Male	Prof.	Role	Digital office administrator responsible for the planning and follow-up of OERs
	A2	Female	Assoc. Prof.		The administrator of the unit that takes an active role in the implementation of the OERs
Other OER Entrepreneurs	OE1	Male	Assoc. Prof.		Administrator of a state sponsored OER initiative
	OE2	Male	Lecturer with Ph.D.		Creative Commons leader, works on OER
	OE3	Male	Prof.		Leading and working on OER initiatives
	OE4	Male	Prof.		

Data Collection Tool

For data collection in the study, semi-structured interviews, focus group interviews, a usability form, and platform data analysis were conducted. The researchers developed the interview questions in alignment with the study's aims. Prior to data collection, the questions were assessed by experts to evaluate their clarity and relevance. Table 2 outlines data sources, collection tools, and their purpose in the research process.

Table 2. Data collection tools, data source, and purpose

Data Collection Tool	Data Source	Purpose
Semi-structured Interview	OER platforms installation team	Identify the practices for OER and receive suggestions for strategies.
	Other OER entrepreneurs	Get updates on the present OER status, processes, and sustainable strategies.
	Strategy team members	Evaluation of the implementation of the strategies.
	Administrator	Evaluation of the implementation of the strategies.
Focus Group Interview	Strategy team	Deciding on appropriate strategies by evaluating the data collected during the research process.
Usability Form	Platforms	Evaluate the usability of the platforms.
Platform Data	Platforms	Analyzing strategy reflections.

Final-stage interviews with the strategy team and administrators were conducted face-to-face, while all others were held online. Interviews were recorded with participants' consent. To ensure data security and maintain anonymity, all identifying information was removed. During data collection, open-ended and non-directive questions were employed to encourage accurate responses. Conducting interviews with different stakeholder groups enabled the collection of in-depth data and allowed for comparisons

across perspectives. To undertake a quantitative analysis of the practical implementation of the strategies, platform activities and user messages have been employed as platform data.

Data Analysis

In the first phase of the research, data obtained from focus groups and interviews were analyzed using content analysis. In the second phase, the identified strategies were organized into thematic categories. In the third phase, these strategies were re-examined according to the 3M framework by Zawacki-Richter and Jung (2023), and macro, meso, and micro level strategies were determined. The analysis of interview data in the study was conducted using the MAXQDA 2020. To ensure the reliability of the coding, categorizing themes, and determining the 3M level two researchers analyzed the data independently and compared their findings. Any discrepancies were discussed and resolved. Direct quotations were employed to present the findings, ensuring the direct inclusion of participants' voices. Furthermore, certain findings were succinctly summarized using tables and figures to provide a concise and visual representation.

Validity and Reliability

Qualitative data collection tools are used in the research. Used in quantitative research; Instead of external validity, internal validity, external reliability and internal reliability, the concepts of transferability, credibility, confirmability, and dependability are used in qualitative research, respectively (Yıldırım & Şimşek, 2021). Table 3 lists the validity and reliability measures performed as part of the study.

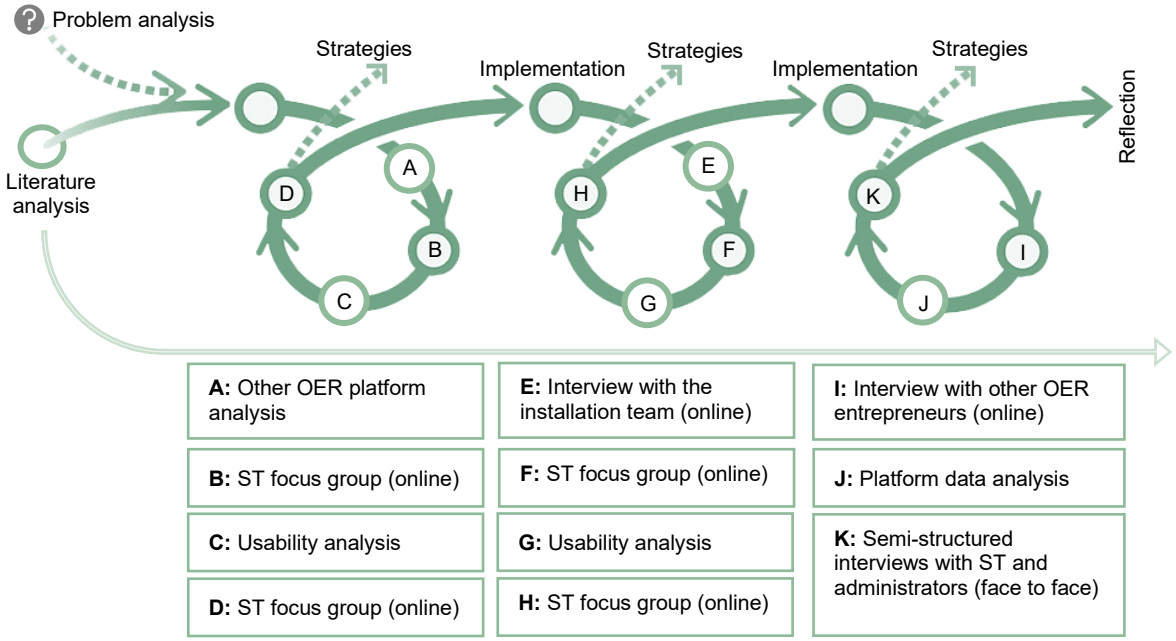
Table 3. Validity and reliability measures

	Measures
Credibility	The research was supervised within the doctoral thesis scope. Expert opinion was obtained for the interview questions. Participants joined after approving the voluntary participation form. The implementation process was completed in 18 months. Direct quotations were used in the presentation of the findings.
Transferability	The research problem, purpose and theoretical framework were explained. Participant characteristics and sampling method were explained. Data collection tools, data collection and analysis process were explained. Research processes were explained in detail.
Confirmability	Recordings were made with participant consent during interviews to prevent data loss, and transcriptions were stored digitally. Participant quotations were included in the presentation of the findings.
Dependability	Peer researchers analyzed the research process and outcome. Data was collected from different data sources.

Research Procedures

The research process consisted of three main cycles, each of which involved developing, implementing, and evaluating a strategy. Figure 1 illustrates the design-based research process.

Figure 1. Research process



The research began by analyzing OER platforms (A). Four online focus group interviews with the strategy team (ST) played a fundamental role in evaluating and refining the design decisions (B, D, F, H). These were followed by usability analyses (C and G) to test the findings and inform new strategies. Furthermore, an online interview with the installation team (E), an online interview with open educational resource entrepreneurs (I), and face-to-face semi-structured interviews with the strategy team (ST) and administrators (K) provided data on the experiences and views of different stakeholders. Analysis of platform data throughout the process (J) provided additional insights into how the developed solution functioned. This iterative, multi-sourced data collection process enabled continuous improvement of the design process and comparative analysis of different stakeholder perspectives.

Limitations

This study has several limitations. Firstly, the application of the strategies identified in this study is primarily based on a single university. Therefore, the reflections on these strategies are specific to contexts with similar characteristics. Secondly, participants were restricted to 18 participants, including members of the OER platform's setup and strategy teams, administrators, and other OER practitioners. Thirdly, it was also impossible to implement every strategy identified within the scope of the research. However, detailed descriptions of the institutional setting, participant profiles and implementation processes were provided to support transferability. While the findings are context-dependent, the study's recurring patterns and design principles may offer valuable insights to researchers or practitioners working in similar educational environments.

Findings and Discussions

In the study, focus group and semi-structured interviews were conducted to identify strategies for sustainable OER initiatives. According to the data, 20 main strategies were obtained in institutional, platform and resource themes.

Institutional Strategies

In the institutional context, 10 main and 12 sub-strategies were identified. OER policy, cultural openness, financial structures, and accreditation approaches within the institutional framework are both macro and meso strategies, impacting beyond the institution's boundaries. All other institutional strategies are addressed at the meso level. Strategies such as creating incentive mechanisms for instructors to participate in OER, planning and implementing activities to promote and advertise OER, providing credit and certification for students' participation, and providing support to instructors in the process of producing and sharing OER were mentioned by all data sources. A participant's view on incentivizing instructors is given below:

> *Most importantly, an incentive mechanism needs to be provided to professors rather than volunteering. I mean, volunteering only goes so far. We have seen this. At most, let's say there were 20 professors, 30 professors. So then, how long will volunteering continue? If we want it to be sustainable, I strongly recommend an incentive mechanism for the lecturer. This incentive can be academic, it can be points or wages. (K4)*

Some participants also stated that sustainability can be ensured when it becomes a culture or policy implemented in the organization beyond incentives. The relevant opinion is as follows “As soon as incentives and support are cut, there is no continuation. It needs to turn into a culture or become a policy.” (OE2). UNESCO (2019) encourages governments and educational institutions to adopt regulations that support the open licensing of publicly funded educational and research materials, and to develop policies that promote the use and adaptation of OERs in ways that support inclusive and quality education. Also, in the interview with the administrators, it was stated that the criteria for promotion to the position were not sufficient to encourage instructors to OER and some alternative suggestions such as wage payment and prioritizing the instructor's project. Marin et al. (2022) also stated that incentive mechanisms are needed to encourage instructors. Jung et al. (2017) include instructor rewards in their OER Implementation Model, whereas Desrochers (2019) and Cox and Trotter (2017) omit incentives in their models for instructors. The Iowa Private Academic Libraries Consortium OER project offered grants to tutors to adopt OER and found that one-time grants had a positive impact on their OER adoption (Breems & Doll, 2023).

Another essential strategy is the provision of credit and certification to incentivize students. This factor is related to the ability of users to integrate the courses they have taken into their formal education through certification or crediting (Reeves et al., 2017; Tlili et al., 2023). Participants stated that there was a legislative obstacle regarding crediting. The related opinions are as follows:

> *The most important obstacle here is the bureaucratic obstacle. I mean, I remember that even if you set up a team, even if you have a hundred people following it all the time, there are some bureaucratic obstacles that you must overcome for the crediting and certification that supports it. This is the reason why it has not become widespread. (ST3)*

Kır and Bozkurt (2022) stated that higher education institutions should work towards providing micro-crediting and associating these credits with existing course credit systems. Indeed, the most common goal of MOOC participants is to receive free or paid course completion certificates (Reeves et al., 2017) to improve their knowledge, gain a chance for promotion, and improve their job prospects (Cilliers et al., 2023).

Another strategy found in the research is that promotions for OER should be planned and implemented regularly. Participants stated that promotions are necessary for both instructor and student awareness. There are also opinions that the current promotional activities for the relevant university are insufficient: “We were a bit regional in our advertising efforts. Maybe we didn't reach many people, I can say that. Maybe more active visual things could have been shared on social media.” (K1)

Instructors' and students' lack of awareness of OER is seen as an important obstacle for OER sustainability (Ofoegbu et al., 2021; Tang, 2020). Bozkurt (2019) states that awareness of OER in higher education is low and recommends studies to increase this awareness. Tlili et al. (2023) points out the importance of promotional activities for OER initiatives in building OER awareness.

Both the strategy team, administrators and OER installation team participants said that instructors needed support in producing and sharing OER:

> *It is very important to support our professors. Most of our professors do not have experience in giving distance courses or online courses or preparing online materials. It is necessary to provide support for them. (OE4)*

Supporting instructors is essential, particularly for the first dimension of OER sustainability, which involves creating and sharing OER (Wiley, 2007). Instructors seek help with using the OER platform, resource adaptation (Petrich, 2020), and instructional design (Prasad & Usagava, 2014). Cox and Trotter (2017) note that institutional support impacts instructors' OER acceptance. Desrochers (2019) recommends an organization-backed support team to cater to user needs.

Platform Related Strategies

The critical strategies that emerged under the platform theme are improving the technical infrastructure, designing a user-friendly platform, ensuring mobile compatibility, providing support to platform users, and offering an individualized learning environment. Interviews revealed that both the strategy team and other OER entrepreneurs emphasized the importance of a robust technical infrastructure for sustaining OER. Technical infrastructure is at both macro and meso level due to the external dependency of the institution. This infrastructure encompasses ICT infrastructure, bandwidth, software technologies, and Web 2.0 support, impacting platform usability (Abeywardena et al., 2017). Engagement and motivation levels in online learning environments are directly influenced by the availability and usability of OERs (Lumadi, 2025). The power of artificial intelligence technology can be used to improve access to OER, promote language diversity and enhance usability (Bulathwela et al., 2024). Papadakis et al. (2023) proposed using big data–driven technologies and artificial intelligence as tools in open education to support individualized learning environments.

Enhancing platform usability is an advocated strategy for a sustainable OER initiative. Usability analysis using forms occurred during the research, prompting improvements. Suggestions for ensuring platform usability were gathered in strategy team focus group interviews. Regarding rectifying identified usability issues, S6's viewpoint is as follows: "Accordingly, a suitable theme was chosen. Unnecessary areas in the theme were removed and this was radically implemented. First, we looked at its usability among ourselves. Then we created a suggestion form." (ST6)

Regardless of the OER platform, research shows that users tend to abandon any web platform that is difficult to navigate or use (Nielsen, 2003). Usability plays a key role in supporting the reuse of OER, which Wiley (2007) identifies as the second dimension of sustainability. In line with this, the Connexions sustainability model emphasizes “site usability” as a critical factor in ensuring the long-term viability of OER initiatives (Dholakia, 2006). Accordingly, the design of user-friendly platforms is recommended (Hu et al., 2015). Regarding usability, the research revealed a strategy of ensuring mobile compatibility of platforms and content for user sustainability. Regarding this, K4 expressed his opinion as "there are users who connect from mobile, so it needs to have an interface that can work fast and be compatible with many systems. The platform needs to support this.".

Another strategy that emerged in the platform context is "Provide support for platform users.". The strategy team stated that a support button was added to the platform. A support topic menu was integrated into the support form provided to users, aiming to enhance process management efficiency. This menu includes the headings "report copyright infringement", "request a course", "I need technical support", "I have an idea", and "I have a suggestion". After this button was added, the requests received through the support button were analyzed. According to the data received from the platform, after the course support button was added, 18 requests were received through the "Request a Course" link, five requests through the "I Need Technical Support" link, one request through the "I have an idea" link, and one request through the "I Have a Complaint" link. According to the platform data, 18 course opening requests were received after adding the "Request Course Opening" link. Some of the requests from users are as follows:

> *Audio recordings won't open (04.10.2021).*
> *Why are there no video lectures except for Arabic and Information Technologies. Please do the necessary (3.12.2021).*

According to Kim and Park (2018), providing support to users in e-learning environments can increase users' trust and perception of usefulness of the system. Lack of support or inadequate support, on the other hand, causes students to leave the distance education courses without completing them (Willging & Johnson, 2009).

One of the strategies that emerged from the platform theme in the interviews is providing an individualized learning environment for users on OER platforms. For students' course retention, Cilliers et al. (2023) recommend that higher education institutions offering MOOCs create a conducive online learning environment that offers independence and freedom of learning. Some participants also stated that individualized learning environments can affect the users' behavior of using and continuing to use the platform. One participant noted: “Different learning processes show unique needs. Hence, what suits me may not suit others. Crafting an environment to meet everyone's needs is challenging, but tailoring to specific groups is more effective, albeit tough.” (OE1)

During the research process, it was stated that the university's OER platform offers individuals the flexibility to progress at their own pace. One participant's opinion on this issue is as follows:

> *Individualized learning exists. The process is individual. We allow users to continue at their own pace and we don't make any limitations. For example, if there is an exam, they can take that exam unlimitedly. He can progress and do it according to his own pace. We can evaluate it like this. (ST6)*

In the interviews, the strategy "Increase the variety of courses." which aims to increase course diversity emerged. When the platform data is analyzed, it is seen that the number of users has increased significantly with Public Personnel Selection Examination courses. Analysis of platform data and course launch dates indicates that visitor activity varied depending on the courses available. The addition of these courses to the platform in July 2021 increased the number of views from 613 in June to 3,588 in the following month. The General Accounting course attracted the most students, with a total enrollment of 11,933. Student numbers were more limited in other courses, such as Project Writing Training (n = 350) and Nvivo Qualitative Data Analysis Training (n = 133). Participants also argued that increasing the variety of courses would broaden the range of users. It was also noted that the launch of attractive courses also contributed to the increase in the number of users. A sample opinion on this is as follows: "We had a recent training called Flutter training. We gave Arabic courses, KPSS courses, and interesting subjects. But their number is limited. Maybe the number of these can be increased." (ST6)

Resource Related Strategies

There are 7 main strategies and 5 sub-strategies in the resource theme. Among these main strategies, quality is at the meso and macro level. Other strategies are distributed between meso and micro. The prominent strategy expressed under the theme is "Publish quality content." In the Connextions sustainability model, content quality is seen as essential in attracting and sustaining students' attention (Dholakia, 2006). Abeywardena (2017) highlights the significance of quality assurance in integrating OER into academic institutions. Content quality impacts users' perceptions and usage of platform resources (Tang, 2020), as well as

The research identified "Providing platform content sources" as a key strategy within the resource theme. Participants emphasized the need for resources meeting user expectations to sustain OER platforms. They highlighted the crucial link between resource and user sustainability. As part of this strategy, an "Become an instructor" button was incorporated into the platform. Analysis revealed 13 lecture requests across various subjects through this feature. One participant's opinion was as follows:

> *These are easy things in words, but it's difficult to call in an expert and to keep it going. The most important reason is that it's free. OER needs to have financial support. Because when such people participate in certain places, they get paid. Of course, this platform is based on volunteerism, but I think the intensity of those people and the fact that they cannot be financially supported here is an important reason. (ST5)*

Tlili et al. (2023) examined OER sustainability from a financial perspective and identified public and institutional funding as the most common models. In Desrochers' (2019) framework for OER sustainability, financing is also considered a necessary resource for sustainability. In addition, it was stated that only a few activities could be shared to share all the activities carried out at the university. The lack of an OER team to control and monitor the content transfer process and the lengthy procedural processes were cited as obstacles to the implementation of the strategy.

> *There are events at many universities, but where are they? The corporate communication directorate was contacted. They said OK, but when the distance education center closed, it didn't continue. Again, it is a situation related to the lack of an OER team. (ST2)*

The first of the two dimensions that Wiley (2007) describes while explaining OER sustainability is the production and sharing of content. Providing "course resources" in OER is vital for sustainability. As producers for OER (Wiley et al., 2017), students can contribute by structuring courses to facilitate resource creation (Warren et al., 2017). Downes (2007) emphasizes the significance of fostering volunteers, community, partnerships, and collaborative resource production for OER sustainability.

Table 4 summarizes all strategies identified in the study, comprising 20 main strategies and 21 sub-strategies across various 3M levels. During the implementation process, some strategies encountered obstacles such as insufficient management support, lack of an OER team, legislative barriers, lack of cooperation between units, copyright issues, limited funding, high instructor workload, and insufficient incentives. Although these strategies may not be universally applicable, they provide flexible guidelines that can be adapted to different institutional, cultural, and political contexts.

Table 4. Sustainability strategies for OER initiatives

	Strategy	3M Level	Strategy Source	Phase	Status	Implementation and Evaluation of the Strategy
Institutional	S1. Develop and implement institutional OER policy.	macro, meso	OE, IT	1		Insufficient management support, lack of an OER team
	S2. Develop a culture of openness in the institution.	macro, meso	OE	1		Lack of an OER team, insufficient management support
	S3. Create a financial sustainability model.	macro, meso	OE	1		Insufficient management support, lack of an OER team
	S4. Provide crediting and certification.	macro, meso	ST, IT, OE	2		Lack of an OER team, legislative barriers
	S5. Create incentive mechanisms.	meso	ST, OE, IT	1		Lack of an OER team
	S5.1. Provide financial rewards to OER-involved lecturers.	meso	ST	3		EER
	S5.2. Prioritize projects of lecturers participating in OER.	meso	ST	3		EER
	S6. Establish a dedicated team.	meso	OE	1		Insufficient management support
	S7. Identify workflows.	meso	OE	1		Lack of an OER team
	S7.1. Plan the course publication process.	meso	ST	1		The planning of the course publication process made it faster and more systematic.
	S8. Provide support to the OER initiative by the administration.	meso	IT	1		Weak culture of openness, insufficient policy, and management support
	S9. Plan and implement promotional activities.	meso	ST, OE, IT	1		Lack of an OER team, insufficient management support
	S9.1. Publish news on the university website.	meso	ST	1		Email sent. But not repeated.
	S9.2. Send informational emails to instructors.	meso	ST	1		The news was published. However, it was not repeated.
	S9.3. Send official letters to instructors.	meso	ST	3		Emerged at the end of the research
	S9.4. Send OER information e-mails to new students.	meso	ST	3		EER
	S9.5. Promote the OER initiative at university events.	meso	ST	3		EER
	S9.6. Evaluate OER activities in academic evaluation meetings.	meso	ST	3		EER
	S10. Provide support for instructors.	meso	ST, IT, OE	1		Tutorials were supported in preparing and sharing courses.
	S10.1. Inform the instructors about copyrights.	meso	IT	1		Instructors were informed during the course creation process.
	S10.2. Create OER communities among instructors.	meso	ST	3		EER
	S10.3. Provide support to reduce instructor workload.	meso	IT	1		Technically, the process of opening a course was simplified. Templates were shared with instructors.
Platform	S11. Improve the technical infrastructure.	macro, meso	ST, OE	1		Problems related to technical infrastructure were resolved.
	S12. Increase platform usability.	meso	OE, ST	1		Usability problems were solved.
	S12.1. Ensure mobile compatibility.	micro	ST, IT	1		Updates were made regarding mobile compatibility.
	S12.2. Provide detailed search by defining the course metadata.	meso	ST	1		Lack of an OER team
	S12.3. Use a standard format for the presentation of resources.	micro	ST	1		Templates were shared with the trainers for the process.
	S12.4 Gather all institutional content on a single open platform.	meso	ST	1		Lack of cooperation between units, lack of an OER team, and copyright issues
	S13. Provide help and support for platform users.	meso	ST, IT, OE	1		Support link was added, and requests were answered quickly.
Resource	S14. Ensure the quality.	macro, meso	OE, IT	1		Lack of an OER team
	S15. Design independent learning environments.	meso, micro	OE, IT	1		Lack of an OER team, limited source media types
	S16. Increase the variety of resources.	meso, micro	OE, IT	1		Insufficient participation, insufficient promotions, high instructor workload, insufficient incentives, and poor awareness
	S17. Increase media diversity.	meso, micro	IT	1		Lack of an OER team, high instructor workload, and poor instructor digital skills
	S18. Increase the diversity of assessment tools.	meso, micro	IT	1		Instructor workload, instructor motivation
	S19. Provide content origin to the platform.	meso	IT, ST	1		Lack of an OER team, weak motivation of the instructor, and an inadequate incentive mechanism
	S19.1. Add an instructor participation form to the platform.	micro	ST	1		A tutorial participation link was added, and 13 requests were received this way.
	S19.2. Invite experts in their fields, including the private sector and different universities.	meso, macro	IT	1		Lack of funding, lack of an OER team
	S19.3. Share the contents of the Open and Distance Education faculty on the platform.	meso	ST	1		After receiving the Legal Counseling Unit's opinion and completing the official correspondence, the content was shared on OCW.
	S19.4. Request instructor to lecturers with high interaction and material density.	meso	ST	1		Lack of an OER team, lack of cooperation between units
	S19.5. Share the digital activities conducted by different units at the university.	meso	ST	2		Lack of cooperation between units, lack of an OER team, and copyright issues
	S20. Establish a notification mechanism for copyright infringement.	micro, meso	ST	2		A copyright infringement reporting link was added.

* Implemented Partially Implemented Not implemented EER: Emerged at the end of research

** ST: strategy team, OE: other entrepreneurs, IT: university OER platforms installation team

Conclusion and Suggestions

This study identifies 20 main and 21 sub-strategies for sustaining OER initiatives in higher education, organized within the 3M framework at the macro, meso, and micro levels. During the implementation process, some strategies encountered obstacles such as insufficient management support, lack of an OER team, legislative barriers, lack of cooperation between units, copyright issues, limited funding, high instructor workload, and insufficient incentives. The analysis reveals several key insights. Firstly, sustainability efforts are most effective when synchronized and mutually reinforcing the three levels. They underscore the importance of a holistic approach that integrates organizational, technical, legal, and human resource dimensions to ensure the long-term sustainability of OER initiatives. Secondly, certain strategies, such as institutional policy, span multiple levels, reflecting the interconnected and overlapping nature of organizational, technical, legal, and human resource dimensions. For instance,

most resource-related strategies are situated at the micro and meso levels, whereas strategies emphasizing quality and large-scale resource provision are positioned at the outer edges of the model due to their complexity and the need for inter-institutional collaboration. Although developed within a specific institutional context, the insights from this study provide transferable guidance for other institutions aiming to strengthen their OER practices. This study provides essential theoretical and practical implications for the sustainability of OER initiatives in higher education. The identified strategies can potentially enhance current understanding of OER sustainability by providing a detailed, multi-level approach. These strategies also offer practical guidance to institutions developing or improving their OER initiatives.

According to these points, recommendations are presented below:

Administrators and Practitioners

- OER initiatives can ensure financial sustainability by institutionally budgeting or providing certificates for course completion.
- Instructors can receive support and mentoring for creating digital content, using OER platforms, sharing, and handling technical problems.
- Financial or moral incentives and courses to improve digital skills can be provided to ensure instructor participation in OER.
- Institutions need a culture of sharing and openness. Planning and implementing activities can embed this culture in higher education. Cultivating a sharing culture within institutions involves embracing the notion of "It's not what you accumulate, but what you share.".
- Courses can be credited and certified to ensure students' use and continuity of OER.
- OER initiatives can form a dedicated team to ensure a smooth process, defining roles aligned with workflows.
- Institutional collaboration, both within and across institutions, can sustain OER. Collaborating with experienced universities can guide OER initiatives effectively.
- Promotions for OER can occur periodically through various channels: social media posts, institution emails, or official letters via the institutional system to inform instructors.
- OER platforms can offer multilingual support, offline use, add social media tags for visibility, and enhance metadata quality.
- Platform and content usability can improve with regular user feedback.
- In OER initiatives, quality control of the platform, resources and services can be ensured.
- Courses that can appeal to different target groups and attract interest can be offered to expand the student body. Content can vary in format to suit diverse learning styles.

Policy makers

- Policies should be developed to set goals, draw boundaries, and clarify processes for the OER.
- Policy makers should support research in the field of OER.
- At the policy level, financing models should be developed to support the sustainability of OER.
- Policy makers and educational institutions should act in cooperation.

Researchers

- Research can be conducted in the context of different OER initiatives to examine changes in strategies.
- A measurement tool can be developed to measure the sustainability of OER initiatives.
- Instructors' motivations for participating in OER can be investigated.
- Quantitative research can be conducted in similar contexts to determine the relationships between the factors revealed in the research.

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Dilara Arzugül Aksoy: Conceptualization, investigation, visualization, writing—original draft preparation, methodology, formal analysis, writing—review and editing. Engin Kurşun: Conceptualization, methodology, writing—review and editing, supervision. All authors have read and agreed to the published version of the manuscript.

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