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Article abstract

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An OER Architecture Framework : Needs and Design

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Abstract

This paper describes an open educational resources (OER) architecture framework that would bring significant improvements in a well-structured and systematic way to the educational practices of distance education institutions of India. The OER architecture framework is articulated with six dimensions: pedagogical, technological, managerial, academic, financial, and ethical. These dimensions are structured with the component areas of relevance: IT infrastructure services, management support systems, open content development and maintenance, online teaching-learning, and learner assessment and evaluation of the OER architecture framework. An OER knowledge and information base, including a web portal, is proposed in the form of a series of knowledge repositories. This system would not only streamline the delivery of distance education but also would enhance the quality of distance learning through the development of high quality e-content, instructional processes, course/programme content development, IT infrastructure, and network systems. Thus the proposed OER architecture framework when implemented in the distance education system (DES) of India would improve the quality of distance education and also increase its accessibility in a well-organised and structured way.

Keywords: Open educational resources (OER); distance education system (DES); open and distance learning (ODL); technology enhanced learning (TEL); information management

Introduction

The distance education system (DES) in India is one of the biggest educational systems in the world. Presently this system comprises 14 open universities (OUs), and about 200 open and distance learning institutions (ODLIs) provide education through distance mode to 3.7 million students in India (DEC, IGNOU, personal communication, 2012). While only a few of the ODLIs have succeeded in providing distance education of reasonable quality, there are many others that cannot do so due to several problems and constraints. There has been little work done in the Indian DES to explore an appropriate organisational system and mechanism that can achieve the wider goal of providing quality distance education to its learners and of increasing access to distance education and training.

Challenges Faced and Solutions Proposed

The major challenges which have resulted in poor participation of the learners and teachers at various stages of the teaching-learning process in education institutions have been identified (UNESCO, 2010) as follows:

- lack of appropriate business and educational models, due to which the study material or open content developed becomes difficult to follow, and this, as a result, reduces the enthusiasm of learners for their studies;

- lack of any clear quality assurance mechanism, which has resulted in unclear standards and poor quality of distance education;

- teachers lacking in the pedagogical competence to effectively develop and use teaching content and techniques of reasonably good quality;

- non-availability of the required finances and a shortage of educational resources needed to support the teaching process;

- lack of an appropriate level of physical capacity and of the financial resources required to accommodate the maximum number of students and thus increase and/or widen participation in the educational system;

- lack of support from the relevant governing bodies, which are already exhibiting poor participation brought about as a result of the lack of appropriate human and infrastructure capacity.

However, the broader challenge that has affected teaching, learning, research, and collaborative intellectual activities as related to the DES of India for years has been that of increasing access to quality distance education and training programmes. It is partly as a result of the lack of any clear educational structure and partly due to the imprecise meta-tagging process that accompanies the lack of proper infrastructure, education

dissemination, and also improper sharing of distance learning technologies and techniques (Betaman, 2006).

In other words, ODL institutions in India are inadequately organized. To support open and distance learning in ODLIs in an effective way, effort is required to explore some reasonable solutions to address the above mentioned challenges. In recent times, one of the most promising developments in the field of education and training is the concept and growing reality of OER.

Literature Review

The term open educational resources first came to use in 2002 at a conference hosted by UNESCO. OER may broadly be considered as teaching, learning, and research resources with an intellectual property license that permits them to be reused, reworked, remixed, and redistributed (D'Antoni, 2009; Hilton, Wiley, Stein, & Johnson, 2009; Plotkin, 2010; Wiley, 2009).

OER has been defined by Hylén (2006) as "digitised materials offered freely and openly for educators, students and self-learners to use and re-use for teaching, learning and research."

UNESCO and COL describe the concept of OER as any educational resources (including course materials, textbooks, curriculum maps, streaming videos, multimedia applications, and podcasts, etc.) that are openly available for use by educators and students, without an accompanying need to pay royalties or licence fees (Butcher, 2011). However in recent times OER have become a major focus of attraction within educational circles, particularly in those educational systems which are related to distance education institutions. They have also been found to be capable of changing the discourse around the educational systems as they can offer a great value and impact for improving such systems (UNESCO, 2010).

In 1994, the term *learning object* was introduced by Wayne Hodgins, which received immediate acceptance by educators and instructional designers and allowed easy reuse in a wide range of teaching and learning situations. However, OER evolution started with MIT Opencourseware and its impact was further strengthened when organisations like UNESCO, COL, ICDE, OECD, BCCampus (Canada), SCORE (US), EDNA (Australia), OERZN (New Zealand), JISC (UK), OPAL (EU), and foundations such as Hewlett, Mellon, Ford, and Gates funded various OER initiatives worldwide. In addition to the various OER initiatives and their potential implications worldwide, educators have developed e-learning, conceptual, and consortium models and frameworks.

The study in the present article pertains to an OER architecture framework for ODL institutions in India. According to MODAF (2005) "An Enterprise Architecture is the formal description of the structure and function of the components of an enterprise,

their interrelationships, and the principles and guidelines governing their design and evolution over time." An architectural framework is a specification of how to organize and present architectural models. Using an architectural framework, architectures can be developed for the smallest subsystem or for an entire enterprise. In other words, frameworks provide a structure and systematic approach to designing systems (Tang, et.al, 2004).

According to Lloyd et al. (2004), a framework is a set of pre-fabricated building blocks with a reusable design that developers can use, extend, or customise to suit their applications. With frameworks, creators do not have to start from scratch each time to build an application. This inherent flexibility enables the rapid creation and development of solutions for the constantly evolving education environment. In addition to this the result of using a framework for n-tier applications is that the quality of OER applications increases dramatically, while decreasing the total cost of ownership and accelerating the delivery time. Also, frameworks capture technical expertise and best practices necessary to solve a particular class of problems with no need to reinvent the wheel.

Margulies (2005) has developed a conceptual model for open sharing for MIT Opencourseware. The concept consists of tools (OSS, LMS, CMS), content (MIT OCW, Google Scholar), and implementation resources (Creative Commons, documentation). Anderson (2009) emphasized that the technical integration of pedagogical, administrative, social, and personal aspects is essential for effective OER applications. Conole and Alevizou (2010) reviewed about twenty key models and frameworks that describe different theoretical perspectives and have been used in e-learning. They indicated that the terms *models* and *frameworks* be considered synonymous since these terms are contested and appear to be used fairly interchangeably in educational contexts. Diallo, Wangeci, and Wright (2012) suggested a consortium model, which highlights collaborative planning, decision making, and OER development across educational institutions that have different political, geographical, cultural, and language backgrounds but that share a common vision to address the needs of their learners. The African Virtual University (AVU) developed a conceptual framework and architecture to meet the needs of learners, teachers, and researchers in Africa and to join the OER movement worldwide. Betaman (2006) emphasizes that AVU OER architecture shall provide space for future developments as the OER movement has yet to mature and will inevitably develop beyond its current limits.

In the context of university education the OER movement leads to a radical rethinking as to how course material and educational resources are to be produced, shared, and reused (Conole & Culver, 2009; Lane & McAndrew 2010, McAndrew, 2010). Lane and McAndrew (2010) give emphasis to the discussion and ask if open educational resources are systematic and appropriately organised for learning practices. McAndrew (2010) argues that it is time for a new educational paradigm (i.e., by creating an appropriate OER framework). Also, if university course material is made more visible, there will be several benefits for all interested parties: good material will be widely used, thus

heightening the teacher's and university's reputation; potential students will be able to preview the programmes they wish to take; and freely available material will enhance the field of distance learning.

One impediment to the increased use of OER in universities and ODL institutes is the difficulty in finding relevant resources. This is mainly due to the lack of an effective and consistent organised system/mechanism such as an appropriate framework in which the relevant resources are organised and become easily traceable without any wastage of time and effort. Another challenge is to find some appropriate organised mechanism for student support services including academic credit for distance learners. Daniel (2010) expressed the view that students seek flexible study opportunities and also want their achievement recognized in credible credentials.

During the past decade, a number of concepts, initiatives, and strategies have emerged worldwide to support the development and use of OER, but in India these are comparatively invisible. Many of the OER which have the potential to reduce costs, improve quality, and increase access to education opportunities (Daniel, 2011; Plotkin, 2010) are presently untapped in the DES of India. The creation of an OER architecture framework is one vital answer to meet the above mentioned challenges and to ensure better accessibility for distance learners. Equality and access to learning and education are supplementary aspects (Atkins, Brown, & Hammond, 2007). It would also assist in more appropriate and effective delivery of distance education.

The OER framework thus established would play a leading role in systematic development and organised use of OER in the DES of India. The OER framework would further provide a unique opportunity to deploy Indian experts to harness the concept of OER to the benefit of distance educations systems, ODL institutions, and associated educators and learners all across the country. The OER framework would provide a wealth of information and educational resources, which could be applied in a variety of face-to-face or distance education environments. There is strong evidence of growing interest in OER but still a great deal of work needs to be done before OER become mainstream practice in the DES of India.

From the above discussion, it may be inferred that an OER framework has gained global prominence within educational circles, particularly those related to open and distance education. Its adaptability in DE would suit the teaching-learning conditions of providing quality education to distance learners. Many organisations (BC Campus OER, 2011; JISC OER, 2010; Betaman, 2006; Stacey, 2011) have worked in the field of OER so as to improve the quality of education to be provided to their learners. However, presently OER are not adequately organised in ODL institutions of India, although there is an urgent need to organise OER in a manner capable of increasing access to distance education and improving its quality. The major challenges faced by ODL institutions in India can be quickly addressed through the use of an appropriate OER framework as it can significantly change the discourse around the existing educational systems and can also improve the availability, affordability, and accessibility of knowledge bound up in

the open educational resources involved. Thus to have a more systematic and good learning environment in ODLIs, it is desirable to establish an appropriate OER architecture framework.

Accordingly in this article an OER architecture framework is presented. The OER architecture framework is based on existing theories concerning open content, open education practices, and the authors' local experiences. These form the theoretical and empirical elements used to populate this architecture framework for establishing OER processes and systems for India. The OER architecture framework is designed as a standard set of six dimensions pertaining to the distance learning environment, all of which have been further integrated with various components involved in the key activity areas of ODLIs. In addition, the authors propose a knowledge and information base and a web portal in the form of a series of knowledge repositories that are built by integrating the ODL-related OERs into a web system. The various advantages obtained by implementing such a system are discussed. The present study offers an approach to refine strategy and tactics associated with OER initiatives for their adoption and long-term sustainable future. Further, it outlines how to start and work iteratively to set up such an educational framework to facilitate the creation of an appropriately structured and highly needed OER-based organisational system for the DES of India.

OER Architecture Framework

The architecture framework (Figure 1) contains six dimensions: pedagogical, technological, managerial, academic, financial, and ethical (Khan, 2001). The dimensions are structured with component areas of relevance: IT infrastructure and services, management support systems, open content development and maintenance, online teaching and learning, and learner assessment and evaluation.
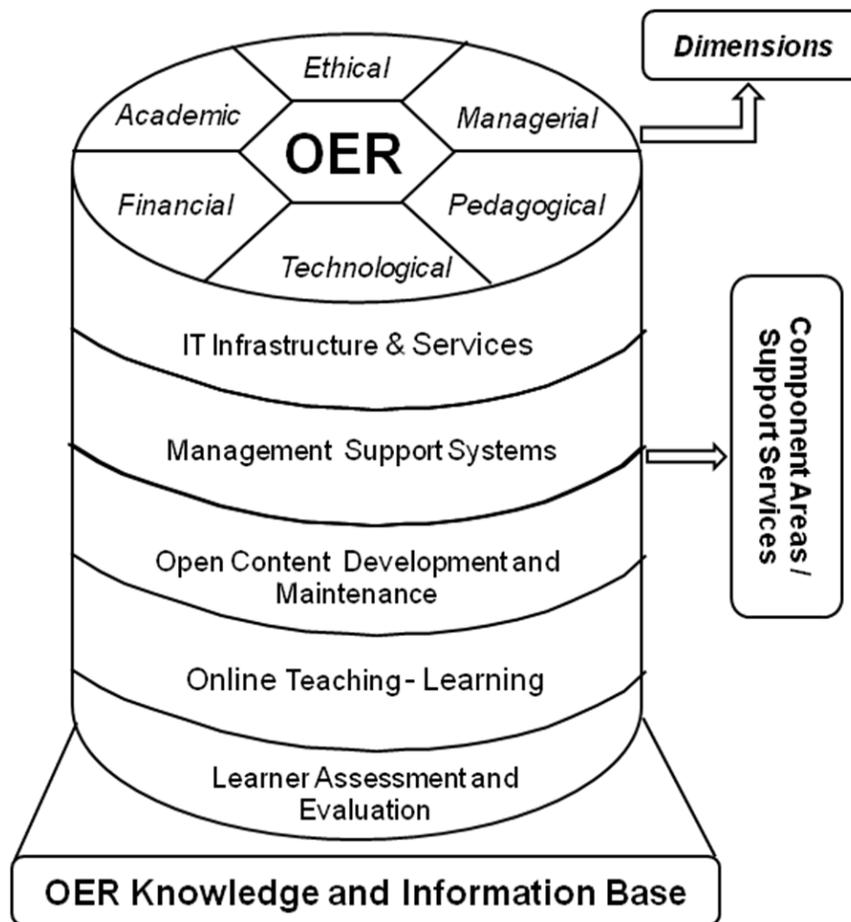
*Figure 1.*The OER architecture framework.

From this basic framework while integrating the characteristic dimensions with key activity areas, the OER knowledge and information base has been created in the form of a group of knowledge repositories.

The Characteristic Dimensions

Pedagogical.

The pedagogical dimension of the OER framework refers mainly to OER-based open initiatives such as open online courses, openly public teaching and learning, open study groups, and so on. This dimension pertains to issues concerning open initiatives such as content analysis, goal analysis, design approach, organisational methods, and ODL strategies.

Technological.

The technological dimension of the OER framework refers to the technological infrastructure of distance learning environments, including issues such as infrastructure planning, designing hardware and software, and technical design for learning

programmes, such as page and site design, content design, animation, multimedia, navigation, and usability testing.

Managerial.

The managerial aspect of the OER framework is mainly concerned with the planning and management of administration and other educational activities required for fostering a distance learning environment. It also includes the execution of open management policies along with opening up access to the institution's managerial information and data. Further to this, management involves framing educational policies and decision making with regard to development and maintenance of a good learning environment, delivery of quality distance education, distribution of associated information, and so on.

Academic.

The academic dimension of the framework involves the creation and use of online courses and programmes and teaching and learning materials and techniques, including open text books and SLMs (self-learning materials), for the benefit of students.

Financial.

The economic/ financial dimension mainly refers to budgeting (i.e., management and availability of finances for the development, implementation, and maintenance of educational systems based on OER). It would also involve developing a sustainable and cost-effective business model, educational systems, and processes for the associated OER initiatives.

Ethical.

The ethical considerations of open and distance learning relate to geographical diversity, learner diversity, legal issues (such as licensing), and information accessibility as related to the general institutional information.

Key Component Areas and Support Services

IT infrastructure (services and networking).

An appropriate OER-based IT infrastructure is required for the proper operation and management of the concerned ODLI. The IT infrastructure should further help in proper dissemination, sharing, and utilization of OER so as to provide good quality course/programme content, e-content, instructional processes, web-based systems, and others. Using an appropriate IT infrastructure, several systems and solutions are to be developed and made available by the relevant services deployment and delivery departments. So, OER-supportive IT infrastructure services would involve open source education technologies that support the development of tools, techniques, and processes

for the distance education system, including the creation of online systems to provide support for online learners. As such the IT infrastructure would involve open source software (OSS) and their applications, Internet, open web, online systems, learning management systems (LMS), and others.

In the context of IT infrastructure services, the OER framework would be employed firstly to establish VPN networking of all ODLIs in the country and subsequently interlinking them through a national/ international telecommunication backbone. The national framework would work through the VPN system with the required IT solutions to be provided by the IT departments. Such a network with required bandwidth would be established with the purpose of providing quick data transmission, retrieval, and free flow of other information. This networking would serve for the DES of India the objectives of online centralised services (such as student admissions and instant confirmation); online assignment generation and online results; increased interactivity; quality promotion; telecounselling; teleconferencing and telecollaboration in strategic matters among associated DE institutions (i.e., all partner institutions [PIs] across India).

Management support systems.

The management support system (MSS) works mainly through the use of FOSS for coordinating and managing the various functions and activities pertaining to the DES in India. The implementation of an OER approach by the MSS leads to adopting the open pedagogies that would leverage open source educational technologies, online instructional design, and open practices of teaching and learning. Thus considering the above mentioned functions the MSS would plan to establish an OER-based organisational system in the DES of India which would streamline its functional activities in such a way that the OER materials would be developed, shared, and adapted efficiently and effectively.

The policy of open management is adopted by the MSS. It is mainly concerned with open access to the institutional managerial information and data. Open management makes management more transparent and open in its activities, ensuring that the associated stakeholders can get better information about the work and activities of the management and the concerned ODLI. In addition it would promote transparency and would be able to stimulate creative and innovative activities around the use of such information so as to deliver significant social and economic benefits.

Open content development and maintenance.

One of the main tasks to be performed under this OER architecture is to make appropriate arrangements for the development of open content of reasonably good quality. Such open content would mainly be used for teaching-learning purposes and include materials related to courses and course components such as learning objects, teaching content, manuals related to practical labs, textbooks, and so on. It may also

include production of audio, video, and animated educational programmes. In addition to this, it may develop new OER and also make use of existing OER (available locally or globally) to subsequently create complete online credit-based academic programmes. Each academic programme would be in the form of a suite of several interconnected applications, structured and presented in a wiki system (Srivathsan, 2009). The OER-based open content is to be developed in two groups, namely an open course guide (OCG) and an open program guide (OPG). The overall TEL components for a programme to be developed would broadly include the following: an open program guide, an open course guide, a wiki, a discussion forum, querying services, SMS, m-learning services, and so on. However, it is suggested that every academic programme of an ODLI may establish the OPG and associated OCG(s) for each course.

Open (online /public) teaching and learning.

Using OERs, educators can undertake the work of teaching by using blogs and wikis. The course syllabus, modules, activities, and assignments would be publicly visible. Students can be officially enrolled in any course and their learning would be viewable by the public. An efficient OER-based TEL system of open e-learning is required to be established so as to provide support for all educational programs/courses offered by the concerned ODLI. Every ODLI would be required to set up various technology systems, such as Web sites, Internet, TV channels, EduSat, IP-TV, mobile, and community radio, so as to have an efficient DES which can help distance learning students. Such a TEL system is also required to support the delivery of various programs/courses offered.

Learner assessment and evaluation.

Learner assessment is involved in certifying the academic level of performance achieved by the students in a particular course of study. A course evaluation system (CES) would be developed for learner assessment through the use of OCG/OPG. OCG/OPG would be set up in the wiki areas (Srivathsan, 2010) of the DES and cover details such as course prospectus, facility for course registration, links to course wiki, querying system. It would also support a testing and evaluation system along with the associated learner database management system. Arrangement for practical, design exercise, and term papers, and timely evaluation of answer scripts and term papers would be ensured.

Thus a learner assessment and evaluation system would initially be a part of the design and conduct of the particular course with its course content and resources to be made available through OCG/OPG. Subsequently the various facilities including automation would be added for an examination and evaluation system. This complete system is to be structured to enable greater interactivity and assured engagement of learners in learning and assessment.

OER Knowledge and Information Base

A knowledge and information base in the form of a series of knowledge repositories involving ODL-related OER would be developed as follows:

1. Establish a dynamic collection of Indian and global OER: Tag and upload available OER, including those currently under development and others that are yet to be developed for inclusion in a DES OER collection.

2. Establish a database involving open pedagogies: Design and build a database involving open pedagogies as related to the DES in India. Also constitute a series of OER monographs as related to the creation, organisation, dissemination, and utilization of OERs and other related Indian open content.

3. Establish a database related to ODL activities: Create and implement a DES-OER research database related to ODL activities in India to ensure the appropriate implementation of OER-based activities and associated academic/educational study programmes in the DES of India.

4. Establish a database of OER practitioners: To extend the support required for the efficient working of an OER community of practice in India, identify competent OER practitioners including experts/authors who can write a series of OER monographs related to the DES in India.

5. Establish a learning object repository: Establish a comprehensive and powerful backend 'database of OERs' featuring a learning object repository of Indian resources.

Information Management in an OER Framework

A knowledge repository would serve as an information management and processing tool for decision makers to address policy issues pertaining to the various aspects of the country's DES. Such a knowledge repository also focuses on identifying and providing for priority needs and available resources of information as inputs in order to promote quality online education provisions through ODL. The tool is to be targeted towards decision makers and would be of value to a wide range of ODL professionals such as instructors, curriculum developers, software engineers, and instructional designers (UNESCO, 2004). A powerful indexing service is to be implemented that would allow federated/browse searches by employing appropriate browsers. Thus a series of knowledge repositories based on the OER architecture framework would support in an organised way the regional and cross-sector development of ODL through a systematic sharing of educational resources.

Creation of Web Repository

The DES knowledge and information base would ultimately be subsumed into an integrated web-based information system (Khanna & Basak, 2011) while creating an OER web repository. A series of learning materials pertaining to various fields of study would be developed and included in the repository. In order to increase reusability, the learning materials would be developed preferably as simple videos or photos, which could be used as materials in online courseware. A subset of metadata, based on IEEE LOM (learning object metadata) or any other suitable technology, is to be tagged to each OER, and different information, such as copyright, quality, and educational characteristics, would be included. Such an approach helps to achieve significantly improved search results and also to realize new value-added services. In other words a developmental process is to be adopted in which the quality of content and metadata would be improved and assured. The standardized curriculum is thus established and the associated web repository is created.

DES-OER Web Portal

The DES-OER web portal would be created for the ODL institutions by adopting a developmental process strictly in accordance with the proposed OER architecture framework. Such a web portal would offer print resources and audio-visual materials and provide telelearning and teleconferencing facilities. This portal would help not only to promote open education but also to supplement the existing teaching-learning process for online distance education.

Benefits and Application

The benefits of using OER in ODL systems as reported in the literature (BC Campus OER, 2010; Daniel, 2012; JISC OER, 2010; Betaman, 2006; Stacey, 2011) are enormous. However, these benefits are further enhanced when the OER are employed in a DES in a well-organised and systematic way (i.e., in the form of an OER architectural framework). Some of the benefits that can be accrued from employing the OER architecture framework as presented in this article are as follows:

1. The educational content is open and free, and teachers while involved in their teaching pursuits can concentrate on the design of learning rather than wasting time and effort creating content. Also using OER, one can build upon other people's work in an ODL system and so improve upon teaching and learning pursuits conveniently and effectively.

2. Copyright of OER can be made available easily under an open license and also can be shared conveniently with the global community for collaboration and further improvement. This process would support learning and would also help

in further enhancement of the module/course developed during its review process.

3. The use of OER in a DES would enable the learners to have access to a wider range of student support activities. Thus,

- The students' learning experiences should improve when they have convenient access to resources like pictorial presentations, photographs, videos, and so on.

- Students can share and access OER and develop case studies as part of their development. OER can help students make their own academic plans.

- Details of the courses would be available before they take up the course for study. The latest and most widely reviewed materials would be available which would improve their knowledge and understanding while pursuing their courses.

- OER would provide major cost benefits. Also their accessibility would be 24 x 7.

- OER can be modified, mixed and matched, and enhanced.

- For learners, whether as formal students, doing non-formal work related training, or studying informally as self-directed lifelong learners, the greater availability and accessibility of such resources should help them to learn new things, to take decisions, and to create or revise OER.

Conclusion

In conclusion the adoption of an OER architecture framework in the DES of India should bring about significant improvements in educational practises and systems pertaining to ODLIs. The proposed OER framework would enhance the quality of distance learning through the development of high quality e-content, instructional processes, course/programme content development, IT infrastructure, and network systems, all of which are considered essential for realising excellence in distance education. The OER framework would improve the existing capabilities of ODLIs and bring standardisation, efficiency, and effectiveness in a systematic and structured way so that they can provide distance education of reasonably good quality.

With full implementation and use of the OER architecture framework, integrated web system, and networking of ODLIs in India, all the associated distance education institutions would be able to share on a national basis the available physical and intellectual resources, evolving a common pattern and structure for high quality distance learning programmes all over the country. Additionally, it would help to integrate and streamline the delivery of distance education around the country by

systematically developing new educational content and resources. Thus, it would pave the way to build an appropriate educational system in India, which would provide equity and quality in distance education at the national level.

Acknowledgements

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