

ŚIVADHARMA DATABASE.
MODELLING A WEB APPLICATION
TO MANAGE SCHOLARLY DATA
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1. Introduction

The *Śivadharma Project - Translocal Identities: The Śivadharma and the Making of Regional Religious Traditions in Premodern South Asia*² aims to investigate the influence of the Śivadharma tradition over the spread of the Śaiva religion in South Asia between the Middle Ages and the early modern times. A heterogeneous wealth of resources known as *Śivadharma corpus*,³ which includes manuscripts in Sanskrit and Dravidian languages, inscriptions, and icons, is currently under study.

The *Śivadharma Project* involves several institutions. In the central Host Institution, i.e., the L'Orientale University of Naples, the École française d'Extrême-Orient, and the Department of History and Cultures of Alma Mater Studiorum University of Bologna (DISCI), the team is engaged in

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² *Śivadharma Project* showcase website: <https://shivadharmaproject.com/> (20/06/2022).

³ F. De Simini, *Śivadharma Manuscripts from Nepal and the Making of a Śaiva Corpus*, in M. Friedrich, C. Schwarke (a cura di), *One-Volume Libraries: Composite and Multiple-Text Manuscripts*, De Gruyter, Darmstadt 2016, pp. 233-286.

the preparation of Scholarly Editions of Śivadharma resources. Although on the other hand, a part of the team at the /DH.arc Research Centre and the Department of Classical Philology and Italian Studies of Alma Mater Studiorum - University of Bologna (FICLIT) is developing a web application called *Śivadharma Database*. It provides an environment for producing *Scholarly Digital Editions* from scratch, including their storage, publication, cataloguing, updating, and tools for visualisation and browsing.

In the present paper, we discuss that it is necessary to provide scholars with a user-friendly environment to prepare *Scholarly Digital Editions* without writing code of any kind to (1) avoid them spending time learning notions of coding; (2) better handling errors; (3) obtain homogeneous scholarly data on which to perform operations, *e.g.*, filtering; (4) prepare and publish their editions directly in their final visualisation.

Achieving flexibility is the primary objective of the project, *i.e.*, to make the environment easily customisable and reusable regardless of the application domain.

Śivadharma Database is a proposal to meet the needs mentioned above.

The paper is structured as follows. In *Section 2*, we argue that there is a need for a user-friendly environment for preparing and publishing *Scholarly Digital Editions*. Then, *Section 3* proposes a benchmark of the related works. Next, *Section 4* describes the *Śivadharma Database* workflow from its design and development point of view. In conclusion, the future work is in *Section 5*.

2. Need for a user-friendly environment for preparing and publishing *Scholarly Digital Editions*

The lack of suitable tools for *Scholarly Digital Editing* is a widely debated topic in literature.

Robinson claims that scholars must be in the position of making digital editions. Some tools are available but require a high level of dedication so as to discourage them from accomplishing this task.⁴ Hagel supports the same

⁴ P. Robinson, *Current Issues in Making Digital Editions of Medieval Texts-or, do Electronic Scholarly Editions have a Future?*, in «Digital Medievalist», I (2005).

argument.⁵ He identifies several criticalities. The main one lies in the high technical skills required for configuring and using the available tools. Scholars often spend time on purely technical issues, while they should remain devoted to scholarly questions. Also, Schmidt⁶ and Pierazzo⁷ complain about the same problem related to the technical experience required in the editing workflow. To meet this need, they should have at their disposal software, tools and services designed to require a minimal technical skillset.

Hagel highlights another gap in the *Scholarly Digital Editing* workflow. The mismatch between the input, e.g., the XML/TEI file,⁸ and the output, e.g., the HTML rendering, can often generate misunderstandings.⁹

A single environment allowing editors to work on their editions directly in their final visualisations by performing *CRUD* (*Create Read Update Delete*) operations, e.g., a *CMS* (*Content Management System*), would facilitate the editing process. In addition, publishing the resources in the same environment could improve their availability.

Schmidt identifies an environment of this kind as one of the possible solutions to overcome the challenges related to the creation and sharing of editions by technically inexpert scholars. On the other hand, to consider this solution sufficient, it is necessary to make a further effort to represent and manipulate the sources.¹⁰ In addition to the mentioned technical issues, Pierazzo adds that a publishing framework for *Scholarly Digital Editions* would help face the significant investments for their production.¹¹

⁵ S. Hagel, *The Classical Text Editor. An Attempt to Provide for Both Printed and Digital Editions*, in F. Stella, A. Ciula (a cura di), *Digital Philology and Medieval Texts*, Pacini, Pisa 2007, pp. 77-84.

⁶ D. Schmidt, *The Current State of the Digital Scholarly Edition and Three Challenges*, https://www.academia.edu/37585331/The_Current_State_of_the_Digital_Scholarly_Edition_and_Three_Challenges.

⁷ E. Pierazzo, *What Future for Digital Scholarly Editions? From Haute Couture to Prêt-à-Porter*, in «International journal of digital humanities», 1/2 (2019), pp. 209-220.

⁸ *TEI Guidelines*: <https://tei-c.org/guidelines/> (20/06/2022).

⁹ Hagel, *The Classical Text Editor*, cit.

¹⁰ Schmidt, *The Current State*, cit.

¹¹ Pierazzo, *What Future*, cit., pp. 209-220.

3. Related works

The central issue of one of the main tools for *Scholarly Digital Editing*, i.e., *Editions Visualization Technology (EVT)*,¹² is related to the technical skills required. *EVT* is a visualiser of *Scholarly Digital Editions*. Starting with supporting only Diplomatic and Diplomatic-Interpretative Editions in *EVT 1*,¹³ the second release, i.e., *EVT 2*,¹⁴ extends its coverage to more sophisticated structures, such as the apparatus. Its technology relies on XML/TEI encoding. Therefore, editors must encode their editions in XML/TEI as a required step. Then, converting the produced documents via specific XSLT stylesheets generates HTML renderings.¹⁵ As Segers points out, this implies that editors must learn how to encode a text in XML and the TEI guidelines. In addition, they still have to rely on specialist assistance to visualise and publish their editions.¹⁶

The *Classical Text Editor*,¹⁷ instead, does not include any encoded documents as input. It is an editor proposed by Hagel which provides user-friendly tools for preparing editions.¹⁸ It supports advanced features for creating the apparatus, notes, and parallel texts. It allows the XML/TEI export for reasons of interoperability as well.¹⁹ On the other hand, the project is more focused on printed editions. Furthermore, its licence does not allow widespread use in the community.

Other editors are designed to support specific textual annotations identifying entities, such as persons and places, in full-text documents. For instance,

¹² *EVT*: <http://evt.labcd.unipi.it/> (21/06/2022).

¹³ *EVT 1*: <https://github.com/evt-project/evt-builder/> (21/06/2022).

¹⁴ *EVT 2*: <https://github.com/evt-project/evt-viewer/> (21/06/2022).

¹⁵ AA.VV., *Edition Visualization Technology: A Simple Tool to Visualize TEI-based Digital Editions*, in «Journal of the Text Encoding Initiative», VIII (2014), pp. 1-29.

¹⁶ H. Segers, *Edition Visualization Technology Project (review)*, in «Digital Philology: A Journal of Medieval Cultures», XI/2 (2021), pp. 340-342.

¹⁷ *Classical Text Editor*: <https://cte.oeaw.ac.at/> (21/06/2022).

¹⁸ Hagel, *The Classical Text Editor*, cit., pp. 77-84.

¹⁹ As stated in AA.VV., *A Catalogue of Digital Editions*, in M. J. Driscoll, E. Pierazzo (a cura di), *Digital Scholarly Editing: Theories and Practices*, Open Book Publisher, Cambridge 2016, pp. 219-38 (<http://books.openedition.org/obp/3423>), pp. 161-182, out of 187 editions recorded in the *Catalogue of Digital Editions*, 37% rely on TEI, i.e., the majority. *Catalogue of Digital Editions*: <https://dig-ed-cat.acdh.oeaw.ac.at/> (21/06/2022).

through the *SPEEDy* editor, it is possible to record and update textual annotations of this kind as stand-off properties stored in *Neo4j*,²⁰ a graph database.²¹ *KWICKWOCKWAC* (*Key Words In Context, Key Word Out of Context, Key Word Alongside Context*)²² accomplishes the same task, returning RDFa documents as output.²³ In addition, editors can assign metadata to the documents.²⁴

In both the projects, the interface allows manipulating the text and the annotations from a single environment without requiring coding skills. However, their annotation systems do not handle more sophisticated structures, such as the apparatus, and do not cover a publishing function.

4. Śivadharmā Database workflow

Śivadharmā Database is a *CRUD* web application under development. It provides a single editing and publishing environment, allowing editors to prepare editions and readers to access them. Specifically, in the *editing* mode, scholars can find tools to (1) create *Scholarly Digital Editions* from scratch, including sophisticated structures, such as the apparatus; (2) publish them online on the same platform; (3) update them over time; (4) make them exportable in XML/TEI for interoperability reasons. On the other hand, users can access and browse the published resources in *reading* mode, performing specific operations, such as filtering.

Consequently, the structure of the application has two pivot sections. The former corresponds to a *CMS* where editors can manage their editions and the related editing process according to a specific controlled set of *CRUD* operations. It does not imply coding by editors, thus allowing the developers to handle errors better and produce homogeneous data. The latter section, instead, serves as an access point to the available resources.

²⁰ *Neo4j*: <https://neo4j.com/> (20/06/2022).

²¹ I. Neill, D. Schmidt, *SPEEDy. A Practical Editor for Texts Annotated with Standoff Properties*, in AA.VV. (a cura di), *Graph Data-Models and Semantic Web Technologies in Scholarly Digital Editing*, Book on Demand, Nordstedt 2021, pp. 45-54.

²² *KWICKWACKWACK*: <https://github.com/sanofrank/KwicKwocKwac> (21/06/2022).

²³ RDFa: <https://rdfa.info/> (21/06/2022).

²⁴ A. Moro, *Edizione Nazionale delle Opere*, 8 voll., Università di Bologna, Bologna 2021: <https://aldomorodigitale.unibo.it/about/docs/processing>.

Although the project is closely related to the *Śivadharma Project*, it aims to provide a user-friendly and flexible environment to meet the needs related to the editing and publishing workflow regardless of the specific application domain.

4.1 Design stage

Recognising the recurring patterns in the editing workflow, regardless of the reference domain, is the key to determining a valuable toolkit for accomplishing the related tasks. For this reason, a preliminary design stage is necessary to identify the specific goals and requirements of the target users, i.e., both editors and readers, and the context of the use of the final product.²⁵ The expected result is that designing a robust application tailored to the target leads to broader adoption within the reference community.²⁶

At this stage, we adopt the user-centred design model proposed by Garrett.²⁷ It considers the design stage a linear but iterative process structured on five-layered levels, called *planes*. It leads to the definition of the web applications' main features and functionalities, including its architecture and look and feel. Then, we integrate the best practices related to the workflow of a project proposed by Tomasi²⁸ into this model.

In the design stage of the *Śivadharma Database*, the user study includes interviews with the team members and non-team Sanskritists, analysis of Sanskrit and non-Sanskrit printed and digital editions, and observation of the scholars' behaviour approaching the preparation and reading of editions. It leads to the definition of several requirements to comply with

²⁵ J. J. Garrett, *The Elements of User Experience: User-centered Design for the Web and Beyond. 2nd Edition*, New Riders, Berkeley 2011; C. Warwick, *Studying Users in Digital Humanities*, in AA. VV. (a cura di), *Digital Humanities in Practice*, Facet, London 2012, pp. 1-21.

²⁶ P. Juola, *Killer applications in digital humanities*, in «Literary and Linguistic Computing», XXIII/1 (2008), pp. 73-83; C. L. Borgman, *The Digital Future is Now: A Call to Action for the Humanities*, in «Digital humanities quarterly», III/4 (2010), pp. 2-30.

²⁷ Garrett, *The elements*, cit.

²⁸ F. Tomasi, *Organizzare la conoscenza: Digital Humanities e Web semantico. Un percorso tra archivi, biblioteche e musei*, Editrice Bibliografica, Milano 2022, pp. 152-156.

during the development stage. The project includes supporting the following features in the “editing” and “reading” mode.

Textus constitutus

The *textus constitutus*, i.e., the reconstructed text of a specific work, is the centre of any edition. It results from the critical and interpretative decisions by one or more editors. For this reason, (1) it should be readily available to the users; (2) specific additional documents should certify its reliability, e.g., documentation of its aims and methods.²⁹

Structure of the textus constitutus

The main components of the structure of texts should be identifiable, e.g., the division into chapters, stanzas, and verses. For this reason, the editors and readers should have tools to identify and move through them, e.g., from chapter to chapter. In the case of poetry, the web application should include functionalities to analyse the related metrical structure.

Metadata

Metadata contribute to (1) describing the content, structure, and context of resources;³⁰ (2) improving their classification and retrieval efficiency.³¹ Including tools to assign the editions with descriptive labels helps in this respect.

Critical apparatus

The critical apparatus aims to trace the process that led to the *textus constitutus* by displaying its variations over time. Hence, it implies the explicit

²⁹ P. Sahle, G. Vogeler, *Criteria for Reviewing Scholarly Digital Editions, version 1.1*, in «RIDE» (2014): <https://ride.i-d-e.de/reviewers/catalogue-criteria-for-reviewing-digital-editions-and-resources/>.

³⁰ S. Barzaghi, *La modellazione dei dati nell'Edizione Nazionale delle Opere di Aldo Moro (2.0.1)*, Università di Bologna, Bologna 2021: <https://zenodo.org/records/5144961>.

³¹ M. Marchiori, *The limits of Web Metadata, and Beyond*, in «Computer Networks and ISDN Systems», XXX/1-7 (1998), pp. 1-9.

declaration of the methodological and critical editorial decisions.³² Each apparatus entry reports (1) the adopted reading in the reconstructed text, i.e., the *lemma*, and the sigla of the witnesses which attest to it; (2) the rejected variants, i.e., the *variantes lectiones*, transmitted by other witnesses and their sigla. In addition, the apparatus can include specific phenomena, such as “omissions”, *lacunae*, and “transpositions”.³³ Consequently, the editing and reading environment should support the mentioned structure and phenomena.

Notes

The notes, which are phrased in natural language, help the readers to understand the work better.³⁴ The project envisages the distinctions between “philological”, “literary”, and “historical” notes.

Transcription

The transcription is not simply an act of mechanical copying,³⁵ but the interpretative act of transcribing the marks from one medium to another.³⁶ Therefore, it is an objective of the project to obtain the transcriptions of the reference manuscripts of the editions by extracting the necessary data directly from the critical apparatus. In addition, it is a priority to make the transcriptions, the *textus constitutus* and the critical apparatus available in different scripts, including Roman and Devānāgarī.

Translation

The *textus constitutus* should be available in English.³⁷

³² F. Fischer, *Digital Classical Philology and the Critical Apparatus*, in M. Berti (a cura di), *Digital Classical Philology: Ancient Greek and Latin in the Digital Revolution*, De Gruyter, Darmstadt 2019, pp. 203-219. DOI: <https://doi.org/10.1515/9783110599572-012>.

³³ The considered phenomena are those reported in the *DHARMA TEI* guidelines: G. Buriola, A. Griffiths, A. Janiak, *Encoding Guide for Critical Editions. Draft Version 0.1*, 2020-2021. *DHARMA Project*: <https://dharma.hypotheses.org/project> (22/06/2022).

³⁴ P. Sahle, *What is a scholarly digital edition?*, in Driscoll-Pierazzo, *Digital*, cit., pp. 19-39.

³⁵ P. Robinson, *Some Principles for Making Collaborative Scholarly Editions in Digital Form*, in «Digital Humanities Quarterly», XI/2 (2017).

³⁶ P. Eggert, *The Reader-oriented Scholarly Edition*, in «Digital Scholarship in the Humanities», XXXI/4 (2016), pp. 797-810.

³⁷ In some specific cases, also the translation in Tamil will be available.

Parallel texts and citations

Parallel texts correspond to identical or quasi-identical literal quotations from later textual sources. The ratio between the original and the quoted stanzas is almost always 1:1. This structure is not a pattern in the case of citations. The tools to manage parallels and citations and their relationships with the edition's text should ensure their availability.

Translating the resulting conceptual framework into wireframes is the next step in the design process. Wireframes allow defining the layout and the interface elements required by the related functionalities.³⁸

The wireframes below show the skeleton of an edition in the two previously described modes,³⁹ i.e., *reading* (fig. 1) and *editing* (fig. 2).

Śivadharmā Database		Home	Editions	Create an edition	Login		
Editions / Śivadharmottara-De Simini		Śivadharmottara Scholarly Digital Edition Edited by Florinda De Simini			XML/TEI export	Metadata	?
<p>× Textus constitutus</p> <p>kāni puṇyāni kṛtveha grhīṇaḥ svargatāḥ punaḥ manuśyalokasambhūtā yogaṃ vindanti śāṅkaram 1.9 par. ▶ app. ▶</p> <div style="border: 1px solid gray; padding: 5px; margin: 5px 0;"> <p>Bhaviṣyapurāṇa 1.187.1</p> <p>kāni puṇyāni kṛtveha svargam gaicchanti mānavāḥ manuśyaloke sambhūtāḥ svarloke gāmināḥ param 1.187.1 </p> </div> <div style="border: 1px solid gray; padding: 5px; margin: 5px 0;"> <p>9a puṇyāni kṛtveha] N E karmāṇi kṛtveha G₄₃^p kṛtvaiva karmāṇi P₇₅^p</p> <p>9b grhīṇaḥ svargatāḥ] N P₇₅^p grhasahasvarggāt G_{43cm}^p grhīṇaḥ svargīṇaḥ E</p> </div> <p>karmayajñas tapoyajñāḥ svādhyāyo dhyānam eva ca jñānayajñas ca pañcate mahāyajñāḥ prakṛititāḥ 1.10 par. ▼ app. ▼</p> <p>eṣām eva yajñānām uttamah katamaḥ smṛtaḥ etadyajñaratānām ca pradāne kīḍṣaṃ phalam 1.11 par. ▼ app. ▼</p> <p>dharmādharmaprabhedā ca kiyantaḥ parikṛititāḥ tatsādhanāḥ katividhā gatayaś ca tadātmikāḥ 1.12 app.</p>		<p>× Parallels</p> <p>Bhaviṣyapurāṇa ▶</p> <div style="border: 1px solid gray; padding: 5px; margin: 5px 0;"> <p>kāni puṇyāni kṛtveha svargam gaicchanti mānavāḥ manuśyaloke sambhūtāḥ svarloke gāmināḥ param 1.187.1 </p> </div> <p>karmayajñas tapoyajñāḥ svādhyāyo dhyānanimitaḥ jñānayajñas ca pañcate mahāyajñāḥ prakṛititāḥ 1.187.2 </p> <p>eṣām eva yajñānām uttamah katamaḥ smṛtaḥ etadyajñāphalānām ca kiṃ kalam kā yatir bhavet 1.187.3 </p> <p>śraddhāpūrvāḥ sadā dharmāḥ śraddhāmadyāntasahashtitā śraddhāniṣṭhāpratīṣṭhā ca dharmāḥ śraddhā prakṛititā 1.187.9 </p> <p>Devīpurāṇa ▶</p> <p>śraddhāpūrvāḥ smṛtā dharmā śraddhāmadyāntasahashtitā śraddhāniṣṭhā pratīṣṭhā ca dharmāśraddhaiva kṛititāḥ 127.12 </p>		<p>⋮</p> <p>Citations</p> <p>⋮</p>	<p>⋮</p> <p>Translations</p> <p>⋮</p>		
Apparatus		Philological notes		Literary notes		Historical notes	

Fig. 1. Wireframe of an edition in “reading” mode

³⁸ Garrett, *The elements*, cit., pp. 128-131.

³⁹ The pilot edition is the ongoing Scholarly Edition of Śivadharmottara edited by Florinda De Simini.

Fig. 2. Wireframe of an edition in “editing” mode⁴⁰

As shown in figg. 1 and 2, the components described in the requirements are available in both modes. In the section *Editions*, they are available in “reading” mode, i.e., viewable but not editable. On the other hand, they are editable in the *Create an edition* section, i.e., in “editing” mode, by using the available buttons and filling in the forms. At the end of their work, editors can publish or save their editions as drafts. The published editions are accessible in the *Editions* section.

As shown in the wireframes, the visualisation of the editions in the two modes is minimal. It gives editors a high level of control over rendering their work.⁴¹ In addition, the layout based on the opening and closing panels allows users to customise their environment depending on their purposes.

⁴⁰ For reasons of space, we include only some examples of specific phenomena related to the apparatus.

⁴¹ Hagel, *The Classical Text Editor*, cit., pp. 77-84.

4.2. Development stage

The design requirements are the reference for the development stage of the *Sivadharmā Database*.⁴² The development workflow follows these steps: (1) set up of the database; (2) backend; (3) frontend development.⁴³

The first step involves configuring a graph database, i.e., *Neo4j*, to store the data editors will produce as nodes connected by their semantic relationships, e.g., a specific edition is linked to its editor, according to ontological models.⁴⁴ We consider the graph an efficient data structure to express the semantics and manage cases of overlapping hierarchies.⁴⁵

Then, we proceed with the development of the backend. It includes the development of the infrastructure of the web application at hand, and its server-side functionalities, e.g., the creation and post of an edition. The leading involved technologies are *Node.js*⁴⁶ and *Express*.⁴⁷

In conclusion, frontend development deals with the rendering of the user interface. It implies the use of *EJS*,⁴⁸ *Sass*,⁴⁹ and *Vanilla JS*.⁵⁰

5. Future work

The *Sivadharmā Database* project requires the implementation of further system functionalities. First, we intend to gather the witness facsimiles in an *Omeka S* environment.⁵¹ It implies that a URI identifies each facsimile. The inclusion of the URIs in the critical apparatus is a means to enrich the editions. The integration of tools for browsing the editions, i.e., facets and data visualisation charts, moves in the same direction.

⁴² *GitHub* repository of *Sivadharmā Database*: <https://github.com/martinadellobuono/shivadharmā-database>.

⁴³ The backend and frontend development are simultaneous stages.

⁴⁴ To import ontologies, it is necessary to integrate a plugin in *Neo4j*, e.g., *Neosemantics* (*n10s*): <https://neo4j.com/labs/neosemantics/> (23/06/2022).

⁴⁵ Neill-Schmidt, *SPEEDy*, cit., pp. 45-54.

⁴⁶ *Node.js*: <https://nodejs.org/en/>.

⁴⁷ *Express*: <https://expressjs.com/>.

⁴⁸ *EJS*: <https://ejs.co/>.

⁴⁹ *Sass*: <https://sass-lang.com/>.

⁵⁰ *Vanilla JS*: <http://vanilla-js.com/>.

⁵¹ *Omeka S*: <https://omeka.org/sl/>.

The project also envisages the customisation of the environment to treat iconographic and epigraphic sources.

In conclusion, user testing sessions are fundamental to gathering feedback and gradually spotting and fixing system gaps and usability issues.⁵² Therefore, a series of sessions during the development stage is in progress.

6. Conclusions

The ongoing *Śivadharma Database* project is a proposal that rises from analysing the issues related to the already available tools for *Scholarly Digital Editing*. Identifying such issues is the starting point for studying a solution that meets the community's needs. The reference community includes all the scholars engaged in the general fields, even though the project domain is related to Sanskrit. Consequently, the aim is to build a flexible environment to accomplish the editing and publishing tasks regardless of the application domain.

One of the main issues of the existing *Scholarly Editing* tools is the requirement for high technical skills. Thus, we decided to design the *Śivadharma Database* web application as a *CMS* for creating, posting, and updating editions. This solution implies low technical skills, as users can perform *CRUD* operations via interface without requiring coding and configurations.

Another identified issue is the mismatch between the input and the output in some of the available editing systems. For this reason, the web application covers the entire editing and publishing workflow. In addition, the match between the interface in “editing” and “reading” modes gives the impression of a unique environment.

From a technical point of view, the application infrastructure relies on a graph database. This technical choice allows solving two issues, i.e., the formal expression of semantics and overlapping hierarchies.

The development of the core functionalities of the *Śivadharma Database* is currently in progress. Finally, it will follow a phase of resource enrichment and enhancement.

⁵² J. Nielsen, *Usability 101: Introduction to Usability*, 2012.