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Lessons Learned from EIAH Metadata Application Profile (EMAP)

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P.7, Line 242, the term"holding-location" is correct.

Q1. Au: Location.?

Q2. Au: Title of article correct?

P.13, Line 425, This reference is to the special edition of "Journal of Library Metadata," Vol 9, Issues 3 & 4

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Lessons Learned from EIAH Metadata Application Profile (EMAP)

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The EIAH Metadata Application Profile (EMAP) has been designed to meet Encyclopedia of Iranian Architectural History (EIAH) needs regarding the organization of architectural resources. The application profile should satisfy community needs and should respect existing conventions; architects may think differently from archivists or museum curators. The key issues in the design process have been addressed here; namely, compliance with the special needs of EIAH data architecture, interoperability, compliance with Persian language and localization, as well as simplicity, critical because of the wide range of non-cataloger users of the system. The EMAP has been designed based on Dublin Core; six element refinements have been defined for the Dublin Core element "subject" to facilitate the interconnection of resources to entities in the EIAH ontology. In particular, human readable documentation guidelines have been emphasized as an important factor in metadata quality. Metadata crosswalks have also been defined with major standards of the domain to improve interoperability.

KEYWORDS Metadata, application profile, Dublin Core, metadata crosswalk, metadata guidelines, localization

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INTRODUCTION

BCE

The Iranian World[1] is a veritable archive of human history with numerous historic sites and monuments, some dating back to the eighth millennium BC. In spite of the high rate of destruction of the cultural heritage in this territory, the remaining evidence is still considerable, estimated to be up to one million historic monuments and sites. This valuable heritage has not been well documented to this point, a critical issue for historical studies, in particular for the study of architectural history, which is inseparable from material evidence. Moreover, documentation is not the only problem; owing to a lack of any integrated network for collaborative research many redundant and parallel studies have been carried out. The lack of any infrastructure for knowledge exchange and interoperability has led to the failure of several attempts for the integration of different information centers and a recess in the architectural studies of the Iranian world.

The Encyclopedia of Iranian Architectural History (EIAH) was established aiming to pave the way for scholars in the field and to remove the aforementioned obstacles. The representation of the resources of the history of Iranian architecture, identification, collection, and long-term preservation are the primary goals of the EIAH project. Toward this end, the EIAH metadata application profile (EMAP) was designed based on the Dublin Core Metadata Initiative (DCMI)[2] to meet the needs of the EIAH in terms of content management, and interoperability with other applications both inside and outside of the organization. The application profile defines new metadata elements and provides usage guidelines. The results were tested within the project and the first version was implemented in Dspace software, which is used as the EIAH digital repository.

This article presents lessons learned from the EIAH experience in the design of a metadata application profile. We particularly look at the issues drawn from the EIAH project centering on the use of the Dublin Core metadata standard in the Persian language, interoperability, localization, and the specific requirements of information retrieval of the architectural documents.

LITERATURE REVIEW

This review of studies dealing with application profiles is not meant to be exhaustive. For comprehensive coverage of the literature on application profiles and metadata best practices, see the special issue on metadata best practices of *Journal of Library Metadata*.[3]

Different institutions have different functional requirements. Also, the differences in the format and knowledge domains of resources cause various needs in terms of metadata. The concept of the application profile

is reflective of the need to support domain-specific semantics and requirements. Heery and Patel introduce application profiles as mixing and matching metadata schemas that are suited for a particular local application.[4] The use of the application profile has two mottos "do not re-invent the wheel" and "reuse existing schemas."[5] In addition, interoperability is an important factor in information system design. By achieving semantic interoperability, application profiles provide a basis for harmonization of metadata and semantic mapping between systems.[6]

A Dublin Core Application Profile (DCAP) is a document or set of documents that specifies and describes the metadata used in a particular application.[7] An application profile defines metadata elements and their structure as well as usage guidelines. It uses identifiers for identifying terms with precision. In addition, it should precisely describe term usage and its attributes. The other important aspect, especially for a formal expression of the application profile, is the constraints on term use; these constraints define whether the usage of the term is mandatory or optional; they also define the cardinality of the term usage.[8]

DCAP emphasizes the importance of human-readable descriptions and the provision of guidelines for the expression of the application profile in Resource Description Framework (RDF) and Extensible Markup Language (XML). The Dublin Core Abstract Model (DCAM) is another important basis on which the application profile is constructed. DCAM precisely defines the schema components and their structure in order to be machine-processable.[9]

The DCMI Abstract Model, published as a DCMI Recommendation in March 2005, provides a metadata model of the type required for formalizing a notion of machine-processable application profiles. In September 2007, Mikael Nilsson presented a framework for the definition of Dublin Core Application Profiles that was dubbed later the "Singapore Framework." The Singapore Framework defines a set of mandatory and optional components for construction of the application profile, including Functional Requirements (mandatory), Domain Model (mandatory), Description set profile (mandatory), Usage guidelines (optional), and Encoding syntax guidelines (optional).[10]

The rapidly growing body of digital repositories calls for systematic examination of documentation practices. Metadata best practices encompassing metadata guidelines and application profiles function as an essential mechanism for metadata planning, application, and management. The growing number of application profiles demand novel approaches and techniques for extracting, analyzing, and comparing locally developed documentations. Such future endeavors may further contribute to the development of mechanisms for sharable and interoperable metadata.

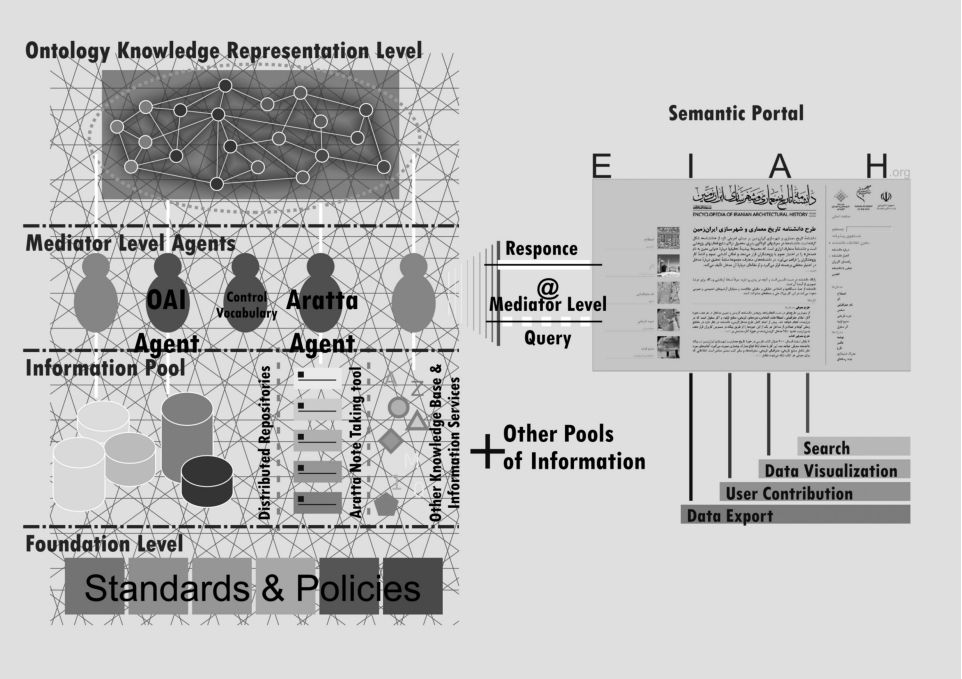

FIGURE 1 EIAH Information Architecture (EIAH-Cake).

METHODOLOGY OF APPLICATION PROFILE DESIGN

EIAH: Information Architecture and the Purpose of Its Metadata Application Profile

EIAH information architecture is a three-layer architecture called EIAH-cake, as Figure 1 illustrates.

There is an information pool consisting of a set of distributed digital repositories. In addition to the EIAH digital repository, some supplementary services such as the Aratta collaborative research tool[11] are included in this layer. On the upper level, there is an ontology of the topics in the domain of Iranian architectural history. The mediator level functions in the middle in order to gather metadata from the information pool and to interconnect the resources in the information pool to the topics in the ontology.[12] According to the very modular nature of this design, interoperability plays a key role in the system. Also, resources should be described in a way which facilitates the interconnection of the resources to the topics of the history of Iranian architecture.

Since metadata plays a key role in the establishment of this information architecture, the EIAH metadata model needs to comply with the requirements of the EIAH information architecture. Thus, the EMAP should have characteristics such as semantic interoperability and extensibility and

be able to be used by many in a wide spectrum of cultural heritage institutions who are not cataloging professionals. Given the characteristics of the Dublin Core Standard, namely, simplicity, semantic interoperability, extensibility, and compliance with the Resource Description Framework (RDF),[13] the Dublin Core metadata standard was adopted by EIAH.

As mentioned, application profiles play a key role in interoperability. Given the primary need of EIAH information architecture to exchange data between standalone agents, the use of an application profile capable of improving interoperability is vital.[14]

The Process of Application Profile Design

To start the process we needed to think about the specific requirements of the EMAP. In addition to the usual procedures and requirements, two additional criteria for EMAP, were identified, namely, ease of use and compliance with the EIAH objectives. Ease of use is an essential factor because this application profile is to be used in a wide range of institutions.

To achieve the highest level of compatibility we decided to follow the most widely used application profile design in the community. The Singapore Framework was in its early stages when the EMAP design process started; therefore, we chose to use the former Dublin Core guideline.[15] In addition, the Singapore Framework emphasis on the formal expression of the application profile in the Singapore Framework was not welcomed by the librarian side of the EIAH project.

Hence, it was decided to design the application profile based on the former guidelines in the first phase and later move incrementally toward the new framework by observation of the development of the application profile notion in the community. Therefore, the application profile in the first phase consisted of a selection of metadata elements and new elements, an agreement on term usage, the choice of appropriate vocabularies, specification of permitted schemes and values (e.g., use of a specific controlled vocabulary or encoding scheme) and the usage guidelines. One of the major objectives of the usage guidelines was defining the appropriate use of the application profile in different institutions for architectural resource description.

Preparing the EMAP

A team was formed consisting of two members of the research department responsible for collection and description of resources, and two members of the IT department responsible for the implementation of tools and software. As a first step, the team studied the available documentation of Dublin Core to gain a shared image of the work. This was an essential stage as there exist

different notions about metadata usage and the lack of conceptual integrity would cause problems in the later usage of metadata terms.

Dspace, an open source software, was adopted as the digital repository platform for digital resource management and preservation. Dspace supports different metadata schemas; however, by default it uses a qualified version of the Dublin Core schema based on the Dublin Core Library Application Profile (DC-Lib).[16] As the project has powerful connections with the library side, and most system users are more familiar with the library legacy, we decided to develop our work based on the DC-Lib approach and to reuse the terms and vocabulary. The team defined its functional requirements initially and then endeavored to define the required elements. Finally, after the early draft, we performed some tests both in-house and outside to measure the efficiency of the early application profile. After the preliminary tests and revisions, the first version of the application profile was compiled and used in the EIAH digital repository and in the Aratta Web-based collaborative note-taking tool. The results from the first phase will be used to improve the next version.

Important Issues of the Design Process

The EMAP is designed to be used by the staff of cultural heritage institutions not familiar with complicated cataloging rules. Therefore, use of overly complicated metadata schemas such as Categories for Description of Works of Art (CDWA) with 532 categories and subcategories,[17] VRA (Visual Resource Association) Core,[18] and Cataloging Cultural Objects[19] (CCO) fell outside of the focus of the project, but we did look to these for reusable elements. At first glance, CDWA or CCO seemed to be sufficient for the description of architectural records; nonetheless, CDWA is designed for curatorial jobs and is based on a museum perspective; for example, it records the history of repairs of the work. Both standards look at architecture as an object; however, architecture has a social and cultural life that is absent in the study of objects. As Christopher Alexander has stated, in architecture we face both spatial and event patterns.[20]

On the other hand, working with these standards calls for a group of highly trained catalogers with a wide knowledge of the arts and art history. In addition, the EIAH repository does not retain the records of objects but the documents, which contain information about architectural artifacts and are stored along with other historical resources including books and articles. Furthermore, a widely accepted standard is needed to provide interoperability with the other data available on the Web and to provide linked data. Owing to the success of Dublin Core as a generally used metadata standard, it was decided to place at the center the Dublin Core Metadata Initiative (DCMI) approach and elements as the basis of the design in order to achieve the highest compliance with DCMI while trying to define crosswalks with the

major standards in the field of cultural heritage such as CIDOC-CRM (Conceptual Reference Model),[21] CCO, CDWA, FRBR (Functional Requirements for Bibliographic Records), and FRBR-Object Oriented.[22]

Inasmuch as the cultural centers are scattered around Iran, frequently without network connections, it was impossible to use a Web-based or an integrated system. Therefore, the solution in many cases was to enter the information in simple spreadsheet files (e.g., Excel) and to import this information later to the digital repository or to a note-taking tool. Accordingly, the description sets had to be as simple as possible to be implemented in the Excel forms with a written guideline for filling the forms. A minimum choice of elements could make the task unambiguous even for a novice user.

THE STRUCTURE OF THE EIAH METADATA APPLICATION PROFILE (EMAP)

Element Set

The EMAP consists of 12 core elements and 31 refinements of which 14 refinements for the core element *contributor* seems to be excessive and should be decreased in the next version. The most important refinements are the *subject* refinements, which narrow down the subject of the resources and can be used to interconnect the resources to the topics of the domain. These refinements are designed to comply with the EIAH ontology entities. EIAH ontology includes three major classes of entities: temporal, spatial, and human (i.e., actors). These major entities are divided into six more comprehensible groups as Persons (subclass of human entities), Works (monuments and sites) and Geographical Names (subclass of spatial entities), Historical Periods, Events (subclass of temporal entities), and General Terms, which is the generic level of all the other classes.[23]

In this way, we defined six refinements for the dc.subject element: Is related to Person, Is related to Work, Is related to Geographical Name, Is related to Historical Period, Is related to Event, Is related to Term. These elements by application of EIAH architectural controlled vocabulary for description of resources help to identify and connect precisely the related resources to the six categories of topics. Table 1 illustrates the six refinements for the dc.subject element:

The metadata element dc.location has two different functions and thus was controversial in the design process. In DCMI metadata terms,[24] the dc.location appears as a class while in DC-Lib it appears as an element for the proposed "holding-location" term, using the existing element of Metadata Object Description Schema (MODS).[25] There were two needs in EIAH; first, to identify the holding location of the physical resource when a Uniform Resource Identifier (URI) is not appropriate; second, to identify the location of creation of the physical item. **Q1**

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The Table borders must be corrected

TABLE 1 EMAP "DC" Subject Refinements

Term Name: Is Related to Event		Term Name: Is Related to Term	
URI	http://eiah.org/en/Entries#Event	URI	http://eiah.org/en/Entries#Term
Label	Is related to Event	Label:	Is related to Term
Definition	An entity responsible for correlating an event to the resource	Definition:	An entity responsible for correlating a term to the resource
Type of term	Property	Type of term:	Property
Refines:	http://purl.org/dc/elements/1.1/subject	Refines:	http:/purl/.org/dc/elements/1.1/subject
Term Name: Is Related to Geographical Name		**Term Name: Is Related to Historical Period**	
URI	http://eiah.org/en/Entries#Geographical_Name	URI	http://eiah.org/en/Entries#Historical_Period
Label:	Is related to Geographical Name	Label:	Is related to Historical Period
Definition:	An entity responsible for correlating a geographical name to the resource	Definition:	An entity responsible for correlating a historical period to the resource
Types of term:	Property	Types of term:	Property
Refines:	http://purl.org/dc/elements/1.1/subject	Refines:	http://purl.org/dc/elements/1.1/subject
Term Name: Is Related to Person		**Term Name: Is Related to Work**	
URI	http://eiah.org/en/Entries#Person	URI	http://eiah.org/en/Entries#Work
Label:	Is related to Person	Label:	Is related to Work
Definition:	An entity responsible for correlating a person to the resource	Definition:	An entity responsible for correlating a work to the resource
Types of term:	Property	Types of term:	Property
Refines:	http://purl.org/dc/elements/1.1/subject	Refines:	http://purl.org/dc/elements/1.1/subject

Ultimately, we decided to use the term in two different ways; first as the DC-Lib, for the resources that had not been published officially (e.g., reports, manuscripts); second as the publication location for the published resources (e.g., books, journal articles). After the first phase, we understood that this approach would cause misunderstandings and the term should only be used as a "location" element in the DC-Lib. Thus we ascertained that location.publication for the latter use should be added to EMAP.

The conceptual difference between work, expression, and manifestation owing to the International Federation of Library Associations and Institutions (IFLA) Functional Requirements for Bibliographic Records (FRBR) was also a major issue in our EMAP.[26] Following the one-to-one principle in Dublin Core we decided to differentiate between the digital manifestation (e.g., pdf version) and the physical manifestation of an expression of the work (e.g., a paper copy). Therefore, we decided to describe these two levels separately. For example, we used the date.created element for the publication or creation of the physical manifestation and the date.issued for the date when a digital manifestation is issued, unless the work is in essence a digital-born resource. This decision created a series of problems. The first and foremost was the confusion in both description and interpretation of data.[27]

Unlike Fedora Commons, Dspace does not support non-literal relationships between items. Therefore, it was not easy to define a description set and relate the digital manifestation of a work to the physical one. According to the test results, we understood that we needed to describe the expression of the works (i.e., the digital manifestation inherits the attributes of the expression as the creator and the creation/original date). Otherwise we would follow the Scholarly Works Application Profile (SWAP) model, which explicitly defines the relation between manifestation and expression of a work.[28]

Syntax, Vocabularies, and Schemes: Problems with the Persian Script and Calendar

Complexities and variations of linguistic structures across languages and cultures have a significant effect on information access.[29] Thus, linguistic and cultural variations need to be taken into consideration in the development of an application profile. Prior to dealing with complicated issues such as word segmentation and boundaries which affect metadata quality, the following basic aspects should be taken into account: In EMAP design two major problems flowed from the nature of localization.

The Persian script is written from right to left; tools should be capable of handling bidirectional algorithms in order to store and manipulate data correctly, especially when Persian and Latin scripts are mixed in a statement. It was also essential to use Unicode character encoding for all data

entered and stored. In Persian, we face difficulties regarding nonstandard localization. The Arabic character Yeh (ي) was usually used instead of the Persian character (ی), the Arabic character Kaf (ك) used instead of the Persian character (ک), and the Arabic character Teh Marbuta (ة) used instead of the Persian (ه). If this problem was not carefully handled, inaccuracy in information retrieval could result. Because Microsoft Windows does not support the Iran localization standard for the Persian keyboard (ISIRI9147), most users enter data through use of Arabic keyboards, exacerbating the inconsistency in data entry. This in turn affects information retrieval. To reduce this inconsistency, the guidelines made compliance with Persian script and Unicode character encoding mandatory for data entry.

The Persian calendar was another major localization issue. The Solar Hejri calendar called Taqwîm-e hejrî-e šamsî has been the Persian official calendar since March 1925. This calendar is a combination of the solar year and the hejri era. The start of the Islamic calendar is the hejra (i.e., Prophet's flight from Mecca to Medina). Iran/Persia has used a solar calendar system called the Jallai calendar since 1079 CE.[30] The Persian year starts at the vernal equinox; therefore, the dates are different from the Gregorian calendar. To achieve interoperability, we adopted the widely used W3 Consortium Date and Time Formats (W3CDTF) and the Gregorian calendar, even though the official calendar of Iran is the Persian calendar. Because services and users outside the organization need access to the stored metadata via the Open Archives Initiative (OAI)–server and they need to retrieve dates in a comprehensible format to be used globally, we decided to store dates in W3CTDF format in all applications. However, the date can be entered and represented in the Persian calendar format and use of a date conversion algorithm based on the most precise algorithm known as the 33-year algorithm is employed.[31] The guideline for implementation of this feature is added to the EMAP documentation. This feature was later implemented in localization of the Dspace digital repository. The dates are stored in W3CTDF in the database but when a user selects the Persian mode the dates are converted by JSP UI to the Persian dates. Thus, in data entry and representation an interim conversion step is implemented to support this feature. Sorting of items by date was not a challenge because the sequences of events are calendar scheme independent and would be the same in both calendars. This process is handled by user interface, making it possible for a user to browse, search, and retrieve data based on the Persian, as well as the Georgian, calendar.

by using

"and use of" must be omitted, "by using" must be inserted

Usage Guidelines

Inasmuch as the system is designed to be used by those who are not metadata experts or catalogers, the guidelines play a significant role in the improvement of metadata quality, especially when enriched by different examples.[32]

The guidelines should place emphasis on basics to reduce ambiguity regarding term usage. The most complicated cases are *title* and *subject*. Most of the documents in the cultural heritage organizations do not have a title, in particular the photos. In certain cases a rhetorical title is used such as "the most beautiful dome of the world!" which is an impression of the photographer in a documentation project. Such titles obviously do not help the user ascertain the name of the edifice or its location.

To overcome this problem, the team studied available resources such as *Guide to the Description of Architectural Drawing*[33] and consulted with domain experts in meeting sessions. Finally, a guideline with different real-world examples was prepared for users on how to provide a title and subject for different types of resources. The lack of thesauri and authority files was another flaw in the domain of Iranian architectural history and Islamic architecture. The Getty *Art and Architecture Thesaurus* (AAT)[34] does not cover Islamic art and architecture and has a Western-centric point of view. Nor do the terms have Persian equivalents. Neither is there a Persian equivalent for the *Thesaurus of Geographic Names* (TGN), and most authority files do not cover the history of architecture.

From the early stages of the EIAH project, there was a serious effort undertaken to prepare controlled vocabularies for the domain of Iranian architectural history. At present, the process has led to the accumulation of 6,000 geographical names, 15,000 architectural monuments, 750 person names, and 6,000 architectural terms. Step by step, these vocabularies were used for different subject fields. In addition, the project provided an open version of the Persian cultural thesaurus, subject headings, and authority files prepared by the National Library and Archive of Iran (NLAI), and expressed in SKOS. The EMAP is planning to use these vocabularies in the next version.

The Crosswalks

While adhering to Dublin Core, EMAP also examined different standards in the domain for reusability of terms and attempted to define crosswalks to the major metadata schemas in the cultural heritage domain. Efficient resource management requires interoperability among systems dealing with different metadata schemas. In order to achieve interoperability, we should be able to define mappings across different metadata schemas.[35] Different crosswalks are available[36,37] between Dublin Core and the other schemas; here only the crosswalk between the EMAP six subject refinements and CIDOC-CRM[38] and FRBR[39] has been addressed. A simple mapping is provided in Table 2.

The EMAP in Use

The EMAP is used primarily in the EIAH digital repository and other digital repositories that use the EIAH platform. EIAH has customized and localized

TABLE 2 Crosswalks between EMAP Six Subject Refinements and CIDOC-CRM and FRBR

EMAP	CIDOC-CRM	FRBR Model
Is related to Person	E21 Person	Has as Subject (Person)
Is related to Work	E26 Physical Feature	Has as Subject (Work[40])
Is related to Geographical Name	E35 Place	Has as Subject (Place)
Is related to Historical Period	E4 Period	Has as Subject (Event)
Is related to Event	E5 Event	Has as Subject (Event)
Is related to Term	E33 Linguistic Object	Has as Subject (Concept)

the open source Dspace software as its institutional repository. The EMAP application profile has been implemented in Dspace. An agent, in the mediator level of the EIAH-cake, automatically retrieves information from the repository and uses EMAP to interconnect different resources in the digital repository to the entries of the encyclopedia implemented in Semantic Mediawiki. This is possible owing to the subject refinement elements and their compliance with entries classification. As mentioned earlier, Dspace cannot handle relationships among repository items; this creates some problems in the implementation of DC Singapore Framework as it cannot handle non-literal properties in this regard.

The EMAP is also used in the Aratta Web-based Collaborative Note-taking tool.[41] This collaborative tool is a semantic wiki used by EIAH scholars for note-taking from a historical resource and for assigning semantic tags to the resources. These notes are used as references for EIAH entries and the aggregated tags will be used for building controlled vocabularies. Again, we have the six DC subject element refinements as the semantic tags for the notes.

CONCLUSION

In the design of an application profile, several aspects should be considered including the very essential issue of context. The application profile should satisfy community needs and respect existing conventions; architects may think differently from archivists or museum curators. When the use of a new technology brings a shift to the community, it is crucial to respect the adaptability of legacy users; a gradual change usually ensures better results. The digital divide may affect application profile design. For example, in the case of the EMAP, it was important that simple spreadsheet files (e.g., Excel, OpenOffice Calc) could be used for resource description.

Guidelines play a vital role in metadata quality, especially for users who are non-cataloging professionals. Providing full details and varied real examples would be very helpful in this regard. Human-readable documentation should be provided in the application profiles as well as technical

documentation. Localization for different contexts is a major issue as well (e.g., Persian calendar and script). This is essential to achieve interoperability. Thinking globally regarding linked data, we should act locally to comply with the specific conditions of different societies, while looking to the standards to prevent reinventing the wheel to contribute to metadata mapping, a key to improving interoperability.

The next phase of work on the EMAP will be focused on compliance with the Singapore Framework and expression of the new version in RDF. Prior to the next phase of development, EMAP competency with the functional requirements and its effect on metadata quality should be assessed. Park emphasizes that metadata quality depends on to what degree it can perform core bibliographic functions,[42] in particular, information discovery. Thus, both recall and precision should be measured. On the other hand, it seems that element refinements could be decreased to achieve a more concise application profile. In the next version, the six subject refinements could be matched with terms from frequently used namespaces (e.g., FRBR). Another task would be the application of compiled controlled vocabularies (e.g., EIAH, ASFA, and NLAI Authority files). The next version will be published in both Persian and English in metadata registries for public use and development.

The whole sentence have to change in this way:
Casting an eye to the standards of the field would prevent the reinvention of the wheel and would contribute to the provision of metadata mapping: a key to improving interoperability.

NOTES

1. The Iranian World is in essence a cultural territory comprising many contemporary political entities and geographical territories beyond the political entity of the present day country of Iran.
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