1 ORIGINAL PAPER

2 # Secondary adoption of technology standards:
3 # The case of PREMIS

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5

7 **Abstract** While archival scholars have identified some of the most important steps
8 for deciding to use and implement metadata standards in archives, very little sys-
9 tematic empirical investigation within the archival science literature regards either
10 how implementation processes actually unfold or the factors affecting implemen-
11 tation. This article analyzes the organizational factors and processes that come into
12 play during implementation of metadata standards, using PREservation metadata:
13 implementation strategies (PREMIS) as an exemplar. Adapting a theoretical
14 framework for secondary adoption of technologies from Gallivan (Database Adv Inf
15 Syst 32(3):51, 2001), the authors apply their model to the PREMIS technology
16 standard and investigate PREMIS implementation by projects/programs on the
17 Library of Congress PREMIS Implementation Registry. Using data from a series of
18 in-depth semi-structured interviews, the authors develop a model for the secondary
19 adoption of PREMIS and outline implications for the secondary adoption of tech-
20 nology standards based on the results of this study.
21
22 **Keywords** Digital curation · Digital preservation · Implementation · PREMIS ·
23 Preservation metadata · Secondary adoption · Standards
24

25 ## Introduction

26 Standards in archives are ubiquitous. They reflect the most current knowledge about
27 professional practices and increase interoperability, consistency, and the safety and
28 security of collections. For archivists working in the digital realm, the pace of
29 standards introduction is swift and the decision to adopt a given standard can mean

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30 altering work processes and/or reconfiguring present technologies during the
31 implementation process (Hofman 2005). Because implementation of standards
32 usually entails these more broad-based changes, standards can be ignored or
33 diffusion may progress slowly as repositories adapt in anticipation of adoption.

34   Archives, libraries, museums, and other cultural heritage organizations that accept
35 responsibility for digital preservation also accept the challenge of implementing
36 preservation systems that conform to emerging standards and best practices (Conway
37 1996). Metadata standards promulgated by archivists include information about the
38 physical attributes of a record, as well as data about the context of a record's creation,
39 its creator, the business process from which it emanated and information about its
40 structural components (Duff 2004 p 27). Concerns over the long-term maintenance
41 of digital objects have resulted in a growing interest in preservation metadata (Duff
42 2004; Wilson 2004), and the digital preservation community has responded to these
43 concerns by creating standards for preservation metadata, the most influential
44 standard being PREservation metadata: implementation strategies (PREMIS).

45   Archival scholars have identified some of the most important steps for deciding
46 to use and implement metadata standards in archives. First, one should consider who
47 developed the metadata standard, why it was developed, to which entities it relates,
48 and what functions it supports (Duff 2004, pp 28–29). Second, an institution should
49 consider its organizational context and how the standard fits into that context and
50 adapt the standard accordingly (Wilson 2004). In addition, institutions must create
51 application profiles, which formally declare how they intend to implement the
52 metadata standards (Wilson 2004). None of these activities are trivial and without
53 challenges, particularly for institutions wishing to make the most of metadata
54 standards for their own management of digital objects while increasing interoper-
55 ability and consistency among repositories.

56   Through their own research and experience, archival scholars and practitioners
57 are aware of some of the issues that arise when trying to implement metadata
58 standards after making the initial decision to adopt. However, very little systematic
59 empirical investigation within the archival science literature regards either how
60 implementation processes actually unfold or the factors affecting implementation.
61 Empirically tested conceptual frameworks in diffusion of innovations (DOI) and
62 management and information science (MIS) address issues related to adoption and
63 implementation of information technology broadly defined and could therefore be
64 useful for understanding challenges and opportunities for implementing standards.
65 Because reliable, authentic digital objects will not be preserved across time without
66 adequate preservation metadata, that is, information about the technical environ-
67 ment in which records are created and exist (Duff 2004 p 27), and metadata are
68 essential for the authenticity, preservation, and use of a digital object, a deeper
69 understanding of the factors and processes that constitute metadata standard
70 implementation is crucial. Rather than reinventing the wheel of "factor" and
71 "process" theoretical frameworks and models to better understand implementation
72 from a methodological perspective, archivists ought to draw on those established
73 frameworks and models and adapt that work to suit their own purposes—which is
74 what this article attempts to do.

75   In diffusion of innovations (DOI) literature, the initial decision to adopt is known
76 as primary adoption, and secondary adoption is the subsequent process, whereby
77 implementation actually occurs (i.e., resources are allocated, existing systems are
78 adapted or done away with altogether, etc.) (Zaltman et al. 1973). The factors
79 affecting primary adoption and secondary adoption differ (Zaltman et al. 1973).
80 Furthermore, high numbers of primary adopters do not necessarily ensure high
81 numbers of successful secondary adopters (Fichman and Kemerer 1999).

82   DOI theory offers many "stage research models" (Prescott and Conger 1995) to
83 explain organizational adoption and implementation as well as factors that have been
84 identified (Davis et al. 1989) as playing a role in explaining individuals' behavioral
85 intentions to adopt. Stage research models "identify the sequences of events that
86 occur during implementation—with most stages focused on events following the
87 adoption decision" (Gallivan 2001 p 58). As Gallivan (2001) points out, stage
88 models are a sub-type of "process research models," and like other process models,
89 are valuable in describing how implementation processes unfold, with a focus on the
90 time ordering of events and identification of the events and conditions necessary for
91 certain outcomes to occur (p 58). More recently, researchers have argued that, in
92 cases where primary adoption has already taken place and secondary adoption is not
93 complete, the most appropriate theoretical frameworks to study this particular
94 phenomenon are hybrid models which combine processes and factors because both
95 affect secondary adoption (Shaw and Jarvenpaa 1997). Gallivan's (2001) hybrid
96 model highlights secondary adoption particularly well using factors (e.g., managerial
97 interventions, subjective norms, and facilitating conditions) and processes (e.g.,
98 initiation, adoption, adaptation, acceptance, routinization, and infusion) (see center
99 of Fig. 1).

100   Managerial interventions (Leonard-Barton and Deschamps 1988; Agarwal 2000)
101 are "actions taken and resources made available by managers" to facilitate secondary
102 adoption, including policy decisions such as mandating usage, providing training, and
103 providing support (Gallivan 2001 p 61). Subjective norms describe individuals'
104 beliefs concerning what colleagues expect of them during implementation (Gallivan
105 2001 p 61). These norms vary depending on the innovation and adoption context
106 (Ajzen and Fishbein 1980; Davis et al. 1989). They "shape potential adopters'
107 understandings about when and why an innovation is being adopted, how much effort
108 to undertake on their own to learn it, or when to abandon the technology for an even
109 newer innovation" (Gallivan 2001 p 61). Facilitating conditions are factors that make
110 implementation more or less likely to occur (Orlikowski 1993). These include
111 "specific attributes of the innovation, the organizational context and culture, and the
112 work task itself" (Gallivan 2001 p 61). Innovation attributes are characteristics of an
113 innovation that make it more or less likely for the innovation to be implemented
114 (Gallivan 2001 p 61). For example, interoperability with other systems and
115 technologies as well as cost could all be seen as innovation attributes. Organization
116 attributes are characteristics of an organization that make an innovation more or less
117 likely to be implemented (Gallivan 2001, p 61). Such attributes can be technological,
118 cultural and/or be related to organizational context. For example, from a technological
119 standpoint, if an organization has flexible technological systems in place, it may well
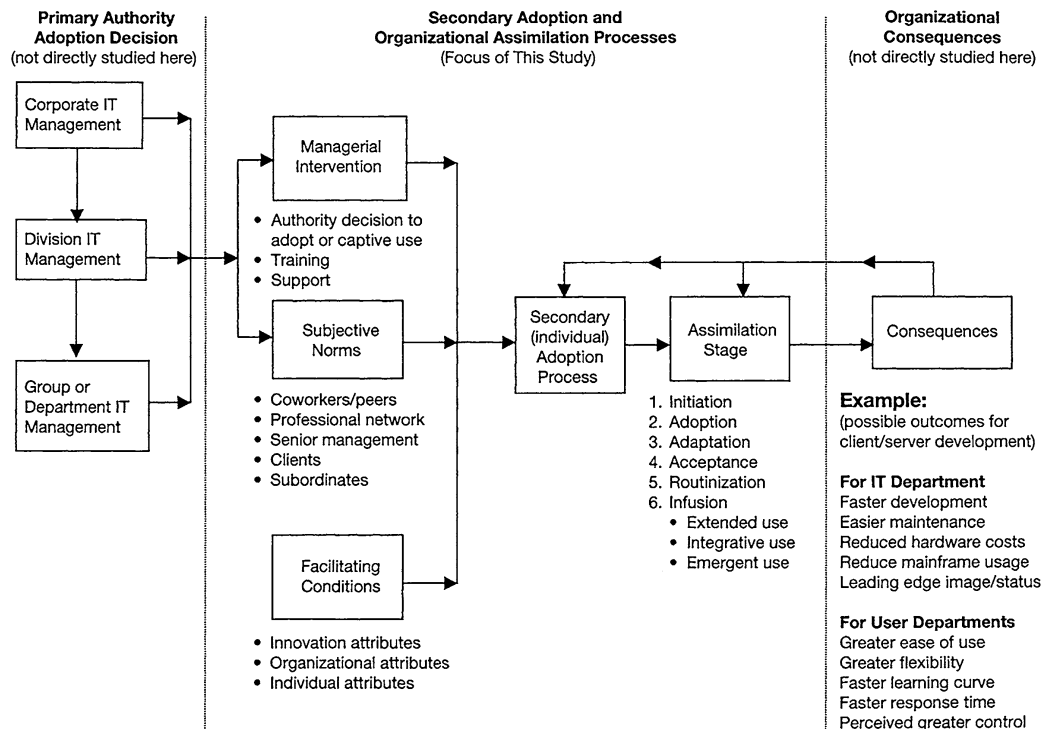120 be easier for that organization to implement an innovation by integrating it within

Fig. 1 From Gallivan (2001 p 60)

121 existing systems. Individual attributes are characteristics of individuals within an
122 organization that make an innovation more or less likely to be implemented (Gallivan
123 2001, p 61). The individuals responsible for implementing an innovation within an
124 organization can affect implementation, for example, by their motivation (or lack
125 thereof) in learning about the innovation or their technical and social skills.

126 Gallivan's framework also incorporates Cooper and Zmud (1990) information
127 technology (IT) implementation process model which occurs in the midst of the
128 assimilation stage[1] and lists determinants of whether an innovation is fully
129 implemented in the secondary adoption phase. The IT process model includes six
130 stages: initiation, adoption, adaptation, acceptance, routinization, and infusion (pp
131 124–125):

132 • Initiation refers to a process by which active and/or passive scanning of
133   organizational problems/opportunities and the IT solution are undertaken.
134   Pressure to change evolves from either organizational need (pull), technological
135   innovation (push), or both.
136 • Adoption refers to rational and political negotiations which ensue to get
137   organizational backing for implementation of an IT application.
138 • Adaptation occurs when the IT application is developed, installed and maintained.
139   Organizational procedures are revised and developed. Organizational members

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1FL01 [1] Zmud (2000) defines assimilation as "the process within organizations stretching from initial awareness
1FL02 of the innovation to potentially formal adoption and full-scale deployment" (p 1).

140 are trained both in the new procedures and in the IT application, and the IT
141 application is available for use in the organization.
142 • Acceptance occurs when organizational members are induced to commit to IT
143   application usage and the IT application is employed in organizational work.
144 • Routinization is a process in which usage of the IT application is encouraged as
145   a normal activity and the organization's governance systems are adjusted to
146   account for the IT application; the IT application is no longer perceived as
147   something out of the ordinary.
148 • Infusion is when increased organizational effectiveness is obtained by using the
149   IT application in a more comprehensive and integrated manner to support higher
150   level aspects of work.

151 If stages within Gallivan's model are thought of as activities, some of which may
152 occur in parallel, the model can encompass a variety of IT applications and
153 implementation processes observed in many organizations (Cooper and Zmud 1990,
154 pp 124–125; Gallivan 2001). Overall, Gallivan's framework combines some
155 constructs from traditional individual adoption models with features of process and
156 stage research models of organizational-level implementation and thus presents a
157 framework "that can explain the interplay among organizational context variables,
158 attributes of managers' implementation strategies, and other characteristics that, in
159 aggregate, shape secondary adoption processes and outcomes" (p 78). Gallivan's
160 (2001) model is one of the most highly cited models in DOI and MIS literature that
161 brings together key factors and processes from some of the most highly cited
162 empirically tested theoretical frameworks to better explain the socio-technical
163 nature of implementation and was chosen in this article as an appropriate lens to
164 analyze the implementation scenario of technology standards in archives.

165 In this article, we focus on the organizational factors and processes that come into
166 play during implementation and the interplay among these elements that influence
167 (positively or negatively) full adoption of a technology standard, using PREMIS as
168 an example, by asking: what happens after institutions make the initial decision to
169 adopt a technology standard? We do this through a series of semi-structured
170 interviews with representatives of eleven of the thirteen projects/programs on the
171 Library of Congress PREMIS Implementation Registry. We conclude with a model
172 for the secondary adoption of PREMIS and outline implications for the secondary
173 adoption of technology standards based on the results of this study.

Background

The origins of PREMIS

176 John Garrett and Donald Waters (1996) first articulated the need for trustworthy
177 digital repositories to preserve culturally significant digital objects by maintaining
178 their integrity and authenticity. Garrett and Waters challenged the digital
179 preservation community to create trusted digital repositories because they found
180 that "as stakeholders disseminate, use, reuse, recreate and re-disseminate various

181 kinds of digital information, they can easily, even inadvertently, destroy valuable
182 information" (p 19).

183   Garrett and Waters significantly contributed to an understanding of digital
184 preservation by outlining the elements of a theory of information integrity requiring
185 the preservation of specific features of digital information, including: content, fixity,
186 reference, provenance, and context. The Consultative Committee for Space Data
187 Systems (CCSDS) (2002) proposed the open archival information system (OAIS)
188 reference model and adopted this model of integrity as the centerpiece of its
189 definition of preservation description information.

190   The Online Computer Library Center/Research Libraries Group (OCLC/RLG)
191 Working Group on Preservation Metadata (2002) mapped a set of metadata
192 elements to reflect the concepts and requirements set forth in the OAIS model. The
193 working group defined the role of preservation metadata within the context of the
194 OAIS model's "Content Information" construct, which consists of a digital object
195 and its associated representation information needed to make a digital object
196 understandable to its designated community (CCSDS 2002 p 2–5). The PREMIS
197 Working Group (2005) took a further step in defining preservation metadata by
198 proposing a data dictionary and an extensible markup language (XML) schema to
199 support implementation of the data dictionary in digital archiving systems. The
200 PREMIS data dictionary and accompanying schema consist of *entities* and *semantic*
201 *units*. PREMIS *entities* are "things" (i.e., intellectual entities, objects, events,
202 agents, and rights) that are considered important to talk about in the context of a
203 digital preservation repository system" (Caplan 2009 p 7). *Semantic units* are
204 "pieces of information or knowledge related to PREMIS entities that digital
205 repository systems need to know and should be able to export to other systems"
206 (Caplan 2009 p 7). After version 1.0 of the PREMIS data dictionary and schema
207 were released in 2005, the PREMIS Editorial Committee was formed to gather
208 feedback from the digital preservation community regarding PREMIS and to keep
209 the data dictionary and schema up to date. So far, two updated versions of PREMIS
210 have been released, in 2008 (i.e., version 2.0) and 2011 (i.e., version 2.1),
211 respectively.

212   PREMIS by itself is an information model that has no direct link to preservation
213 practice unless the model is embedded in a working preservation system.
214 Institutions wishing to take full advantage of the power of PREMIS to define
215 preservation metadata to manage their digital objects must have a digital repository
216 management system in place and make a commitment to utilize PREMIS within it.

217 PREMIS implementation in the literature

218 The PREMIS data dictionary is implementation independent, meaning the core
219 metadata define information that a repository needs to know, regardless of how, or
220 even whether, that information is stored (PREMIS Editorial Committee 2011 p 4).
221 In addition, an institution does not have to adopt the entire PREMIS data dictionary
222 in order to be considered a PREMIS implementer. The PREMIS Editorial
223 Committee (2010) only requires that whichever entities and semantic units an
224 institution uses be defined according to definitions provided in the data dictionary.

225 Regardless of the great flexibility the PREMIS Editorial Committee allows, how
226 institutions go about implementing PREMIS is still important to research because
227 those choices have a direct effect on the digital objects preservation metadata are
228 created for and also have implications for interoperability and consistency among
229 repositories.

230 While there are many case studies which focus on a particular institution's
231 experience with PREMIS implementation (e.g., Dappert and Enders 2008), only a
232 handful of research articles present specific data on the PREMIS implementation
233 process or speculate on the barriers that may affect implementation. Woodyard-
234 Robinson (2007) focuses on how institutions implement the PREMIS data
235 dictionary. Alemneh (2009) explores the barriers to adoption of PREMIS in
236 cultural heritage institutions. In a qualitative case study analysis, Donaldson and
237 Conway (2010) examine a digital archive during its process of PREMIS
238 implementation.

239 At the time Woodyard-Robinson (2007) wrote, most of the institutions she
240 described were still in the planning stages of preservation metadata implementation;
241 a few had started development, some had mapped their existing metadata to the
242 PREMIS data dictionary; and many were planning further development to their
243 current systems—specifically by integrating the PREMIS data dictionary into their
244 systems. She examined sixteen institutions and uncovered specific information
245 about which PREMIS entities and semantic units implementing institutions were
246 using or planning to use. Her results suggest that the most important decisions
247 regarding PREMIS implementation concern choosing entities and semantic units,
248 gathering appropriate information corresponding to PREMIS entities and semantic
249 units and representing this information in a repository system. However, her study
250 says little about the actual nature or pattern of this decision-making process.
251 Alemneh (2009) suggests that many institutions were waiting for the PREMIS
252 Editorial Committee to release the second version of the data dictionary and XML
253 schema before adopting PREMIS. Beyond this, the most frequently identified
254 barriers to the adoption of PREMIS include lack of training/expertise and perceived
255 lack of knowledge to confidently implement PREMIS (Alemneh 2009 pp 115–117).
256 This study also finds that while many institutions have made the decision to adopt
257 PREMIS, few have fully done so (Alemneh 2009 p 117). While Alemneh's study
258 identifies barriers to the adoption of PREMIS, it does not focus on actual PREMIS
259 implementation, either the processes that embody it or the factors that affect it.

260 To examine the PREMIS implementation process, Donaldson and Conway
261 (2010) conducted a qualitative case study analysis of the Florida Digital Archive
262 while it was in the middle of PREMIS implementation. They found that adaptation
263 was central to PREMIS implementation. During implementation, the Florida Digital
264 Archive had to adapt its preservation repository management system to use
265 PREMIS effectively: this iterative process involved collaboration among program-
266 mers and project managers (p 286). While Donaldson and Conway focused on
267 understanding the PREMIS implementation process, they did not focus on how or
268 which factors and processes affected each other during implementation and their
269 examination was limited to the Florida Digital Archive's experience.

270   In order to implement any metadata standard, institutions must create organi-
271   zational application profiles, which formally outline the elements from existing
272   metadata schemas an organization uses in metadata implementation (Wilson 2004).
273   For PREMIS, typical application profiles involve use of PREMIS in METS
274   (Guenther and Xie 2007; Vermaaten 2010). Institutions using PREMIS in METS are
275   encouraged to register their profiles on the METS website hosted by the Library of
276   Congress. As of March 2012, 7 institutions have registered their application profiles
277   (Library of Congress 2011). These application profiles can be challenging for
278   institutions to create because there are so many choices that have to be made in
279   order to decide how to encode what preservation metadata is needed. Because
280   PREMIS is so flexible and institutions can choose which entities and semantic units
281   they want to include in their application profiles, this flexibility is both a blessing
282   and a curse. On one hand, institutions interested in using PREMIS in their
283   preservation systems can benefit from looking at other institutions' profiles before
284   formulating their own. In this respect, viewing other institutions' profiles can give
285   institutions ideas about how to create their own. On the other hand, the fact that
286   application profiles vary so much can make it difficult for institutions to reuse
287   others' profiles.

288   While technological difficulties no doubt pose barriers for the implementation of
289   PREMIS, the reasons why standards are difficult to implement reach beyond
290   technological factors solely. As such, there is a gap in the archival science research
291   literature in understanding the implementation of metadata standards from a
292   methodological perspective as a socio-technical process. This article seeks to
293   address the identified gap in the literature by drawing upon an empirically tested and
294   firmly established theoretical framework from the DOI/MIS literature, Michael J.
295   Gallivan's (2001) model for secondary adoption and organizational assimilation
296   processes, using this model as a guide to ask the following research questions:

297   1. From the perspective of secondary adopters, what happens during secondary
298   adoption of a technology standard?
299   2. What processes occur during secondary adoption of technology standards?
300   What factors influence these processes, and what is their effect?

Methodology

302   We used a qualitative methodology informed by Gallivan (2001) to investigate
303   secondary adoption of PREMIS. This section discusses the rationale for the
304   selection of our study population as well as the methods used to recruit participants,
305   conduct interviews, and analyze the resulting data.

Rationale for the choice of study population

307   Since we were interested in the issues associated with secondary adoption, we
308   identified the Library of Congress PREMIS Implementation Registry as a good
309   population with which to begin our inquiry. This group was selected for several

310 reasons. First, the registrants self-identify as engaged in the implementation process.
311 Second, one of the goals of this study was to identify and understand in-depth the
312 factors associated with PREMIS implementation. We assumed that organizations
313 that publicly identified themselves might be more willing to reflect on their
314 experiences and clarify all the dimensions of implementation. Third, although only
315 thirteen projects/programs are on the registry, they are diverse. Participants in the
316 registry include eight universities, four national archives or libraries, one statewide
317 consortium, and one commercial vendor. They are from four countries, and the data
318 preserved in the repositories spans textual resources, audio files, images, and
319 scientific research data sets. Finally, we judged that the projects/programs (Kenney
320 and Rieger 2000) were in different stages of the implementation process given their
321 varied status as projects, programs, or transitioning from projects to programs.
322 While our dataset is small, it does provide an in-depth examination of PREMIS
323 adoption in a diverse group of organizations.

324 Recruiting participants

325 Beginning in mid-January 2010, the first author contacted the designated
326 representatives for all thirteen projects/programs listed on the PREMIS Implemen-
327 tation Registry by email and asked for a telephone interview. If that person indicated
328 that s/he was not responsible for PREMIS implementation at the organization, we
329 asked that person to forward the recruitment email to those who were. In the end,
330 thirteen participants from eleven organizations representing ten projects/programs
331 agreed to participate in this study. The eleven organizations represented ten
332 projects/programs because one of the projects/programs involved a collaboration
333 between two organizations (i.e., the commercial vendor and an organization).

334 Data collection/interview protocol

335 We conducted semi-structured 45-min audio-taped interviews over the telephone.
336 The interview protocol (see "Appendix") is divided into two sections. "Introduc-
337 tion" focused broadly on management practices, the business and technology
338 drivers underlying these practices, and the context and culture of each cultural
339 heritage organization. "Background" captured information about each organiza-
340 tion's objectives for adopting PREMIS, their implementation process, and
341 approaches for retraining existing employees, hiring new employees, and/or
342 outsourcing aspects of PREMIS implementation. For "Introduction", the interview
343 data were collected and analyzed without any particular theoretical framework in
344 mind, however, for "Background", Gallivan's (2001) framework provided a high-
345 level lens to guide interviews and structure data analysis. The constructs in the
346 center of Fig. 1 were perceived as rather broad, and therefore, more specific
347 examples of secondary adoption factors and processes were sought to illustrate these
348 constructs. For this reason, subjects were asked about policies, key milestones,
349 resources, participants, as well as critical events, obstacles, or surprises that they
350 perceived to be significant to implementation.

351   The individuals responsible for PREMIS implementation at Organizations 7 and
352 11 were unable to conduct interviews over the telephone. In these cases, the first
353 author emailed each representative the interview protocol and the individuals
354 replied with responses to all of the questions.

355 Data analysis

356 Following each interview, detailed transcripts were prepared, the interview data
357 were compared with the factor and process constructs in Gallivan's framework, and
358 key themes were identified through the coding process. As interview results
359 accumulated, analytical induction methods (Miles and Huberman 1994) were used
360 to identify themes that were important to the implementation process at each
361 institution. Isolating these themes required dialogical reasoning (Klein and Myers
362 1999) or constant iteration between the data and Gallivan's framework. Next, the
363 constant comparative method (Corbin and Strauss 2008) was used to identify
364 similarities and differences across institutions, and several key themes were found to
365 be relevant for explaining the observed processes and outcomes in the various
366 institutions.
367   In the findings section, we place factor and process constructs from Gallivan's
368 framework within the context of secondary adoption of PREMIS, and in the
369 discussion section, we present the themes that emerged from the data and propose a
370 model for the secondary adoption of PREMIS. We also speculate on the extent to
371 which secondary adoption of PREMIS can relate to secondary adoption of other
372 technology standards.

373 **Findings**

374 This section presents information about study participants and then takes each of
375 Gallivan's factor and process constructs, providing evidence from the data to show
376 how each construct is instantiated in an organization. Since this qualitative research
377 study did not address the primary decision-making process concerning PREMIS
378 adoption, this study focuses on the "secondary adoption and organizational
379 assimilation processes" comprising the center of Fig. 1. As such, after a description
380 of the sample interviewed, we discuss three factors (managerial interventions,
381 subjective norms, and facilitating conditions) and six process-related elements
382 (initiation, adoption, adaptation, acceptance, routinization, and infusion). In
383 addition, we present and discuss a seventh process-related element we found,
384 experimentation, which also was a critical dimension of PREMIS secondary
385 adoption.

386 Study participants

387 This study captured seventy-seven percent (i.e., ten of thirteen) of the entire
388 population of registered PREMIS projects and programs (PREMIS Maintenance
389 Activity 2010). Of the organizations included in this study (See Table 1), four were

Table 1 Participating organizations

Participants (P)	Organization (O)	Organization type	Implementation type
P1O1[a]	Organization 1 (O1)	University	Project/full program
P2O2, P3O2	Organization 2 (O2)	National archive or library	Full program
P4O3, P5O3	Organization 3 (O3)	University	Full program
P6O4	Organization 4 (O4)	University	Project
P7O5	Organization 5 (O5)	National archive or library	Project
P8O6	Organization 6 (O6)	University	Project/full program
P9O7	Organization 7 (O7)	National archive or library	Full program
P10O8	Organization 8 (O8)	Commercial vendor	Project
P11O9	Organization (O9)	University research center	Project/full program
P12O10	Organization (O10)	Consortium	Full program
P13O11	Organization (O11)	National archive or library	Full program

[a] The numbering scheme is used to uniquely identify each participant interviewed in this study by giving each participant a number and a link to each participant's organization. For example, Participant 1 (P1) works for Organization (O1)—hence P1O1.

national archives or libraries, four were universities, one was a commercial vendor, one was a consortium, and one was a university research center. One of the organizations included in this study, Organization 2 (O2), was a client of the commercial vendor, Organization 8 (O8), and used the vendor's product in their effort to implement PREMIS. Thus, O2 and O8 represent one program on the PREMIS Implementation Registry. Organizations 1, 6, and 9 had experience implementing PREMIS in project and full program contexts. Organizations 2, 3, 7, 10, and 11 had experience in full program implementation of PREMIS. Organizations 4, 5, and 8 only had experience implementing PREMIS in a project context.

Factor construct: Managerial interventions

Managerial interventions are "actions taken and resources made available by managers" to facilitate secondary adoption, including policy decisions such as mandating usage, providing training, and providing support (Gallivan 2001 p 61). Participants in this study cited several examples of managerial interventions. At several sites (O1, O2, O3, O4, O7, O10, and O11), managers making the primary decision to adopt PREMIS engaged in high-level discussions about implementing PREMIS with select staff. This suggests that managers assessed the ability of their organizations to implement PREMIS during primary adoption. Often, one result of these consultations was a managerial decision to add additional resources, specifically staff with project management and programming skills, to expedite implementation. For example, managers at Organizations 2 and 3 hired staff to help with PREMIS implementation. Interviewees P2O2 and P4O3 described their expertise in programming, and they both noted the necessity of this skill. P3O2 and P5O3 possessed project management skills, as evidenced by their years of experience working in libraries addressing various information systems issues. These were all new hires to support

PREMIS implementation. The importance of managers hiring employees with programming expertise is perhaps best captured by P5O3's statement; "when it came down to it, [P4O3] was instrumental in actually making [PREMIS implementation] happen, because I think there's a lot of programming that's involved in actually implementing PREMIS functionality into a repository system."

Managerial intervention was also evident at Organization 6 where managers supported staff involvement with community-based PREMIS standard development work:

> [P]eople, in terms of upper management, they supported my training, my being involved in the PREMIS Working Group, going to meetings, they supported my travel, and let me spend my time on [PREMIS], and you know, talking with colleagues, and, so, you know, I think there was a lot of support for [PREMIS] (P8O6).

For the managers, the payoff was that P8O6 developed a thorough understanding of PREMIS and was able to make sure that PREMIS development activities suited their organization. Additionally, P8O6 was able to provide clarification to colleagues concerning the rationale behind the PREMIS data dictionary and schema.

Factor construct: Subjective norms

Subjective norms "describe individuals' beliefs about the expectations of relevant others regarding their own secondary adoption behavior" (Gallivan 2001 p 61). Participants cited subjective norms as influential to secondary adoption of PREMIS. For example, in Organization 2, staff members' beliefs about managers' expectations of them during PREMIS implementation were important. P3O2 noted, "[o]ur boss's boss's boss … in a meeting here, when she was introducing herself, told us it was okay to fail, but fail quickly. So, that's kind of the attitude, is, we're going to put some stuff in place, and if we fail, the community will benefit from our failure." In this example, the manager gave staff license to try many things, and fail if need be, in order to try to make PREMIS work for their organization. The manager's statement influenced staff members' beliefs about how she expected them to approach PREMIS implementation. This "fail, but fail quickly" endorsement was critical to implementation because, as a result, P2O2 and P3O2 were not reluctant to try different things in order to get PREMIS to work—knowing that management recognized the need for experimentation.

Co-workers' expectations of how to approach the task of PREMIS implementation were also key to secondary adoption. In Organization 3, P4O3 stated, "we had these high level goals, and we all agreed about them, and so there was a mindset for the group that we're going to take [adoption] as far as we can, and so the programmers were just as invested … as the archivists." According to P4O3, the shared belief that everyone was in the PREMIS implementation process together was very motivational. A co-worker (P4O3) noted that his boss also possessed this mindset and provided "enough time and resources." As a result, P4O3 believed that all of this would lead not only to effective use of PREMIS, but also to better a repository system.

458 *Factor construct: Facilitating conditions*

459 Gallivan (2001) identifies facilitating conditions as factors that make implemen-
460 tation more or less likely to occur, such as specific attributes at the (1) innovation,
461 (2) organization, and (3) individual levels (p 61).

462 *Innovation attributes* Innovation attributes are characteristics of an innovation that
463 make it more or less likely for the innovation to be implemented (Gallivan 2001
464 p 61). Participants cited the ability of PREMIS to complement other technology
465 standards currently used by their organizations as an innovation attribute. Specif-
466 ically, participants cited use of PREMIS in concert with other metadata standards,
467 including, but not limited to: the metadata encoding and transmission standard
468 (METS) and the metadata for images in XML (MIX) Standard (P1O1, P2O2, P4O3,
469 P6O4, P7O5, P8O6, P9O7, P10O8, P11O9, and P12O10); encoded archival
470 description (EAD) (P9O7); the metadata object description schema (MODS)
471 Standard (P7O5, P4O3, and P6O4); Dublin Core (P4O3, P3O2, and P10O8); XML
472 digital signatures (P7O5); and the data document initiative II (DDI 2) (P13O11). The
473 fact that PREMIS complemented other metadata standards made it easier for
474 PREMIS to work with existing or developing preservation repository systems.

475 *Organization attributes* Organization attributes are characteristics of an organi-
476 zation that make an innovation more or less likely to be implemented (Gallivan
477 2001 p 61). In some cases, the status of an organization's preservation repository
478 was seen as an organization attribute. Organizations that were in the process of
479 making significant changes to or creating entirely new preservation repository
480 systems and software were well suited to engage in implementation, because these
481 organizations were in the midst of changes and could adapt more easily to PREMIS
482 specifications (P8O6, P1O1, P2O2, P3O2, P4O3, P5O3, P7O5, P11O9, and P10O8).
483 For example, as P11O9 stated:

484 We are in the process of updating our underlying system […] A few years ago,
485 we decided to start working toward OAIS compliance … and so we started
486 talking about and thinking about and actually did a few internal projects, to
487 figure out, this actually started before PREMIS was even released, … what
488 [information] we thought we should be keeping, and then actually, the first
489 thing we did with PREMIS was compare our list of what we thought we
490 should be keeping with what PREMIS had available to see if they were
491 compatible, and they were.

492 In order to become OAIS compliant, P11O9 stated that one of the areas requiring
493 alteration was preservation metadata. P11O9 and her colleagues decided to use PREMIS
494 for the information they needed, and then began the process of implementing it.
495 System flexibility was another facilitating factor. For example, P4O3 stated that,
496 "in the absence of like, real restrictions from the software we were using, we chose
497 [PREMIS] as a format," and P5O3 stated, "because we were doing something like
498 custom-built here we could use [PREMIS]."

499 *Individual attributes* Individual attributes are characteristics of individuals within
500 an organization that make an innovation more or less likely to be implemented
501 (Gallivan 2001 p 61). The data suggest that when individuals are motivated to seek
502 out formal and informal mechanisms to deepen their understanding of PREMIS, this
503 has a positive effect on implementation. Seven participants acknowledged that
504 during implementation they joined the PREMIS Implementers' Group listserv (i.e.,
505 the PIG list) and utilized this resource by posting messages, reading messages, or
506 both, and they utilized resources on the PREMIS maintenance activity website
507 frequently (P8O6, P9O7, P12O10, P2O2, P3O2, P4O3, and P5O3). Utilizing these
508 resources aided them in implementation at their organizations by being able to ask
509 other listserv members specific questions about implementation and downloading
510 the data dictionary again if ever they lost their copies. Several participants noted
511 that they communicated with PREMIS Working Group and Editorial Committee
512 members and that these interactions were also influential to implementation (P1O1,
513 P3O2, P7O5, P8O6, P10O8, P11O9, and P12O10):

514   [m]e and our application vendor have emailed [one of the PREMIS Editorial
515   Committee Members] with specific questions about PREMIS, you know, what
516   do you guys mean by this? (P3O2)

517   [o]bviously we have the extra benefit of, at the time, [one of the PREMIS
518   Working Group members] was just down the hall. So, it certainly made
519   discussing PREMIS a lot easier (P7O5).

520 Similarly, four participants noted that they communicated with implementers at
521 other organizations, and that these interactions were influential to implementation
522 (P1O1, P3O2, P8O6, and P10O8). P2O2 thought talking with implementers at other
523 organizations was particularly useful because he "knew the right people" to talk to
524 and knew that they were "in the same place" in the PREMIS implementation
525 process as he was. By being able to discuss the rationale behind the PREMIS data
526 dictionary and ask questions about specific implementation choices and conse-
527 quences, participants found reaching out to PREMIS Working Group members,
528 PREMIS Editorial Committee members, and implementers at other organizations
529 helpful in advancing implementation at their organizations.

530 *Process construct: initiation*

531 Initiation refers to the process of active and/or passive scanning of organizational
532 problems/opportunities and IT solutions (Cooper and Zmud 1990). During this time,
533 pressure to change evolves from either organizational need (pull), technological
534 innovation (push), or both, and, as a result, a match is found between an IT solution
535 and its application in an organization (Cooper and Zmud 1990, p 124). Data from all
536 of the organizations in this study suggest that initiation took place during PREMIS
537 implementation. Participants spoke about the initiation phase in terms of both
538 organizational need (pull), specifically to address digital preservation information
539 needs, and technological innovation (push), in which use of PREMIS was proposed
540 as the solution:

541 The IT Department saw the need of keeping preservation metadata when
542 implementing applications for digital preservation. It was then decided that
543 PREMIS should be used since it is the most widely accepted standard for
544 preservation metadata (P9O7).

545 In this example, P9O7 describes the pull as the need for keeping preser ation
546 metadata and using PREMIS as the push because it is a widely accepted standard for
547 preservation metadata that staff believed could satisfy Organization 7's needs. In
548 another example, P6O4 describes pull as the need to develop a packaging profile for
549 the digital objects they preserve and the push as PREMIS because there was no
550 other viable option for use of a standard that was both supported by the Library of
551 Congress and for preservation metadata:

552 We had this … system, focused on preservation, and the first thing we decided
553 we needed to do was come up with a packaging profile, and METS seemed to
554 be the natural choice for that … and … we settled on PREMIS for preservation
555 metadata, partially [because we were partnering with the Library of Congress,
556 so we wanted to try to use the standards they support], and also because there
557 really wasn't anything else available at the time.

559 *Process construct: Adoption*

560 Adoption refers to the negotiation process which ensues to get organizational
561 backing and to invest the necessary resources throughout the implementation effort
562 (Cooper and Zmud 1990, p 124). Ongoing negotiations were a feature at two of the
563 organizations (P1O1, P11O9). P1O1 stated,

564 The process we went through, was a process of pairing, starting with what we
565 first thought was going to be of interest [i.e, initiation], and then, driven by the
566 reality, the economic reality of time and money and personnel, we've slimmed
567 down to the point where it's what we can reasonably do automatically. We had
568 to face the reality of the future is going to get only what we are capable of
569 giving the future, and not more, which sounds sort of like a tautology, but we
570 didn't know that in the beginning.

571 During these discussions at Organization 1, staff realized the economic implications
572 of full program PREMIS deployment and scaled back their plans to better align with
573 organizational resources. During initiation, P1O1 and his colleagues considered how
574 to use PREMIS in light of all they wanted, but during conversations in the adoption
575 process, what was economically feasible became clearer, and these discussions led
576 to decisions to limit the scope of PREMIS use.

577 During adoption at Organization 9, P11O9 and her colleagues discussed and then
578 applied for external funding in order to amass the resources necessary to
579 accommodate PREMIS implementation:

580 The next step was to get a grant, and the grant was to test and demonstrate
581 implementation of an Archival Information Package. And the Archival
582 Information Package would have data, and it would have, ummm, you know,

583 all that various kinds of metadata, and so that's where the METS, PREMIS,
584 ISO thing came into play, and so that was sort of a demonstration.

585 Beyond these examples, other participants did not address an adoption process as
586 defined in this sub-section. Perhaps the reason P1O1 mentioned this process is
587 because he had been involved in PREMIS implementation from the onset. In
588 contrast, several other participants in this study (P2O2, P3O2, P4O3, P5O3, P9O7,
589 and P13O11) were hired after PREMIS implementation began at their organizations.
590 As such, these participants may not have mentioned this process during the
591 interviews either because it had already occurred before they were employed or they
592 were not involved in this particular process.

593 *Process construct: Adaptation*

594 Adaptation is when an innovation is "re-invented so as to accommodate the
595 organization's needs and structure more closely" (Rogers 2003 p 424). Adaptation
596 can also refer to changes in the organization itself as a result of the innovation (Van
597 de Ven 1986; Leonard-Barton 1988). All organizations experienced adaptation.
598 Adaptation of PREMIS to work with other metadata schemas was most
599 frequently cited. For Organization 2, this type of adaptation seemed to be standard:

600 They've gone through and adopted a lot of [PREMIS] in a practical
601 application way, and, so, they actually take PREMIS elements and wrap them
602 in with other things like Dublin Core and other types of metadata in a schema
603 that they've developed (P3O2).

604 Organization 1 finished one project in which PREMIS was adapted to work within
605 METS to represent technical metadata; "[w]e used PREMIS embedded in METS …
606 and our principle was we didn't want to duplicate any metadata within the METS
607 file. So anything that was covered by METS we excluded from our PREMIS"
608 (P1O1). In a subsequent collaborative project with other organizations, P1O1
609 adapted PREMIS to track provenance information about digital objects as they are
610 transmitted among the participating organizations. In this project, P1O1 and his
611 colleagues adapted PREMIS to work outside of METS.
612 In Organization 3, development of the entire repository system and PREMIS
613 implementation went hand in hand. This provides some evidence for organizational
614 changes as a result of PREMIS implementation:

615 We looked at [the PREMIS] model early on and mapped it to FEDORA in a
616 lot of ways. So I'd say [PREMIS] influenced the design of our FEDORA
617 implementation on a high level, and on a low level, we sort of iteratively
618 improved our events[2] (P4O3).

2FL01 [2] Here P4O3 is referring to PREMIS events. PREMIS events correspond to the PREMIS event entity
2FL02 which "aggregates information about actions that affect objects in the repository. An accurate and
2FL03 trustworthy record of events is critical for maintaining the digital provenance of an object, which in turn is
2FL04 important in demonstrating the authenticity of the object. The information that can be recorded about
2FL05 events includes: a unique identifier for the event (type and value); the type of event (creation, ingestion,

620 *Process construct: Acceptance*

621 Acceptance refers to the process in which organizational members are induced to
622 commit to an innovation's usage, and the IT application is employed in
623 organizational work (Cooper and Zmud 1990 p 124). One participant (P7O5)
624 stated that his boss encouraged all employees in his department to use standards,
625 and this, in part, influenced his use of PREMIS. But for the most part, participants
626 used PREMIS because it was a standard (O2, O7, O11). Because participants were
627 not aware of another standard for preservation metadata, there was no alternative,
628 other than inventing or maintaining home-grown, ad hoc means of capturing and
629 representing preservation metadata for their digital objects. The latter part of
630 acceptance, in which the IT application is employed in organizational work, is
631 supported by additional data in "Process construct: routinization".
632   One participant (P7O5) shared details about why the acceptance process went
633 unfavorably in a full program context at his organization. P7O5 was instrumental in
634 implementing PREMIS in a project context, but decided not to use PREMIS in a full
635 program context based on his project experience. When asked, "[d]oes using
636 PREMIS advance your institution's goals with respect to preservation of digital
637 objects?" P7O5 responded,

638   I don't think PREMIS itself added anything to the process. We just as easily,
639   more easily could have encoded the data we wanted to in our own schema as
640   opposed to using something like PREMIS. PREMIS actually, like METS or
641   MODS, made our job of validating our digital objects much more complicated.

642 According to P7O5, creating home-grown mechanisms for the capture and
643 representation of preservation metadata was easier than using PREMIS, and he
644 and his colleagues ultimately chose home-grown means of handling preservation
645 metadata. Although Organization 5 did not accept PREMIS at a full program level,
646 P7O5 said that their experience with PREMIS influenced their current practice of
647 placing a lot of emphasis on keeping track of the fixity of files so that they know
648 their attempts at preserving collections are successful.

649 *Process construct: Experimentation*

650 Experimentation refers to a testing process in which staff test a technology standard
651 on a small scale before attempting to implement it within an organization's systems
652 and use trial and error to assess fit throughout the implementation process. Though
653 this construct was not proposed as part of Gallivan's framework, it is proposed here
654 in response to the data we collected. Nearly, all organizations seeking full program
655 PREMIS implementation (O2, O3, O6, O7, O9, O10) were actively engaged in
656 experimentation at the time of this study.

2FL06
2FL07 Footnote 2 continued

2FL08 migration, etc.); the date and time the event occurred; a detailed description of the event; a coded outcome
2FL09 of the event; a more detailed description of the outcome, etc." (Caplan 2009, p 10).

657   Participants identified experimentation as a critical step occurring before and
658 building directly upon prior implementation processes:

659   We had a pilot repository that [grew out of our completed project] testbed,
660   where we used essentially the same PREMIS implementation that we had
661   developed as our combination of METS and PREMIS within METS as an
662   object descriptor accompanying each file that we stored. We scrapped that
663   repository and are now building another one (P1O1).

664   P1O1 took what he learned from the PREMIS project he had completed and
665 applied it to building a pilot repository. He then took what he learned from the
666 experience of building a pilot repository to build a full program repository system.
667 Although he was in the beginning phases of constructing this new repository, he was
668 already making preparations for the role PREMIS would play in it, namely that
669 PREMIS would be used to track specific preservation activities:

670   At the moment, there is no PREMIS metadata going into [the new] repository
671   because it's still in the building phase. I'm currently building a PREMIS
672   events[3] database that will track the events that happen within the archive, but
673   outside the archive. So, theoretically, we will end up with technical metadata
674   produced from JHOVE [i.e, JSTOR/Harvard Object Validation Environment],
675   or by descriptive metadata that's produced wherever depending on who
676   creates the objects in the first place, and then there will be [PREMIS] event
677   metadata, along with things like, of course, [PREMIS] agent,[4] and you know,
678   we'll flesh it out as we can.

679   Organization 2 was in the experimentation phase. P2O2 and P3O2 were in the
680 process of checking the accuracy of PREMIS adaptations related to capturing
681 information about preservation activities (e.g., migration) before moving on to other
682 PREMIS implementation processes:

683   We are still, this very minute, and this very day, we are still in the process of
684   testing the phase 2 functionality that the developers have given us, which means
685   we are spending a lot of time looking in great detail at the [PREMIS] data model
686   and at what should be happening to populate the data model and how the data
687   model should be driving functionality. [...] I mean, just know currently we're in
688   the job of finding defects ... which means it's not fully nailed down yet (P2O2).

689   Once P2O2 and P3O2 ascertain that PREMIS is capturing the information they
690 need it to capture during ingest, they will add new parts of PREMIS to their
691 program. At that point, making further adaptations to their use of PREMIS will be
692 difficult and highly unlikely.
693   Several participants cited that the experimentation process often involved the
694 creation and testing of use cases (also referred to as prototypes, specifications (i.e.,
695 specs), or templates) (P2O2, P7O5, P8O6, and P11O9):

3FL01   [3] See footnote 3.

4FL01   [4] PREMIS agents are "actors that have roles in events and in rights statements.... Agents can be people,
4FL02 organizations, or software applications" (Caplan 2009 p 11).

696 The defining factor I guess for whether we use PREMIS elements or not within
697 the system is we have to define a use case for it and show how we will use it,
698 would use, and what value it brings for the extra overhead of developing it
699 within the system (P2O2).

700 We created prototypes with PREMIS for, let's see, it was kind of a two step
701 process, for each type of format. So textual resources was one sort of format.
702 Audio files was another format. Geospatial was another format. So, for each of
703 those formats, there was a prototype, or kind of a spec is what I would call it,
704 that was created. For each project there was an assessment made for how
705 PREMIS would fit that prototype, if that makes sense. So the first project
706 where there was a new format involved more prototyping really than
707 subsequent projects with similar formats (P8O6).

708 We shared what we called templates, which were example documents that
709 showed and annotated the use of how we would encode our digital objects. So,
710 you know, the thing that people would look at is an example METS record
711 which contained some PREMIS in it used the way we intended to use
712 PREMIS. So that's how we communicated, you know, discussed our use of
713 PREMIS (P7O5).

714   The creation and testing of these use cases during the experimentation process
715 gave participants valuable preliminary experience in assessing the extent to which
716 they could use PREMIS to capture and represent preservation metadata for the
717 digital objects they preserve without having to use their entire collections or engage
718 their entire program. Participants learned from their experiences during experi-
719 mentation, which made future adaptations of PREMIS easier and advanced
720 subsequent implementation processes (P1O1, P8O6, P9O7, and P11O9).

721 *Process construct: Routinization*

722 Routinization refers to a process by which use of an innovation becomes a normal
723 activity; the organization's governance systems, processes, and routines adjust and
724 the IT application is no longer perceived as something out of the ordinary (Cooper
725 and Zmud 1990, p 124). The data suggest that in some organizations, routinization
726 had already taken place (P8O6, P9O7, and P12O10): "Use of PREMIS is
727 implemented in our applications for managing digital preservation. Currently,
728 PREMIS information is created and maintained by our applications … ingest
729 control and our archival storage system" (P9O7).
730   In four organizations, routinization had either not yet started or was incomplete
731 (O1, O2, O3, and O9). When asked, "[i]s PREMIS embedded in your organization's
732 preservation systems and protocols?" P11O9 responded, "not quite yet." P11O9
733 gave this response because, at her organization, they had successfully completed a
734 proof of concept to demonstrate that PREMIS could represent the information they
735 needed for the kinds of digital objects they preserve, but had not completed the
736 process of "operationalizing" PREMIS within Organization 9's systems. As of the
737 time of this study, Organizations 2 and 3 had not yet routinized PREMIS in their

738 repository systems because they were still testing them, and Organization 1 had not
739 yet routinized PREMIS because P1O1 was in the beginning stages of constructing a
740 new repository along with an accompanying database which would record
741 information about preservation activities using PREMIS.

Process construct: Infusion

743 Infusion, in which organizational effectiveness is increased by using an IT
744 application in a more comprehensive and integrated manner to support higher level
745 aspects of work, can be characterized by three different facets: *extensive use* of an
746 innovation (i.e., using more technology features); more *integrative use* (i.e., using
747 technology to create new workflow linkages among tasks); and/or *emergent use*
748 (i.e., using technology to perform tasks not previously considered possible) (Cooper
749 and Zmud 1990 pp 124–125; Saga and Zmud 1994).
750 No organization in this study uses the PREMIS data dictionary and its
751 accompanying schema in their entirety. However, several organizations use PREMIS
752 extensively by applying their specifications for use of PREMIS to all objects within
753 their projects/programs:

754 [S]ince 2010, PREMIS metadata is being registered automatically when
755 [Archival Information Packages] are created and stored in our archival storage
756 systems (P9O7).
757 [PREMIS] [e]vents are captured as objects pass through the ingest process
758 (P13O11).
759 We use PREMIS in [our] project for some of the metadata for the digitized
760 [materials] that we collect (P7O5).

761 The data support both integrative and emergent use of PREMIS. In terms of
762 integrative use, several participants cited use of PREMIS by embedding PREMIS in
763 other metadata standards the organizations used (see "Process construct: adapta-
764 tion") and placing these formalized adaptations within organizational systems
765 ("Process construct: Routinization"). Emergent use was evidenced when partici-
766 pants discussed use of PREMIS in terms of being able to reach specific preservation
767 goals and document specific preservation activities, including: tracking provenance,
768 representing technical metadata, and linking digital objects to rights information
769 (P1O1, P5O4, P11O9, P2O2, and P3O2). For example, when asked, "[d]oes using
770 PREMIS advance your organization's goals with respect to preservation of digital
771 objects?" P8O6 responded, "[y]eah, I really think it does. I mean, I think,
772 particularly when it comes to finding a place to just keep references and keep the
773 basics together, like rights, and like IDs. I think [PREMIS] can be very simple, and
774 automated, and that furthers [our] goals."
775 Based on interviewee responses, only one organization sought to verify emergent
776 use by seeking assessment from their data providers:

777 I want to say restoring, but it's not the same sense. Giving back the product,
778 giving back the resource to the original data provider, by reconstituting the
779 digital resource and making sure that we close the loop. You know, that they

780 got back what they thought they should be getting back. So PREMIS was
781 critical in that in order to give them back their original name, for instance. I
782 mean, just key. They could run it through their presentation system or
783 whatever they were doing with them. And so I suppose another step of that
784 would be, reconstituting is a step, giving it back to the data provider is a step,
785 and having them reuse it. So, in other words evaluate the reconstituted […]
786 and then giving feedback to us (P8O6).

787 According to P8O6, all of the work she and her colleagues did to initiate, adopt,
788 adapt, accept, and routinize PREMIS would be a failure unless the original data
789 providers would be able to reuse the data they provided, and also understand what
790 effect, if any, preservation activities have had on the data they provided since the
791 data became a part of Organization 6's collections.

792 **Discussion**

793 The purpose of this study was to address the research questions: *From the*
794 *perspective of secondary adopters, what happens during secondary adoption of a*
795 *technology standard? Specifically, what processes occur during secondary adoption*
796 *of technology standards? What factors influence these processes, and what is their*
797 *effect?* In particular, we were interested in the organizational factors and processes
798 that come into play during implementation and the interplay among these elements
799 that influence full adoption of a technology standard. We used Gallivan's (2001)
800 conceptual framework, which models secondary adoption of information technol-
801 ogy more broadly, to understand secondary adoption of technology standards in
802 archives, using PREMIS as an example of a technology standard.
803 Based on interviewee responses, we found that a variety of factors and processes
804 seem to drive PREMIS secondary adoption. In terms of factors, there were
805 similarities and differences among the organizations highlighted in this study, such
806 as the level of management support, resource commitments, and assumptions about
807 how to attain a skilled workforce with programming and development expertise. In
808 terms of processes, there were also similarities and differences among organiza-
809 tions. Only two organizations (O7, O8) experienced all of the implementation stages
810 (e.g., initiation, adoption, adaptation, acceptance, experimentation, routinization,
811 and infusion). The others were not far enough along in the implementation process
812 to have experienced some of the latter stages (O1, O2, O3, and O9). All
813 organizations followed whatever stages sequentially. This suggests that the
814 outcomes and lessons learned from each stage of the implementation process were
815 important and built upon each other in meaningful ways.
816 By comparing data across these organizations, we have identified several themes:
817 strong support from top management (Theme A), resources committed (Theme B),
818 and cultural norms that encourage experimentation and learning (Theme C). These
819 all facilitate secondary adoption. Furthermore, some of these factors are more
820 important at different stages of the secondary adoption process (Theme D).

821 Participants perceived two aspects of implementation approaches as essential to
822 facilitating implementation of PREMIS, corresponding to Themes A and B:

823 • Theme A. Strong and clearly communicated top management support for
824   PREMIS facilitated implementation—including early stages (.e.g., initiation and
825   adoption) and later stages (e.g. adaptation, acceptance, experimentation,
826   routinization, and infusion).
827 • Theme B. Resources committed facilitated implementation.

828 As data from "Factor construct: managerial interventions" suggest, managerial
829 interventions and influence directly affected the adaptation and experimentation
830 stages of PREMIS implementation. Support from managers enabled P8O6 to get a
831 thorough understanding of PREMIS, which, in turn, positively affected PREMIS
832 implementation. Based on the support managers provided, P8O6 developed
833 expertise, which she subsequently used to develop scenarios for appropriate use
834 of PREMIS. She handed off these scenarios to other program staff who then
835 adapted, experimented with, routinized, and infused them. Managers' commitments
836 of additional resources, particularly hiring of new staff for programming and project
837 management, were also key to implementation. As P5O3 mentioned, none of the
838 technical work necessary to adapt, experiment, routinize, and then infuse PREMIS
839 within Organization 3's systems began until they hired P4O3, a programmer.

840 • Theme C. Cultural norms that encourage experimentation and learning facilitate
841   later stages of implementation.

842 As data from "Factor construct: subjective norms" suggests, subjective norms
843 facilitate implementation processes, such as adaptation and experimentation.
844 Furthermore, we found that subjective norms come from the top down as well as
845 from peers. The top down norms, though, appear to have more influence. For
846 example, P2O2 and P3O2 knew that management expected them to try different
847 things in order to implement PREMIS. P2O2 and P3O2 cited this "fail, but fail
848 quickly" endorsement as influential in their being able to adapt to and experiment
849 with PREMIS in order to get it to work as desired.

850 • Theme D. Some innovation, organization, and individual attributes do not
851   influence the early stages of secondary adoption (e.g., initiation and adoption);
852   however, they do affect later stages of secondary adoption (e.g., adaptation,
853   acceptance, experimentation, routinization, and infusion).

854 The fact that PREMIS had the innovation attributes of being flexible and able to
855 complement several other metadata standards proved to be crucial to organizations
856 in getting through the latter stages of implementation, including adaptation,
857 experimentation, routinization, and infusion. During each one of these stages,
858 participants found ways to use PREMIS to complement other metadata standards
859 that in aggregate shaped project/program preservation repository management
860 systems to suit organizations' needs. Participants mentioned specific examples of
861 their use of PREMIS along with other metadata standards which showed how
862 organizations have adapted PREMIS, routinized PREMIS by embedding it within
863 systems and infused PREMIS into their routines in order to keep track of

864 provenance, record technical metadata, and link digital objects to rights information
865 more effectively than before (P7O5, P10O8, P6O4, P11O9, and P8O6).

866   Although Gallivan designed his framework to explore secondary adoption of
867 information technology more broadly, we used Gallivan's framework to explore
868 secondary adoption of technology standards and found the framework helpful. As
869 evidence from the interview data suggests the organizations included in this study
870 participated or were planning to participate in all of Gallivan's processes of
871 secondary adoption. Factors highlighted in Gallivan's study including managerial
872 interventions, subjective norms, and facilitating conditions also affected organiza-
873 tions. Our data also suggest that certain aspects of Gallivan's model are not relevant
874 and may not apply to PREMIS implementation. We attribute this to a difference
875 between implementing information technology and implementing technology
876 standards. For example, in contrast to managers involved with implementation of
877 information technology (Gallivan 2001 p 66), most managers did not actively
878 provide resources to support training of employees in use of PREMIS. Perhaps this
879 was because PREMIS has more limited organizational applications and at most only
880 a handful of people in any organization would be "using" PREMIS at any one time.
881 Of course, one could also say that managers did not provide training in PREMIS
882 because they did not have the financial resources to provide such training.[5] Thus,
883 staff responsible for implementation of PREMIS must learn how to use PREMIS
884 "by doing," and learn from staff at other organizations about what does and does
885 not work when trying to implement PREMIS. Staff should also learn from other
886 institutions by analyzing PREMIS in METS application profiles registered on the
887 Library of Congress website. We speculate that, in contrast to information
888 technology, PREMIS is a technology standard that members of the digital
889 preservation community—a community of practice—created for the community
890 (Wenger et al. 2002). As such, members of this community are expected to develop
891 PREMIS based on their experiences, share their experiences with others, and report
892 feedback to the PREMIS Editorial Committee. Perhaps the only support managers
893 could provide to their staff for learning how to use PREMIS would be to pay for at
894 least one of their staff to attend a PREMIS tutorial or implementation fair.[6] During
895 these events, members of the PREMIS Editorial Committee provide a detailed
896 overview of the PREMIS data dictionary and schema, and current implementers
897 share case studies. Attending these events would enable staff to network, and
898 hopefully keep in touch to help one another through their PREMIS implementation
899 processes.

900   Of course, each implementer has to read the PREMIS data dictionary and its
901 accompanying XML schema in order to learn how to use PREMIS. However, the
902 data show that learning how to use PREMIS takes much more than this. For
903 example, when asked, "what sorts of things did you do/are you doing to learn how
904 to use PREMIS?" P11O9 replied,

5FL01 [5] The large firms included in Gallivan's study had millions of dollars to support training for information
5FL02 technology applications, whereas none of the organizations included in this study had that magnitude of
5FL03 resources to devote to training.

6FL01 [6] For more information about previous and upcoming PREMIS tutorials and implementation fairs go to
6FL02 the PREMIS maintenance activity website at http://www.loc.gov/standards/premis/.

Table 2 Proposed Model of PREMIS Implementation

Factors	Managerial interventions		Subjective norms	Facilitating conditions
Themes	A strong clear messages of management support	B measures for committed for support	C cultural norms that encourage experimentation	D Innovation organization and individual attributes
Processes				
Initiation	✔	✔	✔	
Adoption	✔	✔	✔	
Adaptation	✔	✔	✔	✔
Acceptance	✔	✔	✔	✔
Experimentation				✔
Routinization				✔
Infusion				✔

The table is a modified version of Gallivan's "secondary adoption and organizational assimilation processes" (see the center of Fig. 1) adapted to account for the context of PREMIS implementation

905 you mean aside from reading the spec, and doing the paper exercises, and then
906 doing a prototype? […] we had to make sure that when we created the METS
907 thing, that it actually, that the schema worked, and that it vetted okay. If you
908 think about that, having to vet against METS and PREMIS and ISO all at the
909 same time, there were some issues with that.

910 Simply put, implementers must also experiment with PREMIS in order to learn how
911 to use it and to learn how to best apply it in their organizations. Then, implementers
912 can routinize and infuse PREMIS in organizational systems. Based on our findings,
913 we modified Gallivan's framework, adding the experimentation construct because
914 of its importance in the context of secondary adoption of technology standards.

915 Table 2 presents a detailed model incorporating data as well as the themes and
916 constructs that emerged from this study, such as experimentation, along with
917 constructs derived from Gallivan's framework. In our adapted model, we attempt to
918 describe the relationships between the factors and processes involved in the
919 secondary adoption of PREMIS.

920 Managers send strong and clear messages of support and commit resources to
921 support PREMIS implementation. These attributes, in turn, can induce implementers
922 to commit to the adaptation of PREMIS within an organization's systems. Cultural
923 norms, which reinforce experimentation and learning, can also positively affect
924 experimentation and adaptation, which, in turn, affects routinization and infusion.

925 Innovation, organizational, and individual attributes also contribute to adaptation,
926 acceptance, experimentation, routinization, and infusion. For example, participants
927 identified PREMIS as lending itself to meeting key information needs for
928 organizations interested in preserving digital objects by being designed to represent
929 relationships among digital objects as well as to document specific preservation

930 activities. They also perceived PREMIS as agile in that it can complement other
931 standards that organizations use. Finally, we found that organizations with flexible
932 preservation repository management systems, those not yet in the production phase
933 of development of their preservation repository management systems, or those in the
934 process of creating new preservation repository systems and software, are all able to
935 adapt PREMIS and engage in secondary adoption of PREMIS more easily.
936 What does it mean to adopt a technology standard? In the case of PREMIS, it
937 does not mean that an institution has to use the entire data dictionary or data model.
938 Looking to DOI and MIS literature affords archivists the opportunity to define what
939 it means to adopt a technology standard more concretely. Using our framework
940 adapted from Gallivan (2001), archivists now have a means of understanding
941 implementation as a process as well as a definition for a secondary adopter—*one*
942 *who still desires to adopt a technology standard after successfully completing all*
943 *processes related to secondary adoption, including: initiation, adoption, adaptation,*
944 *acceptance, experimentation, routinization, and infusion.* The reason the definition
945 of secondary adopter has to be qualified as *one who still desires* to adopt a
946 technology standard after successfully completing all secondary adoption processes
947 is because sometimes, as P7O5 demonstrates, the result of completion of any one or
948 combination of secondary adoption processes is to undo primary adoption.

Conclusion

950 In this article, we applied the phenomenon of secondary adoption to technology
951 standards. What we found is that there are differences between the implementation
952 of IT and implementation of technology standards. While we cannot generalize our
953 findings to all technology standards, we do propose refinements to Gallivan's (2001)
954 existing hybrid factor/process model which illustrate the complex relationships
955 between factors and processes in the case of PREMIS. By refining this hybrid
956 framework, this article suggests a complex and, hopefully, a more realistic
957 framework that can explain the interplay among organizational context variables,
958 attributes of managers' implementation strategies, and other characteristics that, in
959 aggregate, shape secondary adoption of technology standards (as shown in Table 2).
960 This article also offers a rich description of multiple organizations implementing
961 PREMIS—an important technology standard for preservation metadata. Many
962 institutions have made the primary adoption decision to adopt PREMIS (Alemneh
963 2009), but few have yet fully implemented it.
964 Moving forward, we propose three recommendations for managers and
965 implementers with respect to secondary adoption of PREMIS. First, provide
966 positive managerial interventions. Not every institution is able to hire new staff, but
967 managers can support existing staff by encouraging experimentation and multiple
968 venues for learning during adaptation. Second, retain flexibility in one's preserva-
969 tion repository management systems beyond the prototyping stage and into
970 production to extend the experimentation period and allow for better infusion.
971 Third, it takes a village. View the PREMIS implementation community as a
972 learning community. Strengthen ties between PREMIS implementers and encourage

973 registration on the Library of Congress PREMIS Implementers Group and
974 participation in the PIG listserv. Register application profiles of PREMIS in METS
975 on the Library of Congress website. Sharing both positive and negative information
976 about the implementation and particularly the experimentation process will benefit
977 all institutions engaged in the secondary adoption process.

978 Most importantly, we argue that this study underscores the value of using
979 theoretical frameworks from DOI and MIS to better understand the social and
980 technical issues archivists face while implementing technology standards. In our case,
981 using Gallivan's framework required a bit of adaptation to suit an archival context.
982 Nonetheless, using Gallivan's framework was helpful for understanding implemen-
983 tation as a process, specifically for the processes that embody it and the factors that
984 affect it. We believe our study demonstrates that DOI and MIS offer methodologies
985 and diagnostic tools for assessing implementation of technology standards as a
986 process and archivists ought draw on these rich and well-developed methodologies.
987 PREMIS is not the first technology standard archivists have had to adopt and embed in
988 their preservation systems, and it certainly will not be the last. Therefore, it is to the
989 benefit of archival scholars and practitioners to draw upon established methodologies
990 for implementation and adapt them to analyze implementation as a process in archival
991 settings. Future studies could test our model to gauge its effectiveness in exploring
992 implementation of other technology standards in archives.

993 As with any study, there are limitations. In this study, we focused on institutions
994 that have decided to adopt PREMIS. This study does not research why institutions
995 did not adopt PREMIS. Future studies could explore why institutions decided not to
996 adopt PREMIS. Also, it is difficult to know how many organizations are actually
997 implementing PREMIS. Those listed on the PREMIS Implementation Registry must
998 initiate the registration process. Consequently, there could be many institutions that
999 are PREMIS implementers, but for whatever reason, decided not to initiate the
1000 registration process, and therefore are not listed. This limits the extent to which we
1001 can make generalizable claims about PREMIS implementers. Nevertheless, we do
1002 think our study has value in addressing the issue of implementation of technology
1003 standards. Whether or not we have a true representation of PREMIS implementers
1004 does not change the fact that we need methodologies to understand implementation
1005 of technology standards as a process, which is the primary aim of this paper.

Appendix: interview protocol

Section 1

1008 (1) What is your institution's mission with respect to preservation of digital
1009 objects?
1010 (2) What information does your institution think is important to know about each
1011 of the digital objects you are responsible for preserving?
1012 (3) What did you use before using PREMIS? How does PREMIS compare to what
1013 you were using before?
1014 (4) What metadata standards or schemes do you use at your institution?

1015 Section 2

1016 (5) What do you use PREMIS for?
1017 (6) Who made the decision to adopt PREMIS at your institution?
1018 (7) For how long have you been implementing PREMIS at your institution?
1019 (8) How does PREMIS interact with the other metadata standards you are using
1020   (i.e., such as METS)?
1021 (9) How many staff members are responsible for implementing PREMIS at your
1022   institution?
1023 (10) How would you describe the PREMIS implementation process at your
1024   institution (i.e., what steps are involved in the implementation of PREMIS at
1025   your institution)?
1026 (11) How easy or difficult has it been to use PREMIS to represent information that
1027   your institution thinks is necessary for preserving digital objects?
1028 (12) Are your institution's policies for preservation of digital objects reflected in
1029   your institution's current implementation of PREMIS? (Please provide
1030   examples)
1031 (13) How does your manager support use of PREMIS at your institution?
1032 (14) What sorts of things did you do/are you doing to learn how to use PREMIS?
1033 (15) Does using PREMIS make your job easier/better?
1034 (16) Does using PREMIS advance your institution's goals with respect to
1035   preservation of digital objects? How so?
1036 (17) Is PREMIS embedded in your institution's preservation systems and
1037   protocols?
1038 (18) What sorts of activities do you do to make sure that PREMIS is "working" as
1039   you desired or hoped it would?
1040 (19) Is there anything that PREMIS does not do that you wish it could do?
1041 (20) How often do you utilize resources on the Library of Congress' PREMIS
1042   Maintenance Activity website?
1043 (21) Are you a member of the PREMIS Implementers' Group, a free listserv
1044   called the PIG list?

1045

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