The Evolution of IT Management Standards in Digital Transformation – Current Status and Research Implications[1]

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Abstract. For more than three decades professional standards have been popular as guidance and orientation to manage IT organizations. Although major standards like ITIL and COBIT have been updated with several versions to reflect changing requirements, basic goals, concepts, and structures remained stable over time. In recent years this situation changed, when a number of new standards appeared to support new requirements for mastering digital transformation. This study explores the evolution of ITM standards during the last 20 years through analyzing a set of 60 formal, de facto, and emerging standards. Besides the rapid increase in number and update frequency starting in 2015, a shift of goals towards agility, lean management, and innovation was found. Finally, new problems and research questions raised by this evolution are presented.

Keywords: IT management, professional standard, framework, digital transformation.

1 Introduction

In the ongoing societal phenomenon known as digital transformation or digitalization, many organizations are constantly in search of guidance and support for successfully managing their individual transformations [1–3]. Driven by digital technologies (DT) that emerge and spread with increasing speed these organizations face a growing innovation pressure to stay competitive in a networked environment characterized by volatility, uncertainty, complexity and ambiguity (VUCA) [4]. Using DT to create innovative digital solutions requires an organization to incorporate the respective capabilities and practices [5]. As DT builds on more conventional information technology (IT) [6], the IT function of an organization consequently is involved in creating and implementing digital innovations. Hence, the discussion of the optimal role, alignment, governance, management and organization of IT (including DT) and the respective department has received many new impulses and contributions during recent years (e.g., [6–8]).

[1] **Note:** This is a preprint of a paper not peer reviewed and published yet. Feedback to the author is highly appreciated.

Against this background, professional management standards appear as promising means expected to provide reliable orientation and systematic guidance for a relevant field of management. The International Organization for Standardization (ISO) defines the term standard as a "document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or for their results, aimed at achieving the optimum degree of order in a given context" [9, p. 12]. Well-known examples of ISO standards for IT management (ITM) include ISO 20000 (IT service management), ISO 27000 (information security management), and ISO 38500 (IT governance). In contrast to the *formal standards* mandated by state-approved bodies, *de facto standards* arise from "unfettered market processes" [10, p. 154]. These processes might be initiated by an originator with professional and/or commercial interest ("sponsored") [10]. One of the most popular de facto standards for ITM, ITIL [11], was originally created by the UK Government's Central Computer and Telecommunications Agency as a set of recommended practices and since 2013 is owned ("sponsored") by the public-private joint venture AXELOS. While the consensus on de facto standards occurs from spreading popularity and practical use, a third category of *standard candidates* is still striving for the necessary spread to become an accepted standard. Nevertheless, the originator might promote its new candidate with the term "standard" right from the beginning. A recent example is provided by The Open Group (TOG) who published the first version of the ITM framework IT4IT as "standard" by declaration in 2015 [12, 13].

IT4IT is also an example for a new generation of ITM standards which explicitly addresses the changing role of the IT function in the course of the digital transformation [14]. Another one is VeriSM, which was introduced in 2017 as "a service management approach for the digital age" [15]. Around the same time SIAM emerged as an acronym for "Service Integration and Management" referring to a collection of practices for managing multiple external IT service providers ("multisourcing") [16]. Until 2019 the emergence of new ITM standard proposals focusing on digital transformation was also partly motivated by an aging ITIL, whose latest version then dated from 2011 and did not mention anything on Agile, DevOps and other new concepts that had become popular in the meantime. In 2019 ITIL4 was published, including many of the missing new concepts and other changes. In addition, others of the more traditional ITM and related standards faced major updates with references to digital transformation, for instance COBIT (2018), TOGAF (2018), or the project management (PM) standards PRINCE2 (2017) and PMBoK (2017).

As a result of this development, the number of available ITM standards has increased significantly, giving rise to a confusing landscape. In this situation, it has become difficult to recognize which standards are competing and which are complementing one another. Companies in search of an ITM standard for supporting their individual digital transformation may choose from a growing number of alternatives requiring increasing effort for evaluation.

The objectives of this study are threefold:

1. to provide an overview of the developments during the last 20 years and the current state in the field of professional ITM standards,
2. to explore the evolution of ITM standards in digital transformation, and

3. to conclude on new research directions towards an improved understanding of adopting and utilizing ITM standards.

The remainder of this article is structured in five main sections. The following section summarizes conceptual foundations and gives a short overview of the related work. The methodology for collecting and reviewing the standards is described in section 3. The fourth section presents the current state of professional ITM standards by listing the collected standards in four categories. Section 5 summarizes the findings drawn from a time-related and content-related analysis of the standards collection. Based on these findings the final section delineates future research directions related to the adaptation, implementation, and evaluation of ITM standards in digital transformation.

2 Conceptual Background and Related Work

Since the term standard is generally used in many different contexts, this section clarifies its meaning in the context of ITM. Its connections to other relevant concepts are illustrated to constitute a framework for the main investigation. Furthermore, a brief overview of related work is given.

2.1 Professional Standards and related Concepts

From a design science perspective [17], a standard is an agreed upon artefact resulting from a design process and describing a to-be state of a domain in reality. Ahlemann et al. [18, p. 293] regard standards as "socio-economic constructs reflecting a balance of perspective between stakeholders". The artefact intended to become a standard is often called a *framework*, similar to a conceptual or research framework. According to Jabareen [19, p. 51], a conceptual framework is "a construct of interlinked concepts […] in which each concept plays an integral role". In software engineering, a framework is considered as reusable design, consisting of components and patterns [20]. Design patterns describe "simple and elegant solutions to specific problems" [21, p. xi]. This points further to *reference models* which are "abstract representations of domain knowledge […] useful for capturing prescriptive and descriptive design knowledge for sociotechnical problems" [22, p. 736]. In addition, they are intended to support "companies in the design of company-specific solutions" [22, p. 736]. While scientific reference models and professional standards share these general attributes, a difference lies in the character of the respective design process. Professional standards usually are designed by practitioners based on practical experience. Although theoretical knowledge and current research may be incorporated, a formalized description and scientific rigor are less important. Upon completion of a framework as standard candidate, the early adopters will select the framework depending on its value proposition which is considerably enabled by the expert level of its authors. The successful further dissemination of a standard can be explained by the network effect theory, indicating that "each additional stakeholder applying a standard makes it more useful for the rest of the community" [18, p. 293]. This way, an increase of dissemination implies a positive

evaluation through practical use. Hence, a professional standard can be regarded as a special type of informal reference model validated through practical use.

Another term closely related to professional standards is *method.* PM standards are often identified as *methodologies* comprising prescriptive descriptions of process models and techniques for PM (e.g., [23]). The term method can be found synonymously for methodology (e.g., [24, 25]) as well as for specific procedures being part of a PM methodology (e.g., earned value analysis [26]). The more comprehensive understanding of method (as with PM methodology) conforms to the concept of a *management method* based on situational method engineering (SME). Winter [27, p. 68] describes a management method as a construct to "guide choices within the 'plan-act-control' solution space of an organization in order to achieve certain (management) goals". A relation between method and framework is shown by Winter and Fischer [28] when they describe method(s) for design and evolution as constituting components of an enterprise architecture framework.

Eventually, *best practice* is yet another term that frequently is used in the context of professional management standards. ITIL is a well-known example which explicitly identifies itself as "best practice method" [29]. The definition of best practice provided by AXELOS describes "a way of working that has been proven to be successful by multiple organizations" [30, p. 2]. In management literature, best practice often is linked to improved performance of an organization [31]. Although being criticized for lacking evidence of cause and effect as well as generalization of results from individual case studies [31, 32], the concept is popular in both academia and practice until today (e.g., [33]). ISO prefers the term *good practice* [34] or (more recently) *recommended practice* [35] but also describes it as "the best way" of doing something [36, p. 3]. In relation to methods, best practice can be understood as an attribute that motivates the prescriptive character of a method. Figure 1 illustrates the relationships between the terms in a conceptual model.

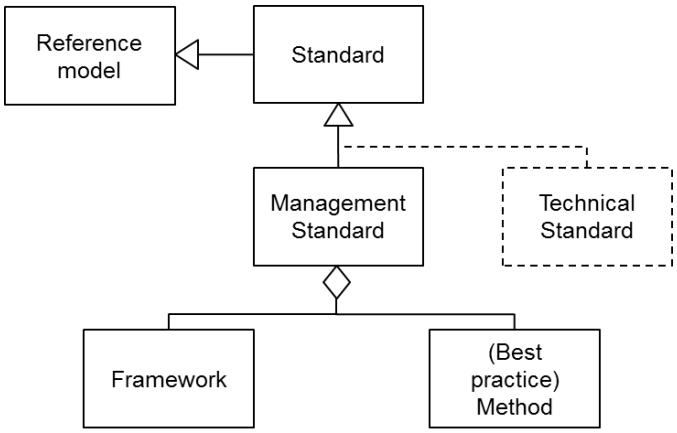

Fig. 1. Conceptual model of management standards and related concepts

2.2 Related work

Research on ITM standards can build on several decades of research in the wider context of general management frameworks and systems. In their literature review, Yadav and Sagar [37] analyze trends in performance measurement and management frameworks from 1991 to 2011 and propose a categorization for 26 frameworks based on broad themes. With a focus on software process improvement, Paulk [38] diagnosed a "quagmire" of process models and standards and discussed strategies for organizations how to integrate multiple frameworks. Later he extended the scope to IT-related quality management and process improvement and proposed a taxonomy to support understanding and comparing diverse frameworks [39]. The idea of overcoming the quagmire through integrating the diverse framework drove the development of Enterprise SPICE (Software Process Improvement and Capability Determination), a domain independent integrated model for enterprise-wide assessment and improvement [40]. Enterprise SPICE was accepted by ISO/IEC[2] as international standard 33071 in 2016, but is rooting deeply in traditional quality management concepts developed prior to the digital era (e.g., [41]).

Existing research on ITM standards often concentrates on certain subareas of ITM like IT governance (e.g., [42]) and IT service management (e.g., [43]) or even single standards like COBIT (e.g., [44]) and ITIL (e.g., [45]). Several authors empirically analyzed the dissemination of standards (e.g., [11, 46]) often connected to questions for perceived and measured benefits after standard implementation (e.g., [45, 47]). When multiple standards are considered, the purpose is usually evaluation (e.g., [48, 49]) or integration (e.g., [50, 51])

3 Research Method

In order to explore the evolution of ITM standards in digital transformation, a research process based on a systematic review was utilized. While the main review was targeted at exploring the standards, in the beginning relevant standards were identified through a preceding systematic literature review following the guidelines and recommendations by vom Brocke et al. [52]. In this review, both peer-reviewed academic and professional literature like white papers, blog posts or commercial websites were included. Non-academic literature was included because academic literature on new standard versions or candidates is sparse or not existent. The conceptual model of management standards was used to create standard-related search words through combination with the terms "information technology", "IT", "information systems", and "IS". For retrieving literature, the databases of Google Scholar, Microsoft Academic Search, IEEE Xplorer and SpringerLink as well as Google Web Search and the ISO Standards Catalogue were searched. In addition to the focus on ITM standards, the search scope was limited to international, technology-independent standards (and candidates) for which official or recognized standard documents or framework descriptions are publicly available in English language. Because of the focus on professional standards, frameworks and

[2] International Electrotechnical Commission.

methods proposed by scientists were excluded. Also excluded were frameworks exclusively developed by a single company like the Microsoft Operations Framework (MOF). Furthermore, standards explicitly targeted at software engineering (SE) were considered out of scope (e.g., ISO/IEC 12207 Software life cycle processes, ISO/IEC 15504 SPICE). Although, there are some close relations between SE and ITM, SE constitutes an autonomous topic. Relevant literature was selected from the original result set by checking title, key words, and abstract for references to ITM standards, before forward and backward search was performed. Eventually, the literature review revealed a total of 60 ITM standards and standard candidates which constituted the data set for the primary review.

In contrast to academic literature reviews, the primary review was performed on a data set consisting of the official or recognized standard documents and framework descriptions. As a first step towards an overview of the recent development and the current state of ITM standards a list was compiled, stating each standard with its main purpose (often reflected through the standard's name), the year of its first publication, and the year of the latest version or update. This list was used for a time-related analysis of ITM standard occurrences and revisions during a period of 20 years. Besides the time dimension, the standard contents were analyzed and categorized. Finally, the standards were compared regarding their central topics, investigating major similarities and differences. As a result of this process, a subject-based classification [53] was created.

4 The Current State of Professional IT Management Standards

Several authors have investigated the changing role of the IT function due to new requirements posed by digital transformation. Horlach et al. [54] describe and analyze the characteristics of a *digital IT* department compared to a traditional one. For the combination of the two operating models, Gartner coined the term *bimodal IT* in late 2013 [54], defining it as "the practice of managing two separate, coherent modes of IT delivery, one focused on stability and the other on agility. Mode 1 is traditional and sequential, emphasizing safety and accuracy. Mode 2 is exploratory and nonlinear, emphasizing agility and speed" [55]. According to Gartner, "both play an essential role in digital transformation" [55]. Haffke et al. add that digital transformation requires the IT function (especially in mode 2) to "become a driver of digital innovation" [56, p. 5460]. For the public sector, Ylinen and Pekkola [57] also highlight agility and additionally emphasize the importance of an adequate enterprise architecture to improve the agility of IT departments. Furthermore, they refer to the importance of a "strong" infrastructure and efficient collaboration between business and IT units, being clearly traditional requirements. Urbach et al. [8, p. 123] stress that "IT functions are required to cooperate proactively and early on with business departments to be able to develop and implement […] innovations jointly".

Obviously, the contemporary ITM standards could offer no guidance for responding to these new requirements. ITIL, as an example, had received a minor update in 2011 with only minimal content changes [58]. Furthermore, due to the consensual nature of standards, it takes time to evaluate and eventually integrate new ideas and concepts.

Nevertheless, along with the rising pressure on the IT function to master the challenges of digital transformation, a growing demand for new guidance towards successful practices was stimulating the efforts of standardization bodies and professional organizations to existing standards and create additional ones [59].

In the following, the collection of 60 current ITM standards as the result from the review of both academic and professional literature is presented. To reflect the reciprocal influences between digital transformation and ITM standards, each standard was assigned to one of four categories representing evolution stages in relation to digital transformation. Each category is represented with a separate table, listing the according standards. All four tables have a common structure, where each standard is listed with a short name (often an acronym), a long name (usually stating the main topic), year of publication, year of current version, availability of documentation, type of certification, and responsible body or organization. Publication year refers to the year of the first publication that describes a framework for professional use in ITM practice. Nevertheless, there might be earlier publications where foundations of the framework were published for a different purpose or audience. The origin of Scrum, as an example, is often attributed to Schwaber and Sutherland's presentation at the OOPSLA'95 workshop [60] although the term Scrum was already used in an article describing the basic approach for industrial product development by Takeuchi and Nonaka in 1986 [61]. Because of the focus on ITM in this study, the year 1995 is considered as publication year of Scrum. Current version indicates the year of the latest update or revision. Documentation (yes/no) refers to an official or commonly accepted description of the standard.[3] Certification (individual/organizational) indicates which type of certification is available. Finally, the organization is listed which provides the standard or has a leading reputation for it.[4]

[3] Yes in parenthesis means literature is available but no standardized description.

[4] In parenthesis when no standard document is provided by this or any other organization.

4.1 Traditional IT Management Standards

The traditional ITM standards have become popular before the new phenomenon of digitalization or digital transformation has occurred. They focus on improving IT performance based on criteria like efficiency, effectivity, and service quality. According to several empirical studies, the service-focused and process-oriented ITIL is the most popular representative of this category. Including ITIL, **Table 1** lists 20 standards assigned to this category.

Table 1. Traditional IT management standards

Short name	Long name/topic	Publ. year	Cur. year	Doc.	Cert.	Stand. org.
ASL2	Application Services Library	2000	2009	y	i	DID Fdn.[5]
BiSL	Business information Serv. Libr.	2002	2012	y	i	DID Fdn.
CMMI	Capability Maturity Model Integr.	2001	2018	y	i	CMMI Inst.
COBIT	Govern. of information & technol.	1996	2018	y	i	ISACA[6]
eTOM	Telco operations processes	2001	2017	y	i	TM Forum[7]
ITIL	IT service management	1989	2019	y	i	AXELOS
ISO16350	Application management	2015	2015	y	-	ISO/IEC
ISO19770	IT asset management	2012	2020	y	o	ISO/IEC
ISO20000	IT service management	2005	2020	y	o	ISO/IEC
ISO24760	Identity management	2011	2019	y	-	ISO/IEC
ISO250xy	System/software quality	2005	2019	y	-	ISO/IEC
ISO270xy	Information security	2009	2020	y	o	ISO/IEC
ISO29100	Information privacy	2011	2018	y	-	ISO/IEC
ISO29146	Access management	2016	2016	y	-	ISO/IEC
ISO33071	Process assessment for enterprise	2016	2016	y	-	ISO/IEC
ISO33074	Process assessment for (IT)SM	2020	2020	y	-	ISO/IEC
ISO3850x	IT governance	2008	2015	y	i	ISO/IEC
KCS	Knowledge-Centered Service	1996	2016	y	i	CfSI[8]
TOGAF	Enterprise architecture mgmt.	1995	2018	y	i	Open Group
ZeroOut	Zero Outage (IT)	2016	2020	y	i	ZOIS[9]

count: 20

[5] Digital Information Design Foundation.
[6] Previously an acronym for Information Systems Audit and Control Association. Since 2016 the organization uses ISACA as name only.
[7] Telemanagement Forum.
[8] Consortium for Service Innovation.
[9] Zero Outage Industry Standard Ltd.

4.2 ITM-related Standards

This category comprises standards for professional management disciplines that exist independently from ITM but are also used in ITM. Starting with project management, this further includes quality, risk, organizational change, knowledge, and innovation management. **Table 2** lists the 13 standards identified for this category.

Table 2. ITM-related standards

Short name	Long name/topic	Publ. year	Cur. year	Doc.	Cert.	Stand. org.
ACMP[10]	Change management	2014	2014	y	i	ACMP
BABoK	Business Analysis Body of Knowl.	2005	2015	y	i	IIBA[11]
ICB	IPMA[12] Competence Baseline	1998	2015	y	i	IPMA
ISO10006	Quality management in projects	1997	2017	y	-	ISO
ISO21500	Project management	2005	2020	y	-	ISO
ISO22301	Business continuity	2012	2019	y	o	ISO
ISO30401	Knowledge management	2018	2018	y	-	ISO
ISO31000	Risk management	2009	2018	y	-	ISO
ISO37500	Outsourcing	2014	2014	y	-	ISO
ISO56002	Innovation management	2019	2019	y	-	ISO
ISO900x	Quality management	1987	2018	y	o	ISO
PMBoK	Project Mgmt. Body of Knowl.	1996	2017	y	i	PMI[13]
PRINCE2	Project management	1989	2017	y	i	AXELOS

count: 13

[10] Association of Change Management Professionals.
[11] International Institute of Business Analysis.
[12] International Project Management Association.
[13] Project Management Institute.

4.3 Digital Technology Management Standards

The third category covers standards and frameworks that are either explicitly referring to digital transformation (e.g., VeriSM) or are dealing with concepts commonly referred to in characterizations of digital transformation (e.g., agile and lean). Since digital transformation is induced by digital technologies, this category is named digital technology management standards. The according 16 standards and frameworks are listed in **Table 3**.

Table 3. Digital technology management standards

Short name	Long name/topic	Publ. year	Cur. year	Doc.	Cert.	Stand. org.
AgileSHIFT	Scaling Agile	2018	2018	y	i	AXELOS
Agile SM	Agile (IT) service management	2017	2017	y	i	(DevOps Inst.)
DA	Disciplined Agile (hybrid)	2015	2018	y	i	PMI
DPBoK	Digital Practitioner Body of Know.	2019	2019	y	i	Open Group
FitSM	Lean IT service management	2015	2015	y	i	ITEMO
IT4IT	IT reference architecture	2015	2017	y	i	Open Group
LeSS	Large-Scale Scrum	2013	2015	y	i	The Less Co.
Nexus	Scaling Scrum	2015	2018	y	i	Scrum.org
P2Agile	PRINCE2 Agile (hybrid)	2015	2015	y	i	AXELOS
Resilia	IT ("cyber") resilience	2015	2015	y	i	AXELOS
SAFe	Scaled Agile Framework	2011	2020	y	i	Scal. Ag., Inc.
Scrum	Agile product development	1995	2017	y	i	Scrum.org
Scrum@S	Scrum@Scale	2017	2020	y	i	Scrum Inc.
SIAM	Service Integration & Management	2017	2017	y	i	Scopism Ltd.
TBM	Technology Business Management	2016	2016	y	i	TBM Council
VeriSM	IT service management	2017	2017	y	i	IFDC[14]

count: 16

4.4 Emerging Standards

Emerging standards are concepts, frameworks or practices that have become popular in ITM in the context of digital transformation without being standardized yet. A recent example is the DevOps concept for improving collaboration between IT development and operations teams based on agile principles. Although there is plenty of literature on DevOps [62], no common accepted standard has occurred yet. Items in this category must not necessarily be new in general, but have been applied or adapted to ITM only

[14] International Foundation for Digital Competences.

recently (e.g., Kanban/Lean IT). Although classified as emerging standards in **Table 4**, their further development to formal standards is still uncertain.

Table 4. Emerging standards

Short name	Long name/topic	Publ. year	Cur. year	Doc.	Cert.	Stand. org.
BMC	Business Model Canvas	2005	2015	(y)	-	-
CyBoK	Cyber Security Body of Knowl.	2020	2020	y	-	Univ. of Bristol
DevOps	Development & operations	2009	n/a	(y)	i	(DevOps Inst.)
DesThink	Design Thinking	1991 [15]	n/a	(y)	(i)	(d.school)
Flow	Flow Framework (IT value stream)	2018	2018	y	-	Tasktop
ISw	Intelligent Swarming	2019	2019	y	-	CfSI
ITR24586	Agile/DevOps	n/a	n/a	n	-	ISO/IEC
Kanban	Lean management	2003	n/a	(y)	-	-
Lean IT	Lean IT	2015	n/a	(y)	i	LITA[16]
Spotify	Scaling agile	2014	2014	(y)	-	Spotify
SRE	Site Reliability Engineering	2016	n/a	(y)	i	(DevOps Inst.)

count: 11

5 Findings

The review of the collected ITM standards and candidates revealed several relevant aspects that characterize their evolution during the last two decades. The first feature appearing from a time-related consideration is a strong increase regarding the number of standards between the years 2000 and 2020. The bar diagram in **Fig. 2** shows this trend for two data rows. The first one (light grey) shows the increase in number through publications of new standards per year (publ. year in tables 1-4). Starting in 2000 with 12 existing standards, the number increases to 59 standards in 2020.[17] The second data row (dark grey) focuses on current versions of the standards (cur. year in tables 1-4) to depict the current state of standard evolution. The diagram shows that the oldest standard version currently dates from 2009 (ASL2) while all other collected standards were published or updated during the following years.[18]

[15] First symposium on research in Design Thinking at Delft University, The Netherlands.
[16] Lean IT Association.
[17] ITR24586 not included because not published yet.
[18] DevOps, Design Thinking, Kanban and ITR24586 are not versioned, hence not included.

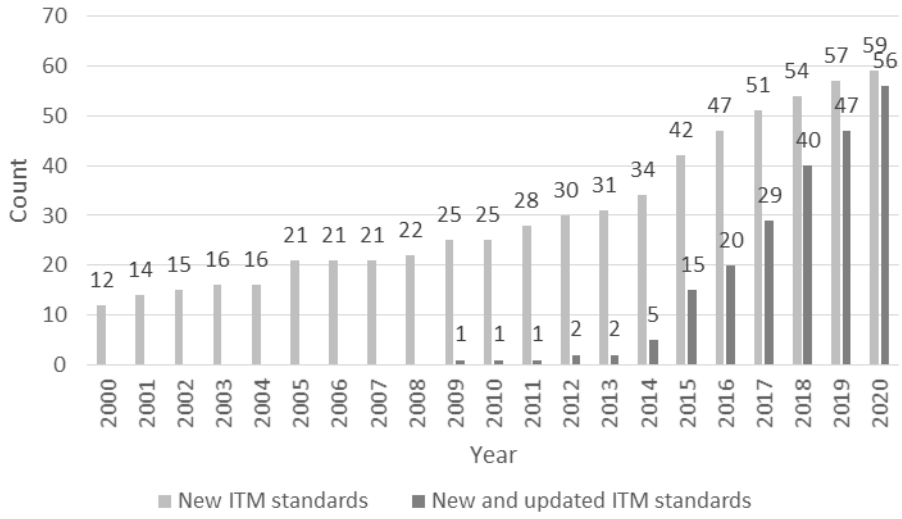

Fig. 2. Appearance of ITM standards and candidates from 2000 to 2020

The bar diagram also shows that from the year 2015 the frequency of standard publications and updates increased significantly compared to the years before. Of the 56 standards published or updated since 2009 only five (8.9%) standards were published or updated before the year 2015 while 51 (91.1%) appeared or were updated in or past 2015.

For a better understanding regarding the role of ITM standards in digital transformation, an additional content analysis was performed investigating the main topics and goals of the collected standards as stated in the standard documentations. The review of main topics allowed for a subject-based classification of the standards. The according subjects were created through identifying ITM subareas and related management areas that are essentially addressed by a standard (e.g., governance, service management, lean ITM). This resulted in 12 subjects with each standard assigned to exactly one subject via its primary topic. **Fig. 3** shows the full classification with all 60 standards and candidates assigned.

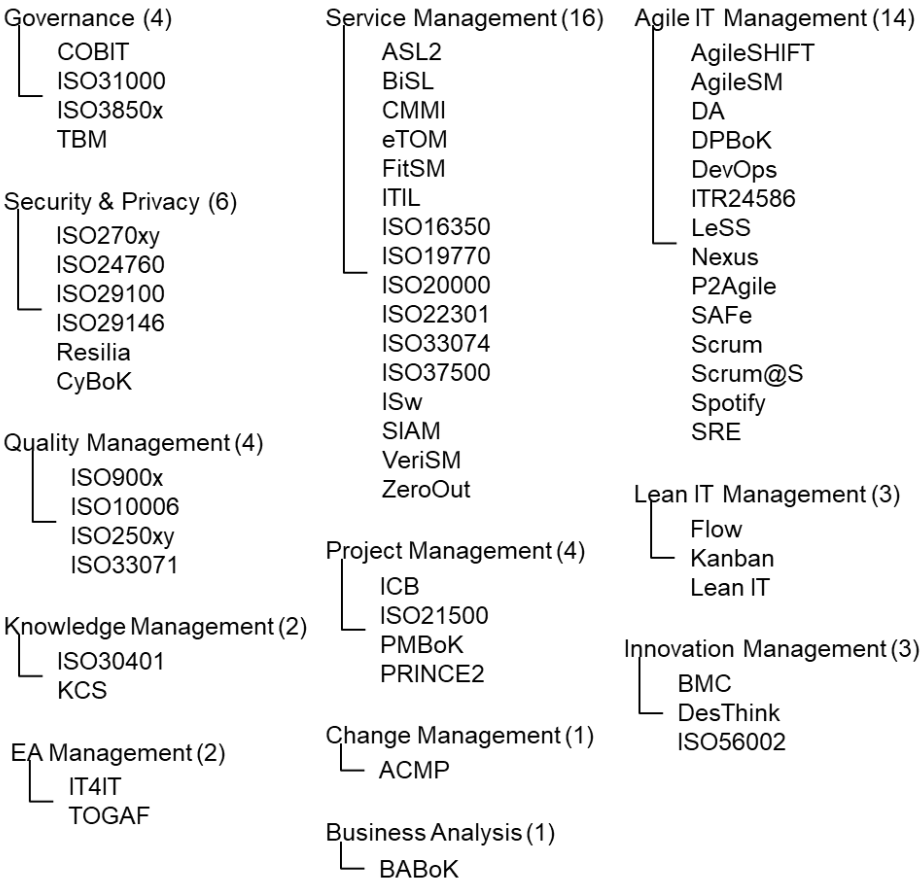

Fig. 3. Subject-based classification of current ITM standards

The subject-based classification shows that except for change management and business analysis several standards were found in each of the remaining ten management (sub)areas. While the content analysis showed that some of the members of the same class are competing (e.g., ITIL and VeriSM), others appear to be complementary (e.g., ITIL and SIAM). A detailed investigation of the relationships between the standards is necessary here, but was out of scope for this study.

A further finding from the content analysis is a shift of goals in support of digital transformation. Agile management principles [63] have clearly found their way from software development into ITM standards. This is obviously for the standards class of agile ITM standards (see **Fig. 3**). But also many traditional standards assigned to other classes have added agility to their established goals or reconciled their concepts and practices accordingly with their latest updates (e.g., ITIL, COBIT, PMBoK). Closely connected to agility and also supporting digital transformation are the goals of lean management and innovation, each constituting a separate class in the standards classification. Together with the class of agile ITM standards, these three classes represent

the evolution of ITM standards in support of digital transformation most prominently. But also all other new versions of ITM standards since the year 2015 clearly show adaptations induced by digital transformation. An interesting observation is, that these adaptions are not exclusively related to agile, lean, and innovation but also reflect the persistent importance of traditional ITM goals like availability, reliability, correctness, and security (e.g., in Resilia, SRE, ZeroOut).

6 Implications for Research

From the current state of the ITM standards evolution and the findings drawn, several interesting research problems arise. The quagmire of standards and frameworks observed by Paulk [38] in the first decade of the century still seems to exist, despite the development and publication of Enterprise SPICE. In the face of our VUCA world, an integration approach to combine multiple standards into one integrated super framework might not be able to meet the requirements of agility, lean management, and innovation. On the other hand, the standards quagmire might have transformed into a cornucopia, offering a rich choice of proven approaches and practices enabling individual responses to the new requirements of the digital era. This view on the ongoing evolution of ITM standards demands for a new approach of dealing with standards. IT organizations in search of support from ITM standards in the context of digital transformation need to find answers to the following questions:

1. *How should standards be selected to receive the best support for implementing a given strategy for digital transformation?*

Because of the rapidly growing number and the increasing update frequency of ITM standards, evaluation and selection require more and more time and effort. While IT service/solution provider working for external customers often situationally use the standards demanded by their customers, such reactive behavior is not appropriate for maximizing the potentials of standard use. New approaches for scouting, evaluating, and selecting standards could offer better results. A current example for a first response to the need for better orientation on available standards is the online compass for information security and data privacy, a website providing an overview on according standards jointly operated by the German Institute of Standardization (DIN) and the German IT industry association (Bitkom) [64].

2. *How can multiple standards be combined and tailored to increase their benefits and avoid conflicts?*

The growing number of standards also makes it more difficult to recognize which standards are competing and which are complementary or synergistic. Many standards explicitly require a tailoring to an organizations specific requirements (e.g., PRINCE2, VeriSM), some are recommended for concurrent use (e.g., ITIL and PRINCE2), and others are open for combination with further standards (e.g., Scrum). While the under-

lying flexibility is clearly an advantage for digital transformation, the process of tailoring, combining and maintaining a larger standards portfolio lacks methodological support.

3. What standards are already known or in use in the organization?

Depending on the size of an IT organization, it may not be trivial to create an accurate picture of what standards are currently in place in which parts of the corporation. Nevertheless, the information about the as-is standard portfolio is important to plan an appropriate to-be portfolio as well as a transformation strategy. Since staff training is a considerable part of implementing a standard, information on existing individual certifications among the workforce is also relevant here.

4. How can value-in-use of standards be measured?

Based on the findings regarding the evolution of ITM standards during the last 20 years, it can be expected that they will continue adapting ever faster to changing requirements. Hence, the effectiveness and efficiency of standards already implemented becomes more relevant for decisions on how to further improve the standard portfolio. According measures and methods will be required to identify, quantify, and monetize positive and negative effects of standards in use.

5. How can standard-related data be used for standard-related decisions?

As with many other activities in the digital era, the implementation and use of an ITM standard creates data. Many standards require the use of specific processes and practices or prescribe the use of specific information systems (e.g., ITIL's service management knowledge system or PMBoK's project management information system), information structures (e.g., COBIT control objectives and KPIs) and document types (e.g., PRINCE2 management products). If this data could be made available for processing and analysis, it would become a valuable resource for dealing with questions 1 to 4. Future research should investigate how approaches and methods from data warehousing, process mining, data sciences, and related fields could transferred and adapted to constitute a digital standards management, where standard selection, adaptation and orchestration is supported by smart digital solutions.

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