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Review

Context matters: A review of the determinant factors in the decision to adopt cloud computing in healthcare

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ABSTRACT

Cloud computing is an IT service paradigm that can, if used meaningfully, enhance traditional health IT approaches and offer major benefits to the healthcare industry. However, its adoption by healthcare organizations has been accompanied by diverse challenges that could impede its meaningful use. Decisions about its adoption should be made after serious consideration of relevant industry-specific factors. Whereas the literature has focused on cloud computing adoption in general, the industrial specificities that influence the decision to adopt cloud computing in the healthcare context have yet to be systematically addressed. We reviewed empirical studies on both information systems and medical informatics to investigate the determinant factors of the cloud computing adoption decision in healthcare organizations and the industrial specificities of those factors. Based on the results of our review, we proposed a conceptual framework of cloud computing adoption studies in healthcare and made seven recommendations for related future research. Our research contributes to the theory by providing a comprehensive list of industry-specific factors that influence cloud computing adoption decisions in healthcare and explains their specificities for the healthcare industry. For practitioners, the identified factors serve as a checklist that informs healthcare organizations' decision making regarding cloud computing adoption.

1. Introduction

Cloud computing (CC) is an IT service paradigm that enables users to gain on-demand network access to a shared pool of configurable computing resources such as servers, storage, and applications (Mell & Grance, 2011). The IT services provisioned by CC (i.e., cloud computing services (CCSs)) are web-based and can be rapidly released with minimal management effort (cf. Section 2). In comparison with traditional IT, CC presents "a fundamental change" (p. 176) in how IT services are developed, deployed, maintained, and paid for (Marston, Li, Bandyopadhyay, Zhang, & Ghalsasi, 2011). If applied properly, CCSs can provide various benefits for numerous organizations (e.g., Dwivedi & Mustafee, 2010; Jones, Irani, Sivarajah, & Love, 2017; Sabi, Uzoka, Langmia, & Njeh, 2016) including those in the healthcare industry that provide care-related goods and services (Benlian, Kettinger, Sunyaev, & Winkler, 2018; Gao, Thiebes, & Sunyaev, 2018; Meri, Hasan, & Safie, 2018). If it is used in a meaningful way (i.e., providing constructive support; Nelson & Staggers, 2018), CC allows healthcare organizations (i.e., hospitals or clinics) with insufficient IT resources/infrastructure to easily access required IT services through a network based on a pay-as-you-go pricing model. CC enables healthcare organizations with a shortage of health IT staff (which is currently a general challenge in the healthcare industry; Zieger, 2017) to deploy IT resources to meet ever-changing medical demands in a timely manner, imposing only a minimal workload on their own IT staff (Gao et al., 2018). Therefore, CC serves as a strong enhancement to traditional health IT and provides great value to healthcare organizations (Benlian et al., 2018; Gao, Thiebes, & Sunyaev, 2016; also cf. Section 2). Practitioners have called for a massive acceleration of CC adoption in the healthcare industry (Joch, 2017; Linthicum, 2017; Pratt, 2017).

A recent survey demonstrated that an increasing number of healthcare organizations intend to adopt CCSs and thereby benefit from the advantages of CC (HIMSS, 2016). However, CC is also accompanied by many challenges for healthcare organizations, particularly with respect to their management (e.g., difficulties in conducting IT audits), technology (e.g., data transfer bottlenecks), security (e.g., privilege

Abbreviations: ASP, application service provision; CC, cloud computing; CCS, cloud computing services; DOI, diffusion of innovations; HICSS, Hawaii International Conference on System Sciences; HOT-fit, humanorganization and technology-fit; IaaS, infrastructure as a service; IS, information systems; ITI, IT innovation; ITO, IT outsourcing; MI, medical informatics; PaaS, platform as a service; SaaS, software as a service; TOE, technology-organization-environment

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abuse), and legal aspects (e.g., applicable law for service contracts) (Kuo, 2011). Healthcare organizations are characterized as highly intricate because of the operational complexity of medical services (Singh & Wachter, 2008), and the healthcare context involves different stakeholders with different interests (Standing & Standing, 2008) and possesses industry-specific features (cf. the next paragraph). Therefore, the phenomenon of CC in healthcare is complex, and its meaningful use by healthcare organizations can be ensured only under certain conditions (cf. Gao et al., 2018). While making decisions to use CCSs (i.e., CC adoption decisions), healthcare organizations should exercise considerable judgment and consider various determinant factors related to those conditions. An adoption decision made without serious consideration of these determinant factors could not only hinder the meaningful use of CC by healthcare organizations but also introduce difficulties: in a recent case, a careless CC adoption decision by a large UK hospital did not lead to the expected benefits but rather to an £8.6 million financial deficit and even a temporary inability to deliver adequate medical services (Mathieson, 2015; Moore-Colyer, 2015), resulting in patients "being put at risk" (BBC, 2015).

The phenomenon of CC adoption has attracted the attention of the information systems (IS) community (e.g., Hsu, Ray, & Li-Hsieh, 2014). According to recent reviews, a very high proportion of IS studies about CC have focused on the factors that influence and thereby explain the CC adoption decision (Bayramusta & Nasir, 2016; Senyo, Addae, & Boateng, 2018). However, many of these studies are limited to general contexts or those with minimal industrial or contextual considerations (Schneider & Sunyaev, 2016; also cf. Section 2). Although some studies have taken the first steps toward the investigation of CC adoption specifically in the healthcare industry (e.g., Bernsmed, Cruzes, Jaatun, Haugset, & Gjaere, 2014; Lian, Yen, & Wang, 2014), these first attempts rely on related research from general contexts or address the specificities of the healthcare industry only in a fragmented manner. The specificities that affect CC adoption in the healthcare industry therefore remain underaddressed. The healthcare industry presents a markedly different context than other industries in which IS research has been conducted (e.g., manufacturing, transportation, financial services; Chiasson & Davidson, 2004). For example, the industry is operationally complex and highly institutionalized (Scott, 2005); healthcare organizations exist in different forms (e.g., for-profit, not-for-profit, government, private for-profit, private not-for-profit) with different motivations and interests (Chiasson & Davidson, 2004). Healthcare organizations usually feature a dual administrative system of medical personnel and administration (Chiasson & Davidson, 2004). Furthermore, health reimbursement and the related financial resources often depend on external insurers or agencies with their own concerns and agendas (Singh & Wachter, 2008). These specificities, which are difficult to find in a general context, could heavily influence CC adoption in the healthcare industry (Gao et al., 2018). It is not surprising that factors from general contexts or other industries are regarded as insufficient to explain CC adoption in a context with unique contextual characteristics such as the healthcare industry (Lian et al., 2014; Schneider & Sunyaev, 2016). The insufficient understanding of these specificities could therefore impede an effective investigation of the phenomenon of CC adoption in the healthcare industry.

In response to the identified research gap, this paper aims to answer the following research questions:

What factors influence CC adoption decisions in healthcare organizations? How do these factors influence the CC adoption decision? What specificities do these factors have regarding the healthcare industry?

To answer these research questions, we conducted a review of the related empirical literature from both IS and medical informatics (MI) publication outlets to provide evidence of CC adoption in healthcare. Our objective was to study the variables mentioned in the related literature that could influence CC adoption in healthcare organizations and to derive their specificities for healthcare, which is a method to understand the phenomenon of IT adoption that is widely acknowledged by the IS community (Dwivedi, Rana, Jeyaraj, Clement, & Williams, 2017; Jeyaraj, Rottman, & Lacity, 2006; Lacity, Khan, Yan, & Willcocks, 2010; Schneider & Sunyaev, 2016). Because CC is an emerging phenomenon in the healthcare industry, we viewed CC as a derivative of IT outsourcing (ITO) and as representative of IT innovation (ITI) in healthcare (cf. Section 2). Our literature review focuses not only on CC adoption in healthcare per se, but it also relies on studies of ITO and ITI adoption in healthcare, which can have implications for CC adoption. After reviewing 67 research studies, we identified five categories with 124 variables that could influence CC adoption in healthcare organizations. Of the identified variables, 40% ($n = 47$) are industry specific. Based on the results of our review, we propose a conceptual framework to advance IS researchers' understanding of the industrial specificities of CC adoption in healthcare and make seven recommendations for future research. Our research makes theoretical contributions by providing a list of industry-specific variables that influence the decision to adopt CC in healthcare. With the proposed conceptual framework, we generalize the characteristics of the identified industry-specific variables and thereby explain the specificities of the determinant variables for CC adoption in healthcare. Our study thus advances the conceptual understanding of the specificities of CC adoption in the healthcare industry.

2. Theoretical background

2.1. Health IT and cloud computing

Health IT and related computer-based data/information have the potential to improve the productivity and quality of healthcare services and are therefore considered crucial to the success of healthcare (Mandl & Kohane, 2017). However, traditional health IT approaches, in which healthcare organizations make or buy and maintain in-house software applications and hardware infrastructures, are often insufficient to fulfill the ever-changing and increasing needs in healthcare. Healthcare organizations, particularly in rural areas, often struggle with a scarcity of IT resources such as computing or storage capacity (Mason, Mayer, Chien, & Monestime, 2017). Insufficient offsite access to or inflexible deployment of in-house IT infrastructure restricts healthcare organizations' ability to address the changing IT demands caused by medical emergencies (Yao et al., 2014). Furthermore, the time-consuming and costly maintenance of existing information systems and the shortage of skilled health IT staff make IT a burden for healthcare organizations (Yao et al., 2014).

With its unique IT service paradigm, CC can enhance traditional health IT approaches. According to Mell and Grance (2011), who provide the most acknowledged definition of CC in the domain of IS, CC provides three service models: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS). Therefore, CC can deliver fundamental IT resources (through IaaS); IT platforms with programming languages, tools, and/or libraries for software development or deployment (through PaaS); or ready-to-use software applications that run on cloud infrastructure (SaaS) to healthcare organizations. Moreover, CC relies on four deployment models (i.e., public, private, community, and hybrid) to provide IT infrastructure that enables service delivery. In a public cloud, the CCS infrastructure is provided for open use by the general public, and the infrastructure of a private or community cloud is provisioned for the exclusive use of either a single organization or a specific group of organizations. A hybrid cloud is a combination of two or more of the aforementioned deployment models. The service paradigm enables CCSs to possess five unique essential technical features: on-demand self-service, resource pooling, rapid elasticity, broad network access, and measured service (see Table A.1 in Appendix A). As highlighted in Table A.1, these technical features enable CC to alleviate the aforementioned insufficiencies of traditional health IT approaches.

2.2. Duality of cloud computing characteristics in healthcare

CC and its adoption as a health IT artifact are complex IT phenomena (Kuo, 2011) and thus deserve attention from different conceptual perspectives (Nickerson, Varshney, & Muntermann, 2013). Based on key characteristics of CC, in this research, we adopt a dual view to conceptualize CC and its adoption in healthcare organizations. This dual view incorporates CC as a derivative of ITO and CC as a representative of ITI.

2.2.1. Cloud computing as a derivative of IT outsourcing

Numerous IS research studies have explained that CC and ITO share common characteristics (e.g., Lang, Wiesche, & Krcmar, 2018). In particular, CC is argued to be similar to application service provision (ASP) and SaaS in ITO (Benlian, Koufaris, & Hess, 2011; Vithayathil, 2017). IS researchers have compared CC with ITO and highlighted the similarities between the two concepts (e.g., Leimeister, Böhm, Riedl, & Krcmar, 2010).

From the health IT perspective, CC is also regarded as a specific form of ITO (Hucíková & Babic, 2016). In health IT, ITO refers to the transfer of responsibility to provide IT services to an external provider (Reddy, Purao, & Kelly, 2008). CC has four deployment models: public, private, community, and hybrid. Although the public cloud is well recognized as a form of ITO because of its off-premise nature, IT infrastructures of private and community clouds are often misunderstood as being on the premises of cloud users. Based on Mell and Grance (2011), private and community clouds may also exist off cloud users' premises, which makes the entire concept of CC more similar to ITO. It must be stressed that although theorists recommend the use of (partially) on-premises CCSs by the healthcare industry for reasons related to data privacy and security issues (Ermakova, Fabian, & Zarnekow, 2017), we are aware of few IT adoption studies that discuss CCSs with an on-premises IT infrastructure in the healthcare (or other) industry. This finding is likely because off-premises CCSs enable adopters to utilize their essential technical features to a greater extent (Kilcioglu, Rao, Kannan, & McAfee, 2017). Hence, research findings on ITO adoption are applicable to CC adoption in the healthcare industry, which has been proven by the previous research (e.g., Chen & Wu, 2013). We argue that it is meaningful to observe CC from the ITO perspective, and CC is deemed a derivative of ITO in the context of this research.

2.2.2. Cloud computing as representative of IT innovation

An innovation can be defined as an idea, practice, or object that is perceived as new by an individual or group (Rogers, 2003). In the context of healthcare, three types of innovation can be observed (Herzlinger, 2006): (1) innovation that focuses on how consumers buy and use healthcare; (2) innovation that applies technology to improve products, services or care; and (3) innovation that generates new business models. By definition, CC is a new practice of applying IT in healthcare organizations (type 2) because it is in sharp contrast to traditional health IT patterns, in which organizations make or buy and maintain in-house software applications and hardware infrastructures (Dwivedi & Mustafee, 2010).

Although the concept of CC has existed for nearly ten years and its adoption occurs in many other contexts (Sultan, 2013), it remains recognized as a highly innovative IT artifact by healthcare organizations (e.g., Fernández, 2017; Gao et al., 2018; Ozkan, 2017). This finding is attributable to the specificity of the healthcare industry in IT adoption. Healthcare organizations have been proven to traditionally act as laggards in ITI and adoption (Cicibas & Yildirim, 2018; Sulaiman & Wickramasinghe, 2018). Rogers (2003) explained that such organizations become aware of ITI (and the related characteristics/benefits) extremely late. Moreover, it must be stressed that the adoption of CCSs can provide flexible IT infrastructure and, thus, opportunities for healthcare organizations to apply other sophisticated information technologies (Jaatun, Pearson, Gittler, Leenes, & Niezen, 2016). Certain researchers claim that CC has become the key enabler of digital transformation in the healthcare industry (Abolhassan, 2017; Bhavnani et al., 2017). Although it is by no means necessary to overvalue the role of CC in healthcare, the essential technical features of CC, particularly *resource pooling*, *rapid elasticity*, and *broad network access*, ensure necessary IT resources and access to different devices. These features are basic conditions for the implementation of most ITIs in healthcare such as artificial intelligence, big data, and sensor technology. Thus, a very high proportion of existing CCSs in healthcare occurs in combination with emerging technologies (e.g., Esposito, De Santis, Tortora, Chang, & Choo, 2018; García, Tomás, Parra, & Lloret, 2018; Zhang, Qiu, Tsai, Hassan, & Alamri, 2017) and provides the most innovative IT services to healthcare organizations.

Based on the argument above, we summarize by stating that CC can be viewed as a representative of ITI for healthcare organizations; in addition, it is meaningful to observe CC adoption in healthcare from an ITO perspective.

2.3. Related research

To the best of our knowledge, there are four literature review studies related to this research.

Ermakova, Huenges, Erek, and Zarnekow (2013) provided a review of the existing studies on CC that are related to healthcare from an IS perspective. The researchers' review identifies the state of the art in CC research in healthcare. According to Ermakova et al. (2013), the existing research studies focus heavily on the development of specific IT artifacts that are based on or related to CC or address the privacy and security challenges of CC in healthcare. Ermakova et al. (2013) did not discuss the topic of CC adoption in healthcare.

In a more recent literature review study on CC in healthcare, Griebel et al. (2015) investigated research articles about CC from an MI perspective. Similar to Ermakova et al. (2013), Griebel et al. (2015) revealed that the research studies in MI have mainly targeted the provision of specific applications that are based on CC. Griebel et al. (2015) have also delivered minimal focus on the adoption of CC in healthcare.

The topic of CC adoption has attracted more attention from researchers in more common contexts according to the literature review study of Schneider and Sunyaev (2016). By adopting an ITO perspective for CC adoption, Schneider and Sunyaev (2016) investigated 88 empirical IS studies. Although the researchers identified a set of determinant factors for CC adoption, almost all such factors originate from contexts other than healthcare. Therefore, those factors are not suitable for CC adoption issues in the healthcare industry, particularly because Schneider and Sunyaev (2016) recognized that different industries have different specificities concerning CC adoption, and the healthcare industry substantially deviates from industries that have traditionally been studied by IS, as described in Section 1.

Finally, the literature review by Jeyaraj et al. (2006) provided an overview of research studies on ITI adoption that is related to our discussion of CC in healthcare from an ITI perspective. Those researchers' review covered both the individual and organizational adoption of ITI and delivered a list of predictors related to the ITI adoption decision. Similar to Schneider and Sunyaev (2016), the identified predictors in Jeyaraj et al. (2006) are limited to contexts other than healthcare. It must be stressed that Jeyaraj et al. (2006) also found that the specificities of an organization's industry or sector have an impact on the ITI adoption decision.

3. Research method

We conducted a review of the research literature on the adoption of CCSs in healthcare. Our review's objective was to identify the independent variables (and their effects) that could influence the decision to adopt CC in healthcare organizations. We drew on acknowledged literature review methods in IS that have been employed by previous high-quality studies closely related to our study (e.g., Jeyaraj et al., 2006; Lacity et al., 2010; Rana, Williams, Dwivedi, & Williams, 2012; Schneider & Sunyaev, 2016) to design our literature review approach because these methods specifically assist us in deriving independent variables (with their effects) for IT adoption decisions. We describe our method in detail in this section.

3.1. Literature search

For our literature search, we acted in accordance with the guidelines of Webster and Watson (2002) to ensure high-quality literature sources. According to Webster and Watson (2002), the major contributions in a particular research field are most likely to be found in high-quality journals with strong reputations. This research, which addresses a topic in health IT, is related to the IS and MI research. Accordingly, we began our literature search with highly regarded IS and MI publication outlets, complemented by additional forward and backward searches. For IS, we included the Senior Scholars' Basket of Journals (Association for Information Systems, 2011), the top 50 journals in the AIS journal ranking (Association for Information Systems, 2005), including selected ACM/IEEE Transactions based on Schneider and Sunyaev (2016), along with leading healthcare-related IS journals, according to Chiasson and Davidson (2004). For MI, we selected the 44 most acknowledged journals in health IT as suggested by Le Rouge and De Leo (2010), the top 20 journals in the MI category according to Google Scholar (2016), and two leading journals (*New England Journal of Medicine* and *Journal of the American Medical Association*) from the medical discipline that can provide insights into the medical field's discussion of MI (Weigel et al., 2013). Because CC is an innovative topic in healthcare, we also included the top three conferences of the IS (Schneider & Sunyaev, 2016) and MI communities (Le Rouge & De Leo, 2010) to cover the latest research. After removing duplicates, we generated a final list of 79 IS journals, three IS conferences, 50 MI journals, and two MI conferences (see Table S.1 in the supplementary material for a full list of the journals and conferences included). *Hawaii International Conference on System Sciences* (HICSS) is suggested as one of the top conferences in both IS and MI. We classified HICSS as an IS conference for this research because its papers are not limited to MI-relevant topics.

We applied the dual view of CC characteristics (i.e., ITO and ITI) and searched publications by *title*, *keywords*, and *abstract*. We used the following list of keywords for the IS journals and conferences to focus on research studies on the topics of CC, ITO and ITI in healthcare organizations: (*cloud* OR '*software as a service*' OR '*platform as a service*' OR '*infrastructure as a service*' OR '*software-as-a-service*' OR '*platform-as-a-service*' OR '*infrastructure-as-a-service*' OR *SaaS* OR *PaaS* OR *IaaS* OR '*application service*' OR *ASP* OR *outsourc** OR *offshor** OR *innovat**) AND (*hospital** OR *clinic** OR **health** OR *nurs** OR **medic** OR **patient**). For the MI journals and conferences, we used only the first half of the keywords in the list (i.e., we ignored 'AND (*hospital** OR *clinic** OR *health** OR *nurs** OR **medic** OR **patient**)') because the scope of the MI publications guarantees that the search results are within the thematic area of healthcare. Table S.1 presents an overview of the search engines we used. The literature search process was conducted in September 2016. Fig. 1 provides an overview of our literature review process. After removing duplicates, a sample of 2185 articles remained.

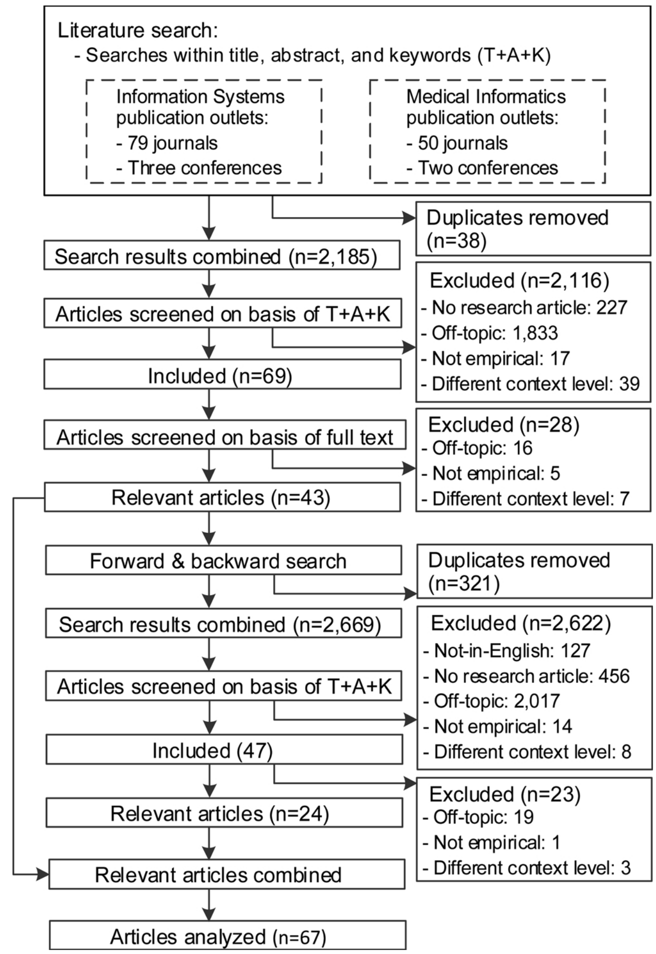

Fig. 1. Overview of literature review process.

3.2. Literature selection

To identify relevant studies for further analysis, we developed exclusion criteria based on our research purpose to which the literature selection strictly adhered. Our research focuses on completed articles that empirically investigate IT adoption with respect to CC, ITO, or ITIs in healthcare organizations. Therefore, we excluded articles if they (1) were *not research articles* (e.g., editorial comments); (2) were not about the topic of 'adoption' of CC, ITO, and ITI, which is relevant for our research (*off-topic*); (3) were not empirical studies (*not empirical*; e.g., Guah & Currie, 2003); or (4) did not focus on the organizational adoption of IT (*different context level*: Choudrie and Dwivedi (2005) demonstrated that IS studies related to IT adoption differ between the organizational level and the individual level; Dünnebeil, Sunyaev, Blohm, Leimeister, and Krcmar (2012), who focused on the individual level, for example, was excluded). Because we regarded CC as a derivative of ITO, we made particular effort to use the *off-topic* criterion to filter IT adoption studies about CCSs that have IT infrastructures on the premises of the healthcare organization. To ensure the applicability of articles concerning ITO to CC, we followed Schneider and Sunyaev (2016) and relied on the descriptive ITO framework of de Looff (1995) to include only ITO articles about the selective outsourcing of at least the maintenance and operation of the hardware or software of any functional information system to an external provider while keeping the business process in-house, which is the core use of CC in healthcare (Kuo, 2011). The research focusing on, for example, software development, help desks, or business process outsourcing is not within the scope of our literature review. Similarly, we employed the descriptive ITI framework of Herzlinger (2006) to include only ITI articles about the new practice of applying IT in healthcare organizations. Accordingly, the research about emerging patterns of healthcare consumption and new business models that do not consider the use of IT were excluded.

The screening process consisted of two substeps that were separately conducted by two researchers. After each step, two researchers compared their results, and differences were resolved through discussion. In the first substep, articles were screened using the title, abstract, and keywords. Both researchers successively applied the four predefined exclusion criteria to each of the identified articles. After the first substep, 2116 articles were excluded from further consideration. Thereafter, two researchers separately screened the remaining articles by reading the full text and successively applying the predefined exclusion criteria. Twenty-eight articles that were *off-topic*, *not empirical*, or had a *different context level* were further excluded in this substep. Finally, 43 articles remained after the screening of the literature identified from the IS and MI publication outlets.

In accordance with Webster and Watson (2002), we conducted a forward and backward search on the relevant articles. We identified 2669 further articles (with duplicates: n = 2990) that either cited one of the 43 relevant articles (i.e., forward search) or that were cited in one of these articles (i.e., backward search). Thereafter, two researchers screened the 2669 articles using the same screening process described above. We noticed that a few newly identified articles (particularly by forward search) were not in English. Therefore, we applied an exclusion criterion *not-in-English* to the 2669 articles before further exclusion criteria were employed. As shown in Fig. 1, 24 additional articles were found to be relevant to our research, 11 of which were identified using forward search and 13 of which were identified using backward search. Consequently, 67 articles were identified as relevant to this research and were analyzed in detail.

3.3. Literature analysis

The literature analysis consisted of three substeps. In the first step, we coded all 67 relevant articles. To ensure a structured analysis of the literature, we developed a coding scheme and thus provided a solid basis for our research (Webster & Watson, 2002). The coding scheme contains three blocks, as explained in Table 1. The first block (see I01-I04 in Table 1) was used to capture the relevant articles' meta-information. Accordingly, this capture included items to describe each article's profile including *research domain*, *research method*, and *research type*. The second block (see I05-I06 in Table 1) was oriented toward Chiasson and Davidson (2004) and examined the use of IS theories in the reviewed articles.

According to Chiasson and Davidson (2004), the high value of a (health IT) research study for the IS community lies in its use of theories to explain the IT phenomena of interest, which has been further confirmed by additional researchers (e.g., Dwivedi, Wade, & Schneberger, 2012; Rana et al., 2012). We used this second block to record how the reviewed studies applied theories to explain the phenomenon of IT adoption (including CC, ITO, and ITI) and to guide the use of related concepts. This approach was inspired by previously acknowledged IT adoption studies (e.g., Dwivedi et al., 2017b; Rana, Dwivedi, Lal, Williams, & Clement, 2017). We thus targeted insights into the conceptual use of these studies in healthcare. The third block focused on the factors that influence CC/ITO/ITI adoption in healthcare organizations. For this block, the coding method of Jeyaraj et al. (2006) was applied to record the dependent (Table 1, I07) and independent variables (Table 1, I08) for CC/ITO/ITI adoption and their relationships (Table 1, I09) for each of the articles. Table 1 summarizes the coding scheme and delivers an explanation/justification for each item. It is stressed that the explanations/justifications serve as the criteria for choosing the independent variables. We applied the defined coding scheme to the 67 relevant articles. To ensure a consistent analytical result, two researchers independently coded all the articles. Thereafter,

Table 1
Overview of the coding scheme.

	ID	Item	Possible value(s)	Purpose and description
Block 1	I01	Research domain	*Information systems* or *medical informatics*	To identify whether a research study originates from the domain of information systems or of medical informatics
	I02	Research type	*Qualitative*, *quantitative*, or *mixed*	To classify which type of empirical research methods the research study conducted
	I03	Research method	Include but are not limited to, *survey*, *experiments*, *case study*, or *interviews*	To describe the specific research method(s) used in the research paper
	I04	Research view	*Cloud computing*, *IT outsourcing*, or *IT innovation*	To identify which topic in the triple view of cloud computing characteristics the research study addressed
Block 2	I05	Theory used	For example, *contingency theory*, *institutional theory*	To capture theory(ies) that was (were) used and/or developed by the research study (based on Chiasson and Davidson (2004))
	I06	Theoretical focus	*IS* (information systems) *only*, *IS-Healthcare*, *Healthcare-IS*, or *Healthcare-only* (based on Chiasson and Davidson (2004))	To identify whether the theoretical focus of the paper is on testing or refining existing IS theories without regard for the healthcare context (*IS only*), on testing or refining existing IS theories with some regard for the healthcare context (*IS-Healthcare*), on examining phenomena in the healthcare context and using theory to explain or build/expand theory in this context (*Healthcare-IS*), or on describing IS or IT in the healthcare context with little consideration of theory (*Healthcare-only*)
Block 3	I07	Dependent variable	For example, *cloud adoption*, or *IT outsourcing decision*	Based on Jeyaraj et al. (2006), to capture dependent variable(s) about the adoption decision of cloud/IT outsourcing/IT innovation that appeared in the research study with its(their) definition(s)
	I08	Independent variable	For example, *organization size*, or *top management support*	Based on Jeyaraj et al. (2006), to capture independent variable(s) that appeared in the research paper with its(their) definition(s). An independent variable is recorded if it has one of the relationships in I09 with a recorded dependent variable (see I07)
	I09	Relationship	*+1*, *−1*, *M*, or *0* (based on Jeyaraj et al. (2006))	To record the relationship between an identified dependent variable and an independent variable; *+1*: the independent variable is positively associated with the dependent variable[1]; *−1*: the independent variable is negatively associated with the dependent variable[1]; *M*: the relationship between the dependent variable and the independent variable is significant but nondirectional[1]; and *0*: the relationship was investigated but a significant relationship was not found and the hypothesis could not be supported

Note. 1: This result is statistically significant and/or supports the related hypothesis for a quantitative study; this result is based on a strong argument for a qualitative study.

the coding results were compared and aggregated, and the two researchers discussed and resolved any conflicts.

In the second substep, in accordance with Schneider and Sunyaev (2016), we generated a list of *master variables* with *master variable definitions*. The purpose of this substep was to provide an aggregated list of independent variables from the previous substep. A *master variable* (e.g., *organization size*) serves as a term that covers all the variables we addressed from the literature with identical or similar definitions or for the same purpose (e.g., *hospital scale*, *number of beds*). Two researchers separately reviewed the coded variables from the first iteration. For each coded variable, each researcher checked whether there was previously a *master variable* that could cover the coded variable based on a comparison of their definitions; if so, the coded variable was added to the list under this *master variable*. The designation of the *master variable* and the related *master variable definition* were refined if needed. Otherwise, the reviewed coded variable was defined as a new *master variable* in the master variable list. Thereafter, the two researchers compared and aggregated their *master variables* and the *master variable definitions*. In addition, they reviewed and discussed all coded variables covered by each master variable and their relationships (Table 1, I09) with the independent variables to finalize the *master variable* list. The final *master variable* list with the *master variable definitions* is presented in Table S.2 in the supplementary material.

In the third substep, we categorized the *master variables* based on their *master variable definitions*. The purpose of this substep was to provide a structured overview of the *master variables*. Thus, we sought to obtain insights into the conceptual use of the determined *master variables* and to address the third research question. We relied on three fundamental concepts from the recorded theories that have previously been applied by the reviewed articles to categorize the *master variables*. Although many of the *master variables* can be categorized using these three fundamental concepts, certain variables remained uncategorized. For these *master variables*, we employed Bailey's (1994) inductive classification, which is well established in IS (e.g., Nickerson et al., 2013), to derive the categories. The basic idea of Bailey's (1994) method is to review empirical data that should be classified (i.e., the *master variables*) and inductively conceptualize the nature of these data as categories. We classified all remaining *master variables* according to their conceptual commonalities and differences in the *master variable definitions* (Bailey, 1994) into two categories. For each category, we derived a term that conceptually covered the belonging *master variables* and their *master variable definitions*.

As mentioned above, the literature analysis (as well as the literature identification and screening) followed the best practices used in the previous research. This method ensures the identification of the relevant variables that affect CC adoption by healthcare organizations in an effective manner.

4. Research findings

4.1. Overview of the reviewed articles

Of the 67 reviewed articles, 35 originate from IS publication outlets, and the remaining 32 articles are from MI. The 35 IS articles are spread over 26 journals or conference proceedings, and the 32 MI articles originate from 15 journals or conference proceedings. Ten of the reviewed articles focus on the topic of CC adoption; 16 address the ITO decision; and 41 refer to ITI adoption by healthcare organizations. Of the 67 articles, 30 use quantitative research methods, and 32 use qualitative research methods; the remaining five articles rely on a mix of both types of methods.

In all, we identified 501 relationships related to the dependent variables that represent the adoption of CC, ITI or ITO by healthcare organizations. For the activity in which healthcare organizations engage when choosing to adopt IT artifacts (i.e., the dependent variable), we identified different expressions from the reviewed articles (e.g., *acquisition*: Baker, Song, Jones, & Ford, 2008; *adoption*: Tsiknakis & Kouroubali, 2009; *decision*: Lorence & Spink, 2004; *purchasing decision*: Mills, Vavroch, Bahensky, & Ward, 2010). All these expressions represent an organization's decision or intention to adopt an IT service or product. We summarize these expressions by using a meta-dependent variable—*adoption*—for this study. The 501 relationships were aggregated into 124 *master variables* that have an impact on the *adoption* of CC/ITI/ITO by healthcare organizations.

4.2. The five categories of the master variables

We identified five categories of the identified *master variables*. As described in Section 3, although the first three categories reflect traditional IT adoption theories, the remaining two categories are not encompassed by traditional theories.

Among the 67 reviewed articles, we found that only 33 employed established theories to guide their empirical studies, thereby obtaining insights into the application of theories to the adoption of CC/ITO/ITI in healthcare. We found that the *technology-organization-environment (TOE) theory* of DePietro, Wiarda, and Fleischer (1990) (10 times) and the *diffusion of innovations (DOI) theory* of Rogers (2003) (9 times) are the main theories employed in the reviewed articles. The TOE theory explains that the main factors that influence the decision of an organization to adopt IT are *technological*, *organizational* and *environmental* aspects that present “both constraints and opportunities” (DePietro et al., 1990, p. 154) related to the adoption of IT (DePietro et al., 1990; Baker, 2012). The *technological* aspect concerns IT characteristics that also include related IT processes. The *organizational* aspect describes the characteristics of the organization that intends to adopt IT, whereas the *environmental* aspect refers to the context and surroundings of the organization. The DOI theory mainly describes innovation adoption and diffusion processes (Rogers, 2003). In this regard, the characteristics of the adopted innovations (i.e., IT) and the adopters (i.e., organizations) have been recognized as crucial for the innovation adoption process, which is in line with the TOE theory. In addition, our review shows that theories focusing on resources (i.e., *resource-based theory*: Barney, 1991; *resource dependency theory*: Pfeffer & Salancik, 2003; *theory of internal resource allocation*: Pondy, Starbuck, & Walter, 1970) for healthcare organizations are also frequently used to explain the adoption of CC/ITI/ITO by healthcare organizations (4 times). Although these theories have different assumptions and/or specifications (cf. Cheon, Grover, & Teng, 1995), they have been used in the reviewed articles to explain the importance of the (internal and/or external) *resources* that are related to the adoption of CC/ITI/ITO (e.g., Kazley & Ozcan, 2007; Leidner, Preston, & Chen, 2010). By definition, the *technological* and *environmental* aspects of the TOE theory cover both internal and external resources of the organization (DePietro et al., 1990). Accordingly, we specified *technology*, *organization*, and *environment* as the three basic categories of the core concepts embodied by the TOE theory, the DOI theory and theories focusing on resources.

The classification of the remaining *master variables* that are not covered by the three basic theoretical categories yielded two additional categories: *data/information* and *stakeholders*. The implications of both of these categories are addressed in Section 5.

4.3. Determinant factors for cloud computing adoption in healthcare

The 124 *master variables* are presented alongside the five categories. We focus on the *master variables* that can provide insights into CC adoption in healthcare. As discussed above, CC in healthcare possesses ITO and/or ITI characteristics. Based on Lacity et al. (2010), we regard a *master variable* as able to provide insights only if it has *consistent empirical results* jointly in at least two types of CC, ITO, and ITI adoption studies and, respectively, in each of these two types. In accordance with Schneider and Sunyaev (2016), we regard a master variable as *consistent* if at least 60% of its empirical results are congruous (i.e., *positive*, *negative*, or only *significant*; Table 1, I09). These criteria ensure that the *master variable* can provide valid insights into CC adoption in healthcare from an ITO perspective (jointly and respectively in CC and ITO: evidence reflecting the ITO characteristics, which is applicable to CC), an ITI perspective (jointly and respectively in CC and ITI: evidence reflecting the ITI characteristics, which is applicable to CC), or an ITO and ITI perspective (jointly and respectively in ITO and ITI: evidence reflecting the characteristics of an innovative ITO, which is applicable to CC). If this *master variable* has been studied *multiple times* (five times, based on Schneider and Sunyaev (2016)) in studies in which consistent evidence can be observed, it is defined as a ***reliable*** determinant factor for CC adoption in healthcare. Otherwise, this variable is viewed as a ***potential*** determinant factor. The multiple investigation requirement (i.e., studied five times) ensures high robustness of the determinant factor and therefore its *reliability* (Lacity et al., 2010). Although *potential* determinant factors lack high robustness, they can inform future research, as set forth in Section 5. Although we identified a small number of *master variables* ($n = 7$) that have been examined only in the context

Table 2
Determinant factors for the cloud computing adoption decision in healthcare.

Determinant factors along five categories	Relationships from a single conceptual view		
	Cloud computing	IT outsourcing	IT innovation
Technology			
● Improvement of quality of care (+ +) ◄	{(+ +); (< 5)}	{(+ +); (< 5)}	{(+ +); (≥5)}
● Improvement of finances (+ +)	(incon.); (< 5)	{(+ +); (< 5)}	{(+); (< 5)}
○ Compliance with standards (+ +) ◄	{(+ +); (< 5)}	{(+ +); (< 5)}	{(+ +); (< 5)}
○ Ongoing costs (− −)	{(− −); (< 5)}	(unclear)	{(− −); (< 5)}
○ Reliability (− −)	{(− −); (< 5)}	(unclear)	{(− −); (< 5)}
○ Setup costs (− −)	{(− −); (< 5)}	(unclear)	{(− −); (< 5)}
Organization			
● For-profit status (+ +) ◄	(unclear)	{(+ +); (< 5)}	{(+); (≥5)}
● IT culture (+ +)	(unclear)	{(+ +); (< 5)}	{(+ +); (< 5)}
Resources			
● Financial resources (+ +)	{(+ +); (< 5)}	{(+); (≥5)}	{(+ +); (< 5)}
● IT budget (+ +)	{(+ +); (< 5)}	{(+ +); (< 5)}	{(+ +); (< 5)}
● IT capabilities (+)	(incon.); (< 5)	{(+); (< 5)}	{(+ +); (≥5)}
● IT sophistication (+)	{(+ +); (< 5)}	{(+ +); (≥5)}	{(+); (≥5)}
○ IT staff (+ +)	{(+ +); (< 5)}	{(+ +); (< 5)}	(− −); (< 5)
Environment			
● Industry standards (+ +)	{(+ +); (< 5)}	(unclear)	{(+ +); (≥5)}
● Market maturity (+ +)	(unclear)	{(+ +); (< 5)}	{(+); (< 5)}
● IT artifact penetration (+)	(unclear)	{(+ +); (< 5)}	{(+); (≥5)}
● Related references (+ +) ◄	{(+ +); (< 5)}	(unclear)	{(+ +); (≥5)}
○ Competitive pressure (+ +)	{(+ +); (< 5)}	(incon.); (≥5)	{(+ +); (< 5)}
Resources			
● Special funding (+) ◄	{(+ +); (< 5)}	{(+ +); (< 5)}	{(+); (≥5)}
Data/Information			
● Data interoperability (− −) ◄	{(− −); (< 5)}	{(− −); (< 5)}	{(−); (< 5)}
● Privacy (− −) ◄	{(− −); (< 5)}	{(− −); (< 5)}	{(−); (< 5)}
○ Security (− −) ◄	{(− −); (< 5)}	{(− −); (< 5)}	(incon.); (≥5)
Stakeholders			
Administrator			
● Top management support (+)	{(+ +); (< 5)}	{(+ +); (< 5)}	{(+); (≥5)}
Patient			
○ Patient preference (+ +) ◄	(unclear)	{(+ +); (< 5)}	{(+ +); (< 5)}
Policy maker			
● Central push (+ +)	{(+ +); (< 5)}	{(+ +); (< 5)}	{(+); (≥5)}
● Mandate (MM) ◄	{(M); (< 5)}	{(MM); (< 5)}	{(MM); (≥5)}
Physician			
● Physician support (+ +) ◄	(unclear)	{(+ +); (< 5)}	{(+ +); (≥5)}
○ Involvement in administration (+ +) ◄	(unclear)	{(+ +); (< 5)}	{(+ +); (< 5)}
Vendor			
● Vendor competence (+ +)	{(+ +); (< 5)}	{(+ +); (< 5)}	{(+); (< 5)}
● Vendor support (+)	{(+ +); (< 5)}	(unclear)	{(+); (≥5)}
○ Business interdependency (M) ◄	(unclear)	{(MM); (< 5)}	{(MM); (< 5)}
○ Physical distance (− −)	{(− −); (< 5)}	(unclear)	{(− −); (< 5)}

●/○: The determinant factor is reliable/potential. Its evidence is consistent in at least two conceptual views and has been examined more than five times in total/but has not been tested more than five times in total
◄: industry-specific determinant factor for healthcare.
(+ +)/(− −): More than 80% of the evidence is positively/negatively significant.
(+)/(−): Between 60% and 80% of the evidence is positively/negatively significant.
(unclear)/(incon.): Evidence is not tested/inconsistent for the conceptual view.
(MM)/(M): More than 80%/between 60% and 80% of the evidence is significant but nondirectional.
(≥5)/(< 5): Factor is examined more/less than five times for the conceptual view.
{}: Evidence for the conceptual view is included to determine the total effect of the factor.

of CC, they either cannot provide consistent empirical results (e.g., *uncertainty about vendor's sustainability*) or have only been examined once (e.g., *system quality*). Thus, these variables are not sufficient to provide meaningful, conclusive insights into CC adoption in healthcare. Table 2 provides an overview of the identified categories and the *reliable* and *potential* determinant factors. A full list of all the identified *master variables* and their relationships with the *adoption* of CC/ITO/ITI can be found in Table S.2 in the supplementary material.

Category:*technology.* This first category summarizes the *master variables* that refer to the characteristics of the to-be-adopted technology or IT service and the expected effects and consequences of its use. Variables that belong to the *technology* category have been studied 103 times, resulting in 26 *master variables*. The most-examined *master variables* are *compatibility* (16 times) followed by *relative advantages* (14 times; cf. Table A.2).

As shown in Table 2, two *master variables*, namely, *improvement of the quality of care* (e.g., Lorence & Spink, 2004) and *improvement of finances* (e.g., Harrop, 2001), are identified to provide *consistent* and *robust* empirical results, serving as *reliable* determinant factors for CC adoption in healthcare. Both determinant factors are related to the expected results of IT adoption and indicate positive empirical results. Similarly, the *master variable* that investigates whether the IT artifact to be adopted is in compliance with related IT standards (*compliance with standards*; e.g., Hunter, Krupinski, & Weinstein, 2013) is also found to have a consistent positive effect on CC, ITO and ITI. However, this result is not robust, and it serves as a *potential* determinant factor. The determinant factor *uncertainty about* the *reliability* of the adopted IT artifact (e.g., Dixon et al., 2013) generates consistent negative empirical results in CC and ITO adoption contexts, although it is examined fewer than five times. *Ongoing costs* (e.g., Yoon, Chang, Kang, Bae, & Park, 2012) and setup *costs* (e.g., Alkraiji, Jackson, & Murray, 2013) are the other two *potential* determinant factors. These factors both deliver a *consistent* negative effect regarding CC and ITI but have been studied fewer than five times.

Category:*organization.* The *organization* category includes the attributes and status of a healthcare organization that adopts CC. This category contains 34 *master variables* that have been studied a total of 167 times. It must be emphasized that 13 of the 34 master variables are related to the healthcare organization's internal resources for IT adoption (studied 68 times; see Table A.2). In this category, the *size* of the healthcare organization has been most frequently studied (25 times; cf. Table A.2).

Six *reliable* determinant factors have been identified for this category. *IT culture* measures a healthcare organization's tradition of using or (traditional) tendency to use innovative IT artifacts (e.g., Mills et al., 2010), whereas *for-profit status* indicates the degree to which the healthcare organization is driven by a profit motive (e.g., Hill, 2000). Both determinant factors are identified as having *consistent* and *robust* positive effects with respect to ITO and ITI. The four remaining *reliable* determinant factors relate to an organization's internal resources for IT adoption. Among them, (general) *financial resources* (e.g., Cao, Baker, Wetherbe, & Gu, 2012), *IT budget* (of the healthcare organization; e.g., Baker et al., 2008), and *IT sophistication* (in terms of IT infrastructure or the general use of IT in the healthcare organization; e.g., Lai, Lin, & Tseng, 2014) are considered *reliable* from the CC, ITI and ITO perspectives. Healthcare organizations' *IT capabilities* (e.g., Wholey, Padman, Hamer, & Schwartz, 2001) are shown to have a *consistent* positive effect on IT adoption when ITO and ITI are considered. The availability of *IT staff* (e.g., Yoon et al., 2012), the only *potential* determinant factor in this category, has a positive effect if we consider CC and ITO studies.

Category:*environment.* The environment category describes the characteristics and status of the surroundings, context or industry in which the healthcare organization operates. In this category, 12 *master variables* were studied a total of 74 times. As shown in Table A.2, the two most frequently examined master variables are *competitive pressure* (17 times) and the *ruralness* of the location of the healthcare organization (13 times). Two *master variables* (i.e., *industrial IT infrastructure* (3 times) and *special funding* (8 times)) that address healthcare organizations' external resources for IT adoption are also included in the *environment* category.

Industry standards (e.g., Yoon et al., 2012), *related references* (e.g., Baird, Furukawa, & Raghu, 2012), *market maturity* (for the adopted IT artifact; e.g., Bodker, 2002), *IT artifact penetration* (i.e., popularity of the adopted IT artifact in the industry; e.g., Potančok & Voříšek, 2015), and *special funding* (from the industry for the adoption of the IT artifact; e.g., Nielsen & Mengiste, 2014) are *reliable* determinant factors in this category. The first two of these determinant factors have a consistent positive effect on CC and ITI, whereas the third and fourth factors have a consistent positive effect on ITO and ITI. The fifth determinant factor, *special funding*, is considered *reliable* for CC, ITI and ITO. *Competitive pressure* (e.g., Li, Chang, Hung, & Fu, 2005) in the healthcare industry is the only *potential* determinant factor in this category. For CC and ITI, this factor has a *consistent* positive effect but is not proven to be *robust*. Although this determinant factor has been studied from an ITO perspective more than five times, no *consistent* result is observed.

Category:*data/information.* This category refers to the use of data or information or the data/information-related considerations of the healthcare organization. Data are structured facts and/or statistics, whereas information focuses on unstructured messages or human thoughts. The three most-studied master variables—*security* (ten times), *privacy* (seven times) and *data interoperability* (five times)—also serve as *reliable* or *potential* determinant factors. *Data interoperability* (e.g., Dixon et al., 2013) refers to concerns about data to be smoothly exchanged or integrated as required with different (internal or external) sources. This determinant factor possesses a *consistent* negative effect across all CC, ITO and ITI contexts that is *robust*. Therefore, this factor is a *reliable* determinant factor in this category. Another *reliable* determinant factor with a negative effect that also relates to the CC, ITO and ITI contexts is (concerns about information and data) *privacy* (e.g., Simon et al., 2007). The determinant factor of *security* (e.g., Sultan, 2014a) represents healthcare organizations' information and data security concerns. Although *security's* empirical results are *consistent* from the CC and ITO viewpoints, the effect in ITI studies is shown to be inconsistent, which prevents this determinant factor from achieving high *robustness*. Thus, *security* is a *potential* determinant factor.

Category:*stakeholders.* The last category covers stakeholders' characteristics, attitudes and behaviors that are related to the adoption of the IT artifact by the healthcare organization. For this category, 46 *master variables* are identified and have been studied 131 times. As shown in Table S.2, these *master variables* are distributed in six stakeholder groups: *administrator* (of the healthcare organization), *patient*, (industry) *policy maker*, *physician* (of the healthcare organization), (IT/IT service) *vendor*, and IT *user*.

The most studied *master variable* among *administrators* is *top management support* (15 times; e.g., Lian et al., 2014), which is the only *reliable* determinant factor with a *consistent* positive effect in this stakeholder group. In the stakeholder group *patient*, the most-examined *master variable* (i.e., (number of) *insured patients*) has been studied only three times (cf. Table A.2). Thus, no *reliable* determinant factors can be found. However, *patient preference* (for the adoption of the IT artifact; e.g., Khoumbati, Themistocleous, & Irani, 2006) possesses consistent positive empirical results from the ITO and ITI views and acts as a *potential* determinant factor. The stakeholder group *policy maker* contains two *master variables* (i.e., *central push* and *mandate*), which are both *reliable* determinant factors with respect to all three perspectives. *Central push* refers to the specific activities of the policy maker that support, promote or mandate the application of the IT artifact (e.g., Lin, Lin, Roan, & Yeh, 2012; Mills et al., 2010; Potančok & Voříšek, 2015). This determinant factor has a positive effect on the adoption of the IT artifact. The other *reliable* determinant factor is the availability of policies that specify the policy maker's mandate regarding the use (or nonuse) of the IT artifact (e.g., Spinardi, Graham, & Williams, 1997). This determinant factor is revealed to have a consistent *significant* effect but no direction. In the stakeholder group *physician*, *physician support* (e.g., Paré & Trudel, 2007) is the only *reliable* determinant factor with a consistent positive effect. Although the degree of physicians' *involvement in administration* (e.g., Yang, Kankanhalli, Ng, & Lim, 2013) also has consistent positive empirical results, it has been examined fewer than five times. The consistent positive effects of both determinant factors relate to ITO and ITI. In the *vendor* stakeholder group, the two most-examined *master variables*, namely, *vendor support* (14 times) and *vendor competence* (8 times), are also the only two *reliable* determinant factors of *vendors*. Whereas *vendor competence* (e.g., Marsan & Paré, 2013) has a consistent positive effect regarding CC, ITO and ITI, *vendor support* (e.g., Li et al., 2005) has not been examined in the ITO context, and its positive effect is thus consistent from the CC and ITI perspectives. Moreover, two *master variables* play the role of *potential* determinant factors for *vendor*. *Business interdependency* (e.g., Yang et al., 2013), which denotes the degree to which the IT vendor is strategically related to or allied with the healthcare organization, has been shown to deliver *consistent* but not-robust empirical results regarding ITO and ITI. A vendor's *physical distance* from the healthcare organization, indicating a *consistent* negative effect with respect to CC and ITO, is the other *potential* determinant factor. Although we identified a further stakeholder group, *user*, which contains four *master variables* that have been studied six times, no *reliable* or *potential determinant* factors can be derived for this stakeholder group.

4.4. Industry-specific variables of cloud computing adoption in healthcare

As described in Section 2.3, Schneider and Sunyaev (2016) and Jeyaraj et al. (2006) delivered comprehensive lists of determinant factors for the adoption of IT in the context of CC, ITI and ITO. By reflecting on our research and comparing our results with those of Schneider and Sunyaev (2016) and Jeyaraj et al. (2006), we identified 47 *master variables* that are specific for the adoption of CC/ITO/ITI in the healthcare industry. These industry-specific variables have not been addressed in general or other industry contexts. In particular, these variables reflect specific characteristics of the healthcare industry that have been stressed by the reviewed literature. We highlight these industry-specific *master variables* in Table S.2 and describe their specificities. These *master variables* are further discussed in Section 5.

5. Discussion

5.1. Specificities of cloud computing adoption in healthcare

By observing the identified *master variables*, we identified the industry specificities of CC adoption in healthcare, which are reflected from two perspectives. On the one hand, the identified *master variables* that also exist in general contexts show different empirical results in the healthcare industry, reflecting the specific situation of CC adoption in the context of healthcare, as discussed below. On the other hand, the industry-specific *master variables* profile the unique aspects of the healthcare industry that must be considered for CC adoption. More specifically, we use induction to generalize from the identified industry-specific *master variables* and propose two special characteristics of the healthcare industry that should be considered for CC adoption. We employed a focus group discussion with seven external researchers from IS or MI to validate both derived characteristics in September 2017. The first characteristic of these variables is summarized as the *medical and clinical role* of the healthcare industry. The *medical and clinical role* addresses the specific medical/clinical considerations or characteristics that are also related to the use of IT (DesRoches & Rosenbaum, 2010; Mandl & Kohane, 2012). The healthcare industry is particularly differentiated from other industries by the high professionalism of its core business: providing care services. Highly specific and complex medical and clinical processes in different healthcare organizations and their different roles in the supply chain of health-related services have an impact on IT activities (Chiasson & Davidson, 2004). Moreover, the uniqueness of health IT (e.g., CC in healthcare) is, in essence, its utility for medical and clinical activities in healthcare organizations and, thus, the resulting improved quality of care (Mandl & Kohane, 2012; Sultan, 2014b). The second characteristic is defined as the *public role*. Although the healthcare industry is by no means a purely public sector, to a certain extent it possesses the characteristics of the public sector for the following two reasons. First, a large portion of the products and outcomes of the healthcare industry are public goods, which benefit and are available to all, at least locally and temporarily (Hemenway, 2010). These public goods are, for example, the prevention or treatment of fatal communicable diseases, vaccination against preventable childhood diseases, and emergency medical interventions (Leaning & Guha-Sapir, 2013). Thus, healthcare organizations' success depends not only on profitability but also (or more so) on social values such as public health. Healthcare organizations voluntarily assume social responsibilities and contribute to the public, with occasional sacrifices. Second, a high level of governmental intervention is present in the healthcare industry. Compared with other industries (e.g., financial services), governments not only strictly regulate healthcare organizations but also are deeply involved in mandating and financing private healthcare organizations' activities and even provide healthcare services directly (Hanson et al., 2008; Hemenway, 2010). According to a recent study, 66.5% of global healthcare expenditures are financed by governments (Dieleman et al., 2016); all major countries have publicly owned entities to provide healthcare services (Mossialos, Wenzl, Osborn, & Sarnak, 2016). The identified industry-specific *master variables* are described/explained by using the *medical and clinical role* and *public role* in Table S.2 and are discussed further below.

The identified *master variables* in the *technology* category correspond to the traditional technological perspective of IT adoption studies. In particular, typical factors such as *compatibility* or *complexity* have been closely examined in the healthcare context (cf. Table A.2). However, these typical factors do not show consistent empirical results for the healthcare context, although they have been proven to be suitable predictors for general CC, ITO and/or ITI adoption studies in IS (Jeyaraj et al., 2006; Schneider & Sunyaev, 2016). The only two *reliable* determinant factors—*improvement of quality of care* and *improvement of finances*—indicate that healthcare organizations are likely to concentrate on direct, specific benefits that can be caused by CC adoption rather than the traditional technical characteristics that are suggested by the DOI theory. The potential for the *improvement of quality of care* can positively influence the adoption of CC, particularly because care-related services are a healthcare organization's core business. In contrast to traditional health IT applications, CCSs show promise in supporting clinical activities (cf. Griebel et al., 2015). Our literature review shows that the direct improvement of health-related services by the adopted IT artifact has therefore become a key adoption motivation of healthcare organizations (e.g., England & Stewart, 2007; Lorence & Spink, 2004). Another *reliable* determinant factor (i.e., *improvement of finances*) holds for CC adoption in healthcare contexts because financial benefits have been argued to be the "principal advantage" (p.5) of CC in healthcare (Kuo, 2011). Other *master variables* such as *ongoing costs*, setup *costs*, and *transaction costs*, also reflect healthcare organizations' financial considerations for CC adoption. The *category technology* contains two industry-specific *master variables* (i.e., *improvement of quality of care* and *compliance with standards*). Whereas the *improvement of quality of care* reflects clinical/medical considerations and, thus, the *medical and clinical role* of the healthcare industry, *compliance with standards* represents the *public role*. CC adoption studies in general contexts merely concentrate on the existence of industry standards for CCSs (cf. Schneider & Sunyaev, 2016). Our study reveals that healthcare organizations additionally regard the degree to which CCSs adhere to related industry standards (i.e., *compliance with standards*) as an important precondition for the adoption decision (e.g., Alkraiji et al., 2013; Raube, 2015). This finding stems from the strict government regulation (or occasionally behavioral mandates) over the use of health IT (Baird et al., 2012), which could directly influence public health or have other social impacts (e.g., pertaining to the privacy of personal health data). Thus, *compliance with standards* has become an industry-specific measurement of the quality of CCSs in healthcare.

We observe that the *reliable* and *potential determinant* factors in the second category originate mainly from the master variables that relate to *resources*. Although the other master variables (i.e., those that are not related to resources) have been examined extensively (21 master variables examined a total of 99 times), only two *reliable* dominant factors can be found. This finding likely stems from the fact that many *master variables* that are valid in general IT adoption contexts do not necessarily play a role in the healthcare context (e.g., *size* or *organizational centralization*). This observation is likely caused by the high complexity of a healthcare organization and the fact that a single factor regarding *organization* is sometimes insufficient to influence CC adoption. The *organization* category has a high proportion of industry-specific *master variables*. The most frequently examined industry-specific *master variable* (i.e., *for-profit status*) is actually one of two *reliable* determinant factors that have a positive effect on CC adoption because for-profit healthcare organizations are more likely to have the financial flexibility to engage in adoption activities (e.g., Burke, Wang, Wan, & Diana, 2002). In the *organization* category, the industry-specific *master variables* have been underestimated; on average, they have been studied less frequently than the general *master variables* (3 versus 5.95 times). Moreover, many significant *industry-specific* master variables have been discussed only within a single context (CC, ITO, or ITI), although they can arguably play a role in other contexts. For example, *teaching status* has a positive effect on the adoption of ITO because *healthcare organizations* with teaching responsibilities receive additional funding (e.g., from medical schools), which can be used for IT adoption (Kazley & Ozcan, 2007). Moreover, healthcare organizations with *teaching status* contribute to medical research, which relies heavily on the processing of large quantities of data. Because the adoption of CC and ITO also requires substantial financial resources and CC can offer scalable computing resources for data processing (cf. Table A.1), the *teaching status* of healthcare organizations can also facilitate CC adoption.

In the second category, there are various types of master variables that represent healthcare organizations' resources, among which only monetary (e.g., *IT budget*) and IT-specific resources (e.g., *IT capabilities*) serve as *reliable* and *potential* determinant factors. This finding reveals the importance of both types of resources. Monetary resources refer to healthcare organizations' budgets or spending, which can be directly or indirectly available for IT adoption projects. IT-specific resources comprise the IT capabilities, IT staff and IT infrastructure of a healthcare organization. Our study shows that monetary and IT-specific resources have a positive impact on CC adoption in healthcare organizations. The previous research demonstrates that CC adoption does not require a high degree of financial and IT input in general contexts, which is one of CC's major benefits for users (Marston et al., 2011). However, our review shows that these findings do not hold in healthcare. Rather, we found that due to the high heterogeneity of healthcare organizations, standard CCSs are often not ready to use and require additional implementation or configuration steps (Sultan, 2014a). Because the IT infrastructure in healthcare organizations is often lagging, additional work to upgrade hardware (e.g., Internet connections) or platforms becomes necessary (Weng et al., 2016). Furthermore, CC projects in healthcare are often large in scale and require the involvement of multiple organizations, including governments (in contrast, CC projects in other industries often involve a single small- or mid-sized enterprise) (Lian et al., 2014), thus entailing the additional effort and expense of coordination (Kipp, Riemer, & Wiemann, 2008). Accordingly, healthcare organizations often need significant IT-specific and/or monetary resources for CC adoption.

The industry-specific *master variables* in the second category can also be explained by the *medical and clinical* aspects and the *public role* of the healthcare industry. Whereas *master variables* such as *clinical needs* and *focus on chronic care* represent medical/clinical considerations, *master variables* such as *intention for social gain* and *for-profit status* reflect the *public role*.

The third category, *environment*, contains twelve *master variables*. One-half of the identified *master variables* provide consistent empirical results and serve as *reliable* ($n = 5$) or *potential* ($n = 1$) determinant factors in CC adoption. Notably, many of these determinant factors (4 of 6) exist in common contexts of CC adoption studies, which have not delivered consistent empirical results (cf. Schneider & Sunyaev, 2016). This finding is likely due to the high consistency of the *environment* (i.e., the healthcare industry) in the studies reviewed in our research, as previously argued by Schneider and Sunyaev (2016).

The only two *master variables* in this category that are industry specific and regarded as *reliable* determinant factors are *related references* and *special funding*. The master variable *related references* refers to the successful use of CCS by other clients who have profiles (e.g., geographic area, size, clinical focus) that are very similar to the profile of the healthcare organization that is interested in adopting CCS. This determinant factor is relevant for CC adoption in the healthcare industry because a remarkable feature of CCSs is that they are often expected to use standardized software (SaaS) or infrastructures (IaaS/PaaS) that serve a wide variety of customers (Marston et al., 2011). However, healthcare organizations differ substantially from one another. Even minor differences among them in terms of healthcare service focus or specifications lead to very different clinical and/or service management processes (Lee, Song, & Kim, 2014). Therefore, one CCS cannot serve all healthcare organizations; rather, it can serve only a few such organizations with similar profiles. The other master variable that serves as a sufficient determinant factor is *special funding* (for CC adoption). This variable represents government and industry financial support that supplements healthcare organizations' internal resources. In contrast to other industries, the monetary resources for CC adoption are often available from government or social sources, reflecting the *public roles* of the healthcare industry that affect CC adoption. Other industry-specific *master variables* in this category also represent the healthcare organization's *public* (e.g., *penetration of health insurance*) and/or *medical and clinical roles* (e.g., *care system maturity*). However, these *master variables* have been underinvestigated, and thus, the examination of their empirical results does not provide sufficient insights.

The *data/information* category serves as another important aspect for CC adoption in healthcare. This category represents *healthcare organizations'* considerations for CC adoption from the data/information perspective. All the *master variables* in this category are industry specific. Although *data/information* contains *security*, which has also been discussed by CC adoption studies in general contexts (cf. Schneider & Sunyaev, 2016), in healthcare, it has a special focus. In contrast to other contexts, in which the definition of *security* is broader and covers IT hardware, software and data (Ramachandran, 2016), the master variable *security* in the healthcare context mainly focuses on concerns about the improper or insufficient protection of data or information from unauthorized use or manipulation (Sultan, 2014a). Similarly, *privacy* concerns, which involve improperly addressing data or information in healthcare and garner minimal focus in general CC or ITI adoption studies (Jeyaraj et al., 2006; Schneider & Sunyaev, 2016), also play an important role in CC adoption in healthcare. Security and privacy issues are deemed the "Achilles' heel" of CCs by a substantial amount of research because data and information in CCSs are often not processed for users onsite (e.g., Jaatun et al., 2016; Sunyaev & Schneider, 2013). Our review shows that healthcare organizations are sensitive to the impact of security and privacy issues that result from CC adoption because healthcare data and information (i.e., from patients) are highly personal, health-related and concern nearly everyone. The leakage or misuse of such data could cause serious losses for a wide range of the public and have a substantial social impact. Moreover, healthcare organizations rely heavily on data/information for clinical decisions and the delivery of healthcare services (cf. Section 5.2). Data manipulation could lead to low-quality care and medical errors. Finally, strict legal regulations force healthcare organizations to assume substantial responsibility to effectively oversee data/information (Choi, Capitan, Krause, & Streeper, 2006). Thus, *security* and *privacy* represent both the *public* and the *medical and clinical roles* of the healthcare industry regarding data/information. The remaining four *master variables—data/information centralization*, *data digitalization*, *data/information processing needs*, and *data interoperability*—involve the use of or need for data/information in healthcare services, as described by Table S.2. Therefore, these industry-specific *master variables* represent the *medical and clinical role* of the healthcare industry with respect to data/information.

The final category concerns the *stakeholders* of healthcare organizations. This category addresses different roles that are relevant to healthcare organizations. Jeyaraj et al. (2006) noted that, in general contexts, ITI studies insufficiently focus on the factors related to individual roles in the organizational adoption of ITI. Schneider and Sunyaev (2016) also identified a very limited number of factors related to individual roles for CC adoption in general contexts. Our study reveals that the *master variables* of the *stakeholders* category have been studied primarily (132 times) in healthcare contexts. In contrast to Jeyaraj et al. (2006) and Schneider and Sunyaev (2016), we reveal a clear differentiation between different stakeholder groups and each of those groups' unique master variables. These groups not only cover the stakeholders who also exist in general IT adoption contexts such as *administrators* or *vendors* (Ali, Warren, & Mathiassen, 2017) but also stakeholders who are specific to the healthcare industry (e.g., *physicians* and *patients*). Industry-specific *master variables* in this category exist primarily in but are by no means limited to industry-specific stakeholder groups. For example, in the stakeholder group *administrators* of healthcare organizations, studies also investigate *administrator's involvement in medical activities* (Kimberly & Evanisko, 1981). The core business of healthcare organizations (i.e., healthcare services) involves a high level of professionalism. Healthcare administrators who are involved in medical activities can therefore better understand their business and medical needs. In practice, it is common for many healthcare organizations to employ physicians or managers with a medical background as administrators. The previous research has also empirically shown that healthcare organizations with such administrators obtain better performance than those with administrators lacking a medical background (Goodall, 2011). Thus, the *administrator's involvement in medical activities* can have a positive impact on CC adoption, particularly because CCSs are expected to directly improve healthcare services. *Administrators' involvement in medical activities* thus represents *the medical and clinical role* of *administrators*. As further examples, we identified industry-specific *master variables* in the stakeholder group *vendor*: *vendor's medical knowledge*, *business interdependency*, and *role multiplicity in healthcare*. Vendors with *medical knowledge* are argued to positively support CC adoption because of the high professionalism of healthcare services (Reddy et al., 2008). *Business interdependency* indicates the degree to which a healthcare organization is strategically related to its IT vendor, and *role multiplicity in healthcare* refers to the additional roles (e.g., care provider) of the IT vendor in healthcare. *Business interdependency* and *role multiplicity in healthcare* refer to a special form of IT sourcing as well as CC sourcing in healthcare (e.g., Glasberg, Hartmann, Draheim, Tamm, & Hessel, 2014; Reddy et al., 2008), in which a healthcare organization serves as the IT provider for its client healthcare organization, particularly because healthcare-related ITO/CC outsourcing in certain areas is legally restricted to IT providers that are also healthcare organizations (Glasberg et al., 2014). In this special form, the IT client healthcare organization relies not only on IT services by its IT provider but also on the related medical resources and therefore has a high level of business dependency on the IT provider. The IT provider healthcare organization plays another role (i.e., healthcare service provider) in addition to IT provider in CC adoption. The relationship between clients and providers is characterized by both cooperation and competition (Reddy et al., 2008) and could have a significant impact on CC adoption, as demonstrated by our review.

5.2. Conceptual framework and recommendations for future research

Through our review, we obtained insights into the use of concepts for CC adoption studies in healthcare contexts that provide implications and directions for future research. We summarize those insights by proposing a conceptual framework of the determinant factors for CC adoption in healthcare contexts, as illustrated in Fig. 2. The framework assists researchers in gaining an improved understanding of the use of the determinant factors for CC adoption in healthcare.

Based on the results of our review, our conceptual framework consists of six categories of variables that influence CC adoption in healthcare organizations: *technology*, *organization*, *environment*, *resources*, *data/information* and *stakeholders*. While the first four categories (the dotted boxes in Fig. 2) acknowledge the relevance of basic categories in traditional IT adoption theories, the last two categories (the solid boxes) reflect the industry-specific categories of variables that influence CC adoption in healthcare. Moreover, our conceptual framework highlights two specific concerns of the healthcare industry that influence CC adoption and are reflected by industry-specific master variables: the *medical and clinical role* and the *public role*. Neither role is restricted to any of the conceptual categories but exists across all of them. We illustrate this observation by drawing a circle across all categories in the conceptual framework. The implications of the conceptual framework and related recommendations for future research are further discussed below. Table 3 summarizes these recommendations and shows how they are related to our research findings.

The four dotted boxes in the conceptual framework reflect the relevance and the eligibility of the TOE theory, the DOI theory, and the theories focusing on resources for CC adoption studies. We therefore recommend that both IS and MI researchers who conduct theory-driven studies on CC adoption in healthcare further adhere to these "good" theories and the four related conceptual categories **(Recommendation 1)**. In particular, as the MI community has begun to recognize the importance of (IS) theories for the healthcare domain (Cockcroft, 2015) and because of the importance of the research topic of CC adoption in healthcare, an increasing number of studies that rely on theories to explore CC adoption in healthcare are expected to appear. Moreover, we suggest that researchers further apply the *master variables*, which have been found to deliver consistent empirical results, in future studies of CC in healthcare (cf. Table 3) **(Recommendation 2)**. It must be stressed that a few of these *master variables* have not been closely examined and thus act as *potential determinant factors*. However, these variables' consistent empirical results will allow them to provide promising insights into CC adoption in healthcare and to support researchers in related future studies.

Our framework proposes two further conceptual categories for CC adoption that reflect the industry specificities of CC adoption in healthcare. The first conceptual category is *data/information*. The previous IT adoption research views data or information either as a subordinate of technology or as an organizational resource (cf., Jeyaraj et al., 2006; Schneider & Sunyaev, 2016). However, both views either restrict or improperly conceptualize the role of information/data for the healthcare industry, according to the following findings. First, in healthcare, data and information are not necessarily products of IT but consumers of IT. In other words, data and information exist and support healthcare organizations with or without IT. In the U.S., where the use of health IT has been strongly advocated, paper-based working processes to collect and address data or information remain common (Badalucco, 2015). Our review reveals that in many healthcare situations, data and information management tools that are not IT-related

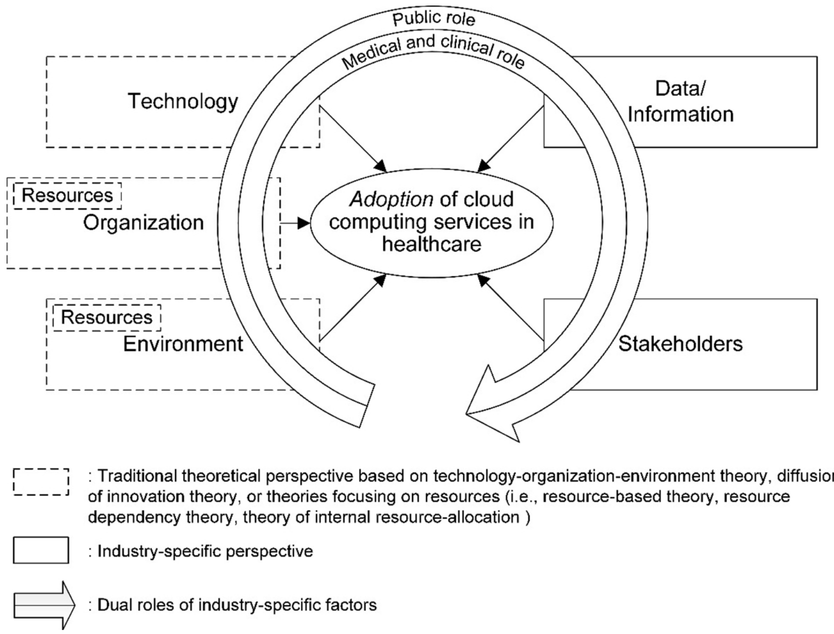

Fig. 2. Conceptual framework of determinant factors for cloud computing adoption in healthcare contexts.

Table 3
Recommendations for future research.

Findings	Related recommendation for future research
Technology, *organization*, *environment*, and *resources* are useful for explaining cloud computing adoption in healthcare	Adhere to IT adoption theories that rely on these four conceptual categories to investigate cloud computing adoption in healthcare
Concrete variables are found to deliver consistent empirical results	Apply identified variables that deliver consistent empirical results as a solid foundation to investigate cloud computing adoption in healthcare
Data/information, which has been discussed only in an unsystematic manner, serves as a relevant conceptual category	Employ a theoretical lens to data or information (in healthcare) to investigate cloud computing adoption in healthcare
Unlike in general contexts, impacts of individuals on cloud computing adoption in healthcare differ largely based on their roles	Differentiate the impacts of different stakeholder roles on cloud computing adoption in healthcare
Despite the relevance of the identified conceptual category *stakeholders*, only limited stakeholder roles have been examined	Expand stakeholder roles for their different impacts on cloud computing adoption in healthcare
Concrete industry-specific variables for healthcare have been identified	Focus on identified industry-specific master variables in future cloud computing adoption studies in healthcare
Features of the identified industry-specific variables can be explained and generalized by using the *public role* and *medical and clinical role* of healthcare	Rely on *public role* and *medical and clinical role* to find and select further industry-specific variables

are sometimes reported to be more effective and/or efficient for healthcare providers and patients (Baird et al., 2012; Mouttham, Kuziemsky, Langayan, Peyton, & Pereira, 2012). Thus, researchers begin to make data and information the focus and examine how IT can orient itself to data and information in healthcare (rather than the other way around) (Lim et al., 2018; Pirnejad, Niazkhani, van der Sijs, Berg, & Bal, 2009; Unertl, Weinger, Johnson, & Lorenzi, 2009). Second, data and information do not mean (only) resources for healthcare organizations. In the context of IT adoption, resources are understood as stocks of available factors (e.g., assets and capabilities) that are owned and controlled by the organization and that enable the organization to achieve competitive advantages and/or improve efficiency and effectiveness (Daft, 2007). It is true that healthcare organizations collect information and data, which originate mainly from patients, to deliver healthcare services. These healthcare organizations do not necessarily own the information and data as their property, and these assets should be controlled by patients (Haug, 2017; Mandl & Kohane, 2016). Healthcare organizations conduct research or analysis by collecting patient data, from which knowledge is produced (Sultan, 2014b). However, these data and the knowledge produced are thereby largely treated as “public goods” (p. 648) instead of individual property (Chestnov, Riley, & Bettcher, 2016). As shown by our studies, the master variables related to data/information do not identify these data and information as resources for healthcare organizations that provide competitive advantages. In contrast, concerns related to data/information, including *privacy*, *security*, and *data interoperability*, can lead to issues and, thus, disadvantages for healthcare organizations. The *data/information* category could play an important role, particularly for the adoption of CC in healthcare, because CC is closely related to data and information. On the one hand, CCSs are web-based by nature and are enabled only by the frequent exchange of data or information between different parties (Dwivedi & Mustafee, 2010; Sultan, 2014b). On the other hand, unique features such as *broad network access*, *resource pooling* and *rapid elasticity* (cf. Table A.1) allow CCSs to effectively support the data/information life cycle in healthcare from data and information collection to processing to archiving (Kuo, 2011). Our review reveals that although certain previous studies began to examine CC adoption by considering data/information, those studies are fragmented and remain in the minority. For future research, we suggest that researchers deepen their understanding of the role of data and information for CC adoption in healthcare. In particular, we suggest that future research investigate CC adoption in healthcare by relying on a specific theoretical lens on data or information in healthcare **(Recommendation 3)**. Organizational theories that consider information or data can provide a suitable foundation. Examples of such theories include *organizational information processing theory*, which focuses on organizational information processing needs, information processing capability, and the fit between the two to obtain optimal performance (Galbraith, 1974).

The other category that cannot be sufficiently supported by the applied theories of the reviewed studies is *stakeholders*. Although the previous research has stressed the need to seriously consider different stakeholders in the use of health IT (Leidner et al., 2010; Standing & Standing, 2008), the reviewed studies examine the roles of different stakeholders in an unsystematic manner. Although several reviewed studies also use theories that discuss the impact of individual roles, these theories do not sufficiently explain the highly complex situation created by the heterogeneous stakeholders in healthcare. The human, organization and technology-fit (HOT-fit) model of Yusof, Kuljis, Papazafeiropoulou, and Stergioulas (2008) is such a theory and was employed by three studies (Alam, Masum, Beh, & Hong, 2016; Alharbi, Atkins, & Stanier, 2016; Lian et al., 2014). The HOT-fit model stresses the importance of *human*, *organization*, and *technology* perspectives and the degree of *fit* among them for the use of health IT. Although the *human* perspective is related to the *stakeholder* idea, it focuses heavily on the attributes of *users* in health IT. Interestingly, the *user* group is the only stakeholder group in our review that delivers no *master variable* with consistent empirical results for CC adoption in healthcare. The adoption and use of IT in healthcare includes a large number of stakeholders (Mantzana, Themistocleous, Irani, & Morabito, 2007). The *user* group can have different types of roles in healthcare (e.g., physicians, nurses, patients, administrators, and insurers) with different attributes, attitudes, interests, and behaviors. Therefore, it is not surprising that the *master variables* from the *user* stakeholder group cannot deliver meaningful empirical results for CC adoption in healthcare. Whereas Schneider and Sunyaev (2016) and Jeyaraj et al. (2006) proposed focusing on general individual factors for CC and ITI adoption in general contexts, we suggest that future research on CC adoption in healthcare systematically examine the impact of different stakeholder roles **(Recommendation 4)**. We recommend the use of a seminal work that focuses on the importance of different stakeholder roles in organizations as the theoretical foundation such as *stakeholder theory*, which discusses the interests and power of different stakeholders for organizational processes (Donaldson & Preston, 1995). Moreover, our review reveals that only a limited number of stakeholder groups ($n = 6$) have been addressed by the current research. Further relevant stakeholder groups that are deemed relevant to health IT adoption (e.g., Mantzana et al., 2007), including but not limited to nurses, insurers, legal professionals and medical researchers, remain untouched. We suggest that future research further expand stakeholder groups and investigate their impact on CC adoption in healthcare **(Recommendation 5)**. The previous studies (e.g., Mantzana et al., 2007; Nielsen, Mathiassen, & Newell, 2014; Pouloudi & Whitley, 1997) that focus on heterogeneous stakeholders in healthcare contexts could serve as a starting point.

We identified specific *master variables* for CC adoption that exist only in the healthcare industry. Although we found that a few of these variables can deliver consistent empirical results (cf. Table 2), most industry-specific master variables have been underinvestigated. For example, a healthcare organization's *focus on chronic care* and a *vendor's medical knowledge* have a positive impact on ITI and ITO adoption, respectively (cf. Table A.2). Both *master variables* have only been studied once, and the review of their empirical results cannot lead to meaningful conclusions about their impact on CC adoption in healthcare. We recommend that researchers conduct in-depth investigations of the industry-specific master variables enumerated by our review **(Recommendation 6)**; these *master variables* represent the specificities of the healthcare industry and thus support researchers' understanding of the uniqueness of CC adoption in healthcare.

The identified industry-specific master variables reflect two specific concerns of the healthcare industry: the *medical and clinical role* and the *public role*. The previous research restricts medicine-related considerations in health IT adoption primarily to the attitudes and behavior of physicians or medical workers (e.g., Ammenwerth, Iller, & Mahler, 2006; Hu, Chau, Sheng, & Tam, 1999). With respect to the *public role*, existing studies strictly limit their understanding to the impact of policy makers in the healthcare industry (e.g., Blumenthal, 2009; Tang, Ash, Bates, Overhage, & Sands, 2006). We find that the identified industry-specific *master variables*, which are explained by both roles, are not restricted to any of the conceptual categories but exist across all of them (cf. Fig. 2). This finding shows us that the industrial specificities of CC adoption in healthcare should be considered, regardless of which theoretical views and related conceptual categories, according to our review, are considered. Therefore, we recommend that future research always seriously consider the specificities of the healthcare industry and further identify industry-specific factors for CC adoption in healthcare; the *public role* and the *medical and clinical role* could serve as two basic criteria for the identification of such factors **(Recommendation 7)**. It is stressed that, regarding the *public role*, future research can employ the determinant factors that influence CC adoption (and more general IT adoption) in the public sector as a starting point and investigate their role in the healthcare industry (e.g., Dwivedi, Weerakkody, & Janssen, 2012; Dwivedi, Shareef, Simintiras, Lal, & Weerakkody, 2016; Lian, 2015), especially as more CC adoption studies are expected to appear in the public sector (Dwivedi & Mustafee, 2010).

5.3. Contributions

This research contributes to both research and practice. With respect to research, we deliver a comprehensive list of master variables that can be applied to CC adoption in healthcare by future research studies. In contrast to the previous related studies (e.g., Schneider & Sunyaev, 2016), our study proposes master variables that are specific to the healthcare industry. Our research serves as a response to the calls for research to both improve the understanding of the CC phenomenon in the healthcare industry by Weigel et al. (2013) and, to a certain extent, investigate specific factors (i.e., the healthcare industry) by Schneider and Sunyaev (2016). More importantly, we propose a conceptual framework to explain the use of the determinant factors for CC adoption in healthcare and to provide specific recommendations for future research. By applying the concepts of the *public role* and *medical and clinical role*, our conceptual framework generalizes both characteristics of industry-specific determinant factors for CC adoption and thereby advances our understanding of the related industry specificities in healthcare. The conceptual framework and the proposed recommendations serve as a cornerstone for theory development with respect to a relevant IS phenomenon (i.e., CC adoption) in healthcare, which has been advocated by the IS community (Chiasson & Davidson, 2004). Because CC is observed as possessing both ITO and ITI features, we especially argue that knowledge from the conceptual framework can also be transferred to ITO and/or ITI adoption in healthcare contexts, which should be further validated by future research.

For practitioners, our list of independent variables can support CC adoption projects in healthcare organizations. Specifically, the master variables with consistent empirical results (Table 2) should serve as a checklist of enablers and barriers by which practitioners could focus their CC adoption projects.

5.4. Limitations

This research has certain limitations. It takes a first step toward a complete list of the determinant factors of cloud adoption by healthcare organizations. We are aware that healthcare environments from different regions/countries are heterogeneous and might respond to a determinant factor differently. The reviewed articles leverage data from a wide spectrum of countries, including but not limited to Belgium, China, Canada, Denmark, Great Britain, France, Germany, Norway, Saudi Arabia, and the United States, ensuring the coverage of existing healthcare systems worldwide (Raid, 2010). Our research particularly focuses on those determinant factors that are consistently (rather than differently) addressed because, in this first step, we aim to generalize our findings to broad healthcare contexts. To further understand the aforementioned differentiations, our list of determinant factors could serve as a starting point: determinant factors with highly inconsistent or conflicting empirical results are, for example, indicators of such differentiations (e.g., *ruralness*; see Table A.2). Similarly, this research does not investigate the prioritization of the determinant factors, their categories, or the correlations between them, which could also depend on different regions of healthcare organizations and influence the selection and use of the determinant factors. We recognize the importance of these points and leave them to follow-up research.

Our literature review focuses mainly on studies in research outlets (i.e., journals and proceedings) that are characterized by high quality and a strong reputation. It is by no means assured that all existing related studies have been addressed in our research. However, these journals and proceedings exclude “noise” and thus ensure high-quality results of the literature review (Webster & Watson, 2002). Moreover, we conducted a forward and backward search to supplement the predefined research outlets (Vom Brocke et al., 2015; Webster & Watson, 2002). Additionally, we reviewed only research studies from IS and MI. The topic of health IT is by nature multidisciplinary and involves additional areas such as medicine, management, economics, or law. We focus on IS and MI because, to the best of our knowledge, the topic of CC adoption in healthcare has been the most systematically discussed by both areas. However, we continue to recommend that future research explore this topic in other research domains.

6. Conclusion

The phenomenon of CC in healthcare remains in its infancy, and calls for research on this phenomenon have emerged in both the IS and MI fields (e.g., Kuo, 2011; Weigel, Hazen, Cegielski, & Hall, 2014). CC adoption is one of the most relevant topics for CC in healthcare because of the existing lagging adoption and the industrial specificities that influence the adoption process. We believe that both IS and MI will focus more on this challenging topic in future research, for which our review's identified master variables, derived conceptual framework, and proposed recommendations can serve as a solid foundation.

Declarations of interest

None declared.

Appendix A

Tables A.1 and A.2

Table A.1
Unique technical features of cloud computing (Mell & Grance, 2011) and their major value for traditional health IT approaches.

Technical feature	Description/definition	Major value for traditional health IT approaches
On-demand self-service	A cloud user can provide or adjust IT services based on own demand without requiring human interaction with each service provider	To increase healthcare organizations’ speed and flexibility in providing unforeseen IT services or resources for emergency events, despite the shortage of skilled IT staff in (rural) healthcare organizations (e.g., Yao et al., 2014)
Broad network access	IT services are available over the network and accessed by diverse client platforms (e.g., PCs; mobile phones; workstations)	To ensure healthcare organizations’ ability to gain offsite access to medical data and IT resources (e.g., Reddy & Bhatnagar, 2014)
Resource pooling	The cloud provider's computing resources are pooled and can be dynamically assigned to serve a cloud user according to his or her demand	To increase IT resources and thus overcome a scarcity of computing and storage capacities that threaten health IT operations (e.g., Ratnam, Dominic, & Ramayah, 2014)
Rapid elasticity	Capabilities can be elastically increased and released, in certain cases automatically, to scale rapidly outward and inward commensurate with demand	To offer timely, dynamic assignment of healthcare organizations’ IT resources based on demand and thus to optimize the use of IT resources and avoid IT bottlenecks (e.g., Ratnam et al., 2014; Ahuja, Mani, & Zambrano, 2012)
Measured service	IT services are automatically used, controlled and monitored by leveraging a metering capability (e.g., a pay-per-use mechanism)	To effectively control IT cost (e.g., Kuo, 2011)

Table A.2
Overview of identified master variables and their relationships with adoption of cloud computing/IT outsourcing/IT innovation.

Independent variable	Cloud computing					IT outsourcing					IT innovation					Σ
	+	–	0	M	#	+	–	0	M	#	+	–	0	M	#	
Category: technology																
Change in working progress												1			1	1
Compatibility	1		1	1	3						8		3	2	13	16
Complexity				2	2						1	2	3	2	8	10
Compliance with standards	1				1	2				2	1				1	4
Costs		2			2				1	1		2	2	2	6	9
Customization				1	1	1				1						2
Improvement of finances	1			1	2	4				4	2		1		3	9
Improvement of quality of care	1				1	2				2	5				5	8
IT production costs			1		1											1
Loss of productivity												1			1	1
Monitoring potential	1				1											1
Observability											2		1		3	3
Ongoing costs		1			1							2			2	3
Performance expectations							1			1						1

(*continued on next page*)

Table A.2 (*continued*)

Independent variable	Cloud computing					IT outsourcing					IT innovation					Σ
	+	–	0	M	#	+	–	0	M	#	+	–	0	M	#	
Relative advantages	1			1	2				1	1	6		3	2	11	14
Reliability		3			3							1			1	4
Responsiveness to IT demands						1				1						1
Return on investment											1	1			2	2
Setup costs		1			1							2			2	3
Shared IT expertise						1				1						1
Specificity						1	1		1	3						3
System quality	1				1											1
Technical barriers												1			1	1
Technical limitations												1			1	1
Transaction costs		1			1				1	1						2
Trialability													1		1	1
Σ	7	8	2	6	23	12	2		4	18	26	14	14	8	62	103
Category: organization																
Affiliation						1	1			2	6				6	8
Age							1		1	2	1	1	1		3	5
Clinical needs											1				1	1
Culture of collectivism											1				1	1
Focus on chronic care											1				1	1
For-profit status						1				1	6	2	2		10	11
Formalization													1	1	2	2
Insurance reimbursement	1				1						1		1		2	3
Intention for social gain											2				2	2
Internal needs											4		2	1	7	7
IT complexity											1	1			2	2
IT culture						1				1	4				4	5
IT formalization						1			1	2						2
Medical specialization									1	1	2				2	3
Occupancy rate													1		1	1
Organizational centralization											2	3	1	1	7	7
Public-owned status							1	1		2						2
Size			1		1	1	1			2	16	3	3		22	25
Staff relationships											1		1		2	2
Strategic importance of IT							1			1	1				1	2
Teaching status											4		3		7	7
Resources																
Commitment											1				1	1
Financial resources	2				2	1				1	7		1	1	9	12
Former experience			1		1	1				1						2
IT capabilities	1		1		2	3	1			4	8			2	10	16
IT budget	1				1	2				2	2				2	5
IT sophistication	1				1	4	1			5	5	1	1	2	9	15
IT staff	1				1		2			2	3				3	6
Knowledge about own business						1				1						1
Medical staff											1	1			2	2
Project team competence											1		1	1	3	3
Presence of champions											1		1		2	2
Slack resources						1				1			1		1	2
Space									1	1						1
Σ	7		3		10	18	8	1	4	32	83	13	21	9	125	167
Category: environment																
Care system maturity											1				1	1
Competitive pressure	2				2	1				1	7	1	5	1	14	17
Environmental uncertainty													1		1	1
Penetration of health insurance											1				1	1
Industry standards	1				1						8				8	9
IT artifact penetration						1				1	4		1	1	6	7
Managed care pressure													1		1	1
Market maturity						1				1	3		1		4	5
Related references	1				1						7				7	8
Ruralness						1	1			2	2	7	2		11	13
Resources																
Industrial IT infrastructure											2		1		3	3
Special funding	1				1	1				1	4		1	1	6	8
Σ	5				5	5	1			6	39	8	14	3	63	74
Data/information centralization		1			1											1
Data digitalization							1			1						1
Data/information processing needs											2				2	2
Data interoperability		1			1		1			1		2	1		3	5
Privacy		3			3		1			1		2		1	3	7

(*continued on next page*)

Table A.2 (*continued*)

Independent variable	Cloud computing					IT outsourcing					IT innovation					Σ
	+	–	0	M	#	+	–	0	M	#	+	–	0	M	#	
Security		3			3		1			1		3	3		6	10
Σ		8			8		4			4	2	7	4	1	14	26
Category: stakeholders																
Administrator																
Administrator's committee participation												1			1	1
Administrator's cosmopolitanism											1				1	1
Administrator's educational level											1				1	1
Administrator's involvement in medical activities											1				1	1
Assertiveness of top management													1		1	1
CIO's innovativeness	1		1		2											2
Existence of IT officer											1	1			2	2
Manager's education substance													1		1	1
Manager's innovativeness											1			1	2	2
Manager's tenure											1				1	1
Strategic importance of IT officer											2				2	2
Top management attitude											3				3	3
Top management IT skills											1		1		2	2
Top management support	2				2	2				2	7		3	1	11	15
Patient																
Elderly patients													1		1	1
Insured patients											1	2			3	3
Patient educational level											1	1			2	2
Patient employment rate												1			1	1
Patient income													1		1	1
Patient preference						1				1	1				1	2
Patient sovereignty		1			1											1
Policy maker																
Central push	1				1	2				2	5		1	1	7	10
Regulations			1	3	4				3	3	1			8	9	16
Physician																
Chief of medicine's cosmopolitanism													1		1	1
Chief of medicine's tenure													1		1	1
Involvement in administration						1				1	3				3	4
Physician's innovativeness											1				1	1
Physician's intention for social gains											1				1	1
Physician support						1				1	6				6	7
User																
Satisfaction with existing IT											1				1	1
User involvement													2		2	2
User support													2		2	2
User's willingness to change	1				1											1
Vendor																
Business interdependency									2	2				1	1	3
Physical distance		1			1		1			1						2
Possibility of onsite audit	1				1											1
Role multiplicity in healthcare							1			1						1
Simplicity of the vendor side						1				1						1
Trust			1		1						1				1	2
Uncertainty about contract fulfillment		1			1											1
Uncertainty about vendor lock-in		1			1											1
Uncertainty about vendor's stainability		1	1		2											2
Vendor competence	3				3	1				1	3	1			4	8
Vendor's medical knowledge						1				1						1
Vendor push													1		1	1
Vendor support	2				2						8		3	1	12	14
Σ	11	5	4	3	23	10	2	0	5	17	52	7	19	13	91	131

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.ijinfomgt.2019.02.002.

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