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Digital transformation in healthcare: Analyzing the current state-of-research

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ABSTRACT

Digital transformation in healthcare is of increasing relevance for both scholars and practitioners in the field. Our article attempts to assess the research question how multiple stakeholders implement digital technologies for management and business purposes. To answer this question, we perform a systematic literature review about the state of the art of digital transformation in healthcare. Our findings show that prior research falls into five clusters: operational efficiency by healthcare providers; patient-centered approaches; organizational factors and managerial implications; workforce practices; and socio-economic aspects. These clusters are linked together into a model showing how these various forms of technology implementation lead to operational efficiencies for services providers. Various directions for future research and management implications are offered.

1. Introduction

Digital transformation (DT) refers to "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019, p. 118). DT affects many aspects of companies, such as the acquisition of digital resources, the design of digital growth strategies, the change of internal organizational structure, and the definition of proper metrics and goals (Verhoef et al., 2019). This phenomenon has become a very popular topic within various streams of business research (e.g. information systems, strategy, marketing) and is revolutionizing the business sector writ large. For many years, healthcare (HC), which refers to all services that medical professionals deliver to preserve people's physical and mental well-being, has been one of the main industries in which DT has occurred (Agarwal, Guodong, DesRoches, & Jha, 2010; Marques & Ferreira, 2020). The digital revolution in HC creates new business opportunities and yields new business models to address issues in medical practice, value creation and other problems related to, among others, the ageing society (Elton & O'Riordan, 2016).

The rising relevance of DT in this industry became evident to both scholars and practitioners (Reis, Amorim, Melão, & Matos, 2018). A recent systematic literature review about DT in HC (Marques & Ferreira, 2020) shows how much research on this topic has increased over the last 20 years and highlights the most common technology-related research themes within this domain. However, due to the strict focus on technology, it does not adequately highlight the various management applications and business impacts of DT on the multiple stakeholders of this industry (Nudurupati, Bhattacharya, Lascelles, & Caton, 2015). A multi-stakeholders perspective is critical to understanding properly how, in practice, the various players of a HC ecosystem (patients, pharmaceutical companies, hospitals, public agencies, and many more) exploit DT technologies and means to quality of care, value creation, and many more managerial issues. Mainstream literature about DT scarcely analyzes the stakeholder perspective, in which it is generically reported that a heterogeneous set of network stakeholders is a crucial condition for the organization of value creation, growth, digitalization and DT (Verhoef et al., 2019; Vial, 2019).

Drawing on these assumptions, the research question of the present article is: how should the industry's multiple stakeholders implement DT technologies for management and business purposes? To answer this question, we perform a systematic literature review (SLR) about the

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state of the art of DT in HC. This article contributes, first, to the general stream of literature about DT (Verhoef et al., 2019; Vial., 2019) by illustrating clearly the roles and activities of more and heterogeneous (employees, customers, services providers and so on…) stakeholders during this process. Second, our findings contribute to the rising body of knowledge about DT in HC (e.g., Marques & Ferreira, 2020) by showing, via a stakeholder-based perspective, how health service providers should gain operational efficiency and strategize via digitalization. The findings of our SLR show prior research about DT in HC falls into five clusters: operational efficiency by HC providers; patient-centered approaches; organizational factors and managerial implications; workforce practices; and socio-economic aspects. These clusters are linked together into a model showing how these various forms of technology implementation lead to operational efficiencies by HC services providers. Various directions for future research and management implications are offered.

2. Background literature

Digital disruption has become a phenomenon of the 21st century that is transformational in all traditional industrial contexts (Ford, Compton, Millett, & Tzortzis, 2017), affecting all levels of business and society (Schallmo & Williams, 2018). The introduction of digital solutions in organizations requires systematic changes of "working, roles and business offering" (Parviainen, Tihinen, Kääriäinen, & Teppola, 2017, p.64). The performance of a company is affected by new technologies and connectivity of all stakeholders across the value-added chain (Schallmo & Williams, 2018). The concept of DT incorporates digital trends at different levels, including technology, processes, organizational aspects, especially business model disruption and society (Klewes, Popp, & Rost-Hein, 2017).

Four disruptive digital-enabled concepts currently are supporting the DT of organizations: 1) The fourth industrial revolution, or Industry 4.0 (I4.0), which relates to "the systematic connection of technical components and processes […], supply and […] business relationships including all logistical elements" (Klewes et al., 2017, p.11). It is based on the concept of I4.0, the Internet of Things (IoT), which describes the interconnection of computing power and data flows of smart objects that enable the autonomous control of daily life processes (Klewes et al., 2017); 2) Artificial Intelligence (A.I.), understood as the transformation of service processes into automated processes that rely on intelligent computer systems or computer-controlled robots that do not require human intervention to execute tasks associated with intelligence (Copeland, 2019). The concept of Big Data was used to describe the "volume, velocity and variety of data" (Manogaran et al., 2017, p. 264) that becomes increasingly difficult to analyze through conventional data processing tools. Currently, digital technologies enable homogenization and storing of significant amounts of data using big data analytics, or "advanced tools and techniques to store, process, and analyze the large volume of data" (Manogaran et al., 2017, p. 264).

The adoption of ICT has been affecting the HC sector since the mid-20th century (Ford et al., 2017). On example of this is improved research and care delivery. The introduction of the Internet in the mid-1990s has strongly impacted the way in which stakeholders communicate (Arni & Laddha, 2017; Suggs, 2006). The paradigm shift in HC organizations has only incrementally changed the HC industry over the last 20 years (Tuzii, 2017). 'DT in HC' refers to the adoption of new technologies that enables the shift towards secure, high-quality care (Haggerty, 2017). Belliger and Krieger (2018, p. 311) add the aspects of "new developments as self-tracking, big data and predictive analytics, e-health, mobile health, participative medical research, e-patient communities, […] and shared decision making in diagnosis and e-therapy". Such connotations makes DT in HC a concept that overlaps with digital health, which refers to the "use of information and communications technologies to improve human health, healthcare services, and wellness for individuals and across populations" (Kostkova, 2015). Recently, Marques and Ferreira (2020), in their review of 45 years of literature about DT in HC, found seven technology-related areas of research: 1) Integrated Management of Information Technology in Health; 2) Medical Images; 3) Electronic Medical Records; 4) Information Technology and Portable Devices in Health; 5) Access to E-Health; 6) Telemedicine; and 7) Privacy of Medical Data.

Big data in HC is rooted in clinical research results, Electronic Health Records (EHR), as well as consumers' personal data retrieved from self-tracking devices, e.g. wearables for work-monitoring or sports (Belliger & Krieger, 2018). Patient data typically includes all treatment-related documentation, such as written and visual medical records, doctors' letters, e-prescriptions, insurance claims (Haggerty, 2017). Siemens, (2016) specifies four main HC data generators: HC providers, ancillary service providers (e.g. pharma companies), public and private institutions, and patients. Given the fact that population is on the rise in the developing parts of the world, health data analytics are driving global changes in medical treatment models. This, among other things, is driving the untapped potential of data from today's HC models is relevant (Reddy & Brahm, 2016). Proper use of medical big data requires accurate data gathering and analysis, including health records, genomics, and information retrieved from different applications. Big Data analytics can promote personalized individual care to predictive models for big population groups.

Big data and data analytics in HC establish a basis for electronic health records (EHR), "[A] repository of patient data in digital form, stored and exchanged securely, and accessible by multiple users" (Häyrinen, Saranto, & Nykänen, 2008, p. 293). By 2015, 'Electronic Medical Records' (EMR) were implemented and used throughout many independent entities including HC providing institutions, insurers, and patients (Evans, 2016). EMR are "digitalized systems which functionally provide patient history, patient demographics and registration details" (Chakravorty, Jha, and Barthwal (2018, p. 9) for professionals' use, often based on telemedicine approaches. The concept of telemedicine traces back to the 19th century (Arni & Laddha, 2017). Telemedicine is "the delivery of [HC] services, where distance is a critical factor, by […] using [ICT] for […] treatment and prevention of disease and injuries, research and evaluation, and for continuing education of [HC] providers, all in the interests of advancing the health of individuals and their communities" (World Health Organization (2010), 2010, p. 8). Related functional branches of telemedicine encompass teleconsultation, telecare, telemonitoring or telehealth, and tele diagnoses (Arni & Laddha, 2017; Ford et al., 2017; Tuzii, 2017).

2.1. General Considerations

Drawing on these assumptions, some general considerations can be developed about operational efficiency led by DT in HC and industry stakeholders. First, digital technologies are often expected to improve the quality of care and operational efficiency by facilitating clinical and administrative tasks linked to the assessment, transmission, evaluation, and precision of medical treatment. The adoption of technological innovations, such as wearables devices and health apps, has mainly had an impact on internal processes and the positioning of patients in the HC system. These and other solutions leverage the progress in big data and data analytics toward new possibilities of personalized care. Second, the traditional stakeholders of the HC market are represented through four closely interacting focus groups (see Fig. 1): patients and consumers, HC providers, policymakers, and third-party creditors (Schachinger, 2013). DT in HC changed the mechanisms of value creation linking together these traditional focus groups and, uppermost, by extending with new players (e.g., digital companies) the set of stakeholders within this industry.

Third, DT does not change only the mechanisms between these traditional industry actors but also revises the overall HC landscape. Various new market actors disrupted the value chain of the telemedicine market: telecommunications companies and mobile operators,

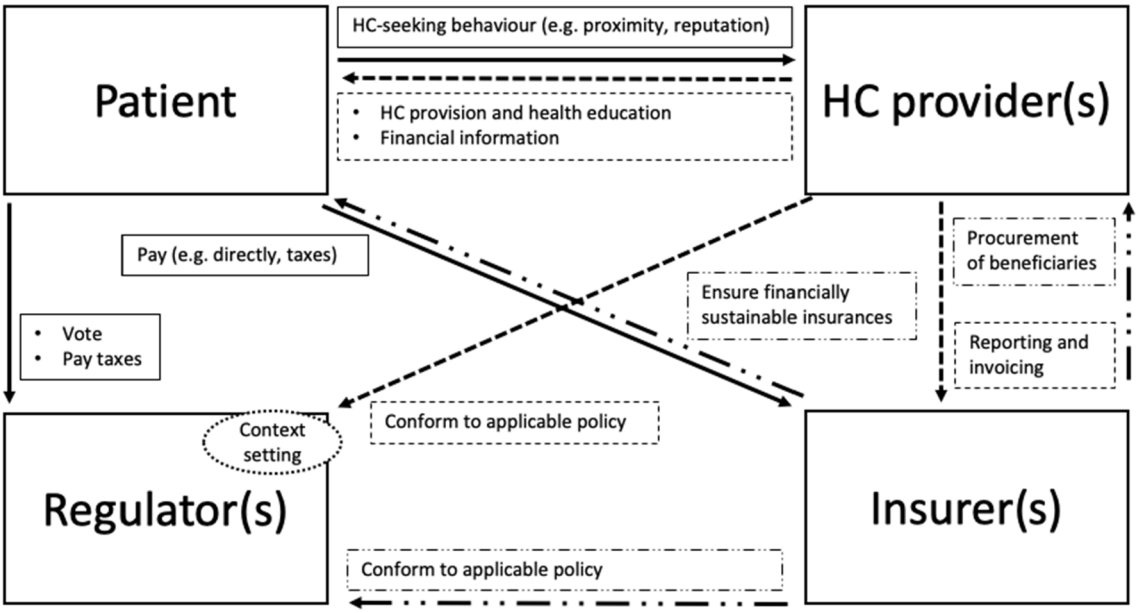

Fig. 1. Stakeholders of the traditional HC system. Source: Own elaboration.

pharmaceutical companies, and manufacturers of medical and monitoring devices and platforms (Wright & Androuchko, 1996; Baum & Abadie 2013).

3. Systematic literature review

3.1. Methodology

To provide an overview of the current state of academic literature, a SLR was conducted in the first semester of 2019, with a focus on publications in the field of Management, Business and other related areas such as Information Systems. In recent years, this research methodology became very popular within the field of innovation and entrepreneurship studies (e.g. Kivimaa, Boon, Hyysalo, & Klerkx, 2019). A SLR "is a review of an existing body of literature that follows a transparent and reproducible methodology in searching, assessing its quality and synthesizing it, with a high level of objectivity" (Kraus, Breier, & Dasí-Rodríguez, 2020, p. 4). The literature review reported in the previous section comprised different peer-reviewed and non-refereed articles, case reports, book chapters and consulting reports. Following a well-established approach used for studies of different types (e.g. Bouncken, Gast, Kraus, & Bogers, 2015; Vallaster, Kraus, Lindahl, & Nielsen, 2019), a SLR focused above a certain quality level of publications in peer-reviewed academic journals with specific criteria chosen to be conducted hereafter. A stepwise research approach has been undertaken to ascertain a broad perspective for an in-depth understanding of the context (Cook & West, 2012) and linkages between DT and HC. The first step was the literature search through the EBSCO host databases 'Business Source Ultimate' and 'Business Source Complete' (see e.g., Mas-Tur, Kraus, Brandtner, Ewert, & Kürsten, 2020). Since digitalization in HC, understood as the use of information technology for processing and managing data, information, and processes, started to become popular in the early 2000s (Agarwal et al., 2010), the 2000–2019 time frame was set. Non-refereed articles, conference papers and book chapters have been excluded from the search.

An initial search included the keyword combinations 'digital*'[1] AND 'healthcare' both in titles only to ensure that publications covering both core areas could be identified. This first search yielded 31 articles. With the intent to increase the breadth of the SLR, a further broader search should produce a more significant number of articles: Hence, even if many were less relevant to the present topic, the combination 'digital*' in titles AND 'healthcare' in abstracts was applied. The search was conducted according to the same search criteria as above, e.g. publication date, source type and language. This further search yielded 114 manuscripts. After excluding 15 multiple entries, the search sample for EBSCOhost consisted of 130 journal articles. Furthermore, to strengthen the inclusiveness of the sample of articles in this field, the databases Elsevier ScienceDirect and SpringerLink were also scanned according to the same keywords as mentioned above. The above search resulted in a total of 340 articles. Articles that did not fall under the conceptual criteria set earlier were then systematically excluded. In order to provide a quality threshold, we adopted the official German journal ranking "VHB-JOURQUAL 3" and considered only those articles that were released in journals ranked at a "C" level or higher ratings remained in the sample (Bouncken et al., 2015). We did not apply other quality criteria (e.g., impact factor) or journal rankings (e.g. ABS). After this check, 198 articles were excluded due to low or non-ranking statuses of the journals they were published in. The revised subsample then contained 142 high-quality articles.

To further the conclusions, after reading the titles, keywords, and abstracts, another 115 articles of the resulting subsample were eliminated, based on subjective decision-making. These publications were determined not to be a fit for the field of research, either because they were not covering the overall focus of digitalization in HC or lacked a meaningful discussion of this topic. This final step of excluding a relatively high number of ill-fitting manuscripts has condensed the sample into 27 academic journal articles. All results have been gathered in Excel data extraction sheets, including the exclusion criteria. Afterwards, the sample was scanned multiple times to develop clusters of recurrent topics covered. A visual overview of the literature search process, including the set of restricting criteria and further limitations, is provided in Fig. 2.

3.2. Descriptive results of research

By analyzing descriptive elements of the sampled publications, the distribution of articles per year (Fig. 3) reveals that publications range

[1] Asterisks at the end of words point variations of the word 'digital' regarding British or American English spelling and variations in its root out, e.g. digitalisation, digitalization, digitalised, digitalized, digitally.

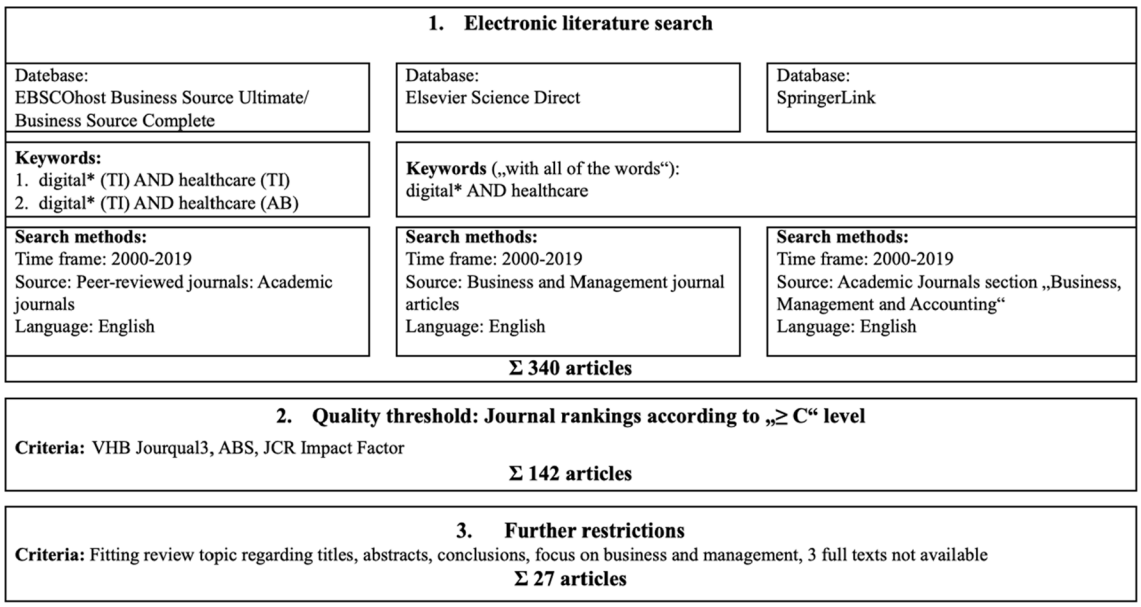

Fig. 2. Literature search process. (Source: Own elaboration).

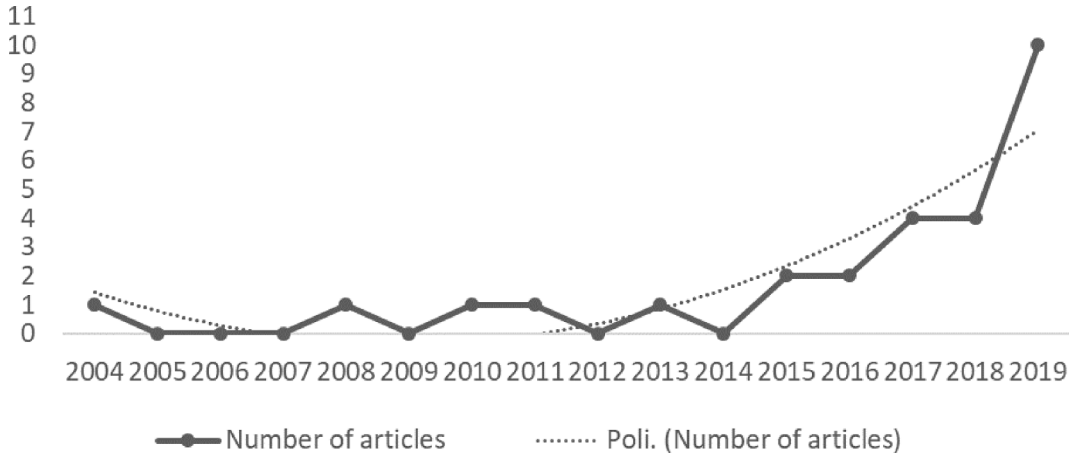

Fig. 3. Chronological development of the number of academic articles, 2004–2019 (n = 27). (Source: Own elaboration).

from the years 2004 to 2019. Only one study of the sample was published in 2004, followed by an interruption until 2008. From 2015, a steadily increasing interest in this field of research can be observed, showing a peak in 2019 with ten manuscripts. Crucially, 67% of all the identified articles have been published since 2017, indicating the generally high topicality of digital health in high-quality journals.

The highest number of papers (n = 7) cover articles from researchers in North America (e.g., Agnihothri, Cui, Delasay, & Rajan, 2020; Gray, El Sawy, Asper, & Thordarson, 2013). Furthermore, five articles originate from cross-country research, especially in the cases of conceptual frameworks (e.g. Mishra et al., 2019, Patrício, Teixeira, & Vink, 2019). Remaining articles mostly have their origins in Europe, especially in the Western and Northern area, e.g. Ireland, Germany, Italy (n = 2 for all), indicating emerging trends and actions by the EU. A total of 18 journals are represented,[2] and the journal with the highest number of accepted articles is 'Health Care Management Science' (n = 5 in 2004–2019). Such findings suggest that research into DT of HC remains rooted in the HC industry area and that the topic remains emergent.

In order to get an understanding of the fields of research the cross-functional topic is rooted in, the general publication subjects represented by the academic journals were also analyzed: For this purpose, the journal publication details from the respective online databases

[2] Information Systems Research (n=2); Health Care Management Science (n=5); MIS Quarterly (n=1); MIS Quarterly Executive (n=2); European Journal of Marketing (n=2); Health Services Management Research (n=1); Journal of Business Research (n=2); Marketing Theory (n=1); Service Business (n=1); Management Revue (n=1); Business Process Management Journal (n=1); Journal of Decision Systems (n=1); Health Policy and Planning (n=1); AMS Review (n=2); International Journal of Operations and Production Management (n=1); Public Relations Review (n=1); Information and Management (n=1); International Journal of Information Management (n=1).

where the articles were retrieved from were also included. Being a topic of high currency and rapid technology adoption, DT of HC is a subject of Business, Management and Marketing research, with 15 articles classified as Business and/or Management, three among them from journals solely publishing about Marketing topics. A focus on consumerization to approach DT in HC becomes evident. On the one hand, main streams relate to more specific technology-linked areas like Information Management, Management of Information Systems, or Information Technology (n = 8). On the other hand, an important number of articles (n = 7) retrieved from journals on the threshold of management and HC stands out. However, DT in HC has been researched in other fields, such as Public Relations (n = 1) and Operations Management (n = 1). In this sense, the relevance of cross-functional research for the management practice becomes evident.

Given the relatively young research field, most of the studies rely on empirical data from qualitative analyzes (n = 10), mostly single or multiple case studies, and in some cases, interviews. Yin (2012) points out that qualitative analysis brings the advantage of gaining an in-depth understanding of people's viewpoints without being limited by certain answers through surveys. Further, seven methods were quantitative in nature, mostly in the context of factor analyzes and structural equation modeling. Additionally, four conceptual papers and four Literature Reviews could be identified and two articles applied multimethod approaches.

3.3. Findings: Five clusters of healthcare research about digital transformation

3.3.1. Cluster 1: Emphasis on patient-centered approaches

Patients are empowered by the rise of digital technologies and are therefore becoming active decision-makers in their medical care process. Gray et al. (2013) examine the value creation of DT on the HC provider-patient relationship through the cumulative value of center-edge models, namely value chains, value shops, and value networks. This relationship is mainly characterized through self-service and feedback cycles. Findings of their qualitative empirical investigations prove that HC is a consumer-centric industry which is well-positioned for a fundamental center-edge transformation. In this regard, Mende (2019) shows that HC consumers are both "co-producers of service" and "partial employees" who must actively become involved in managing their own health. According to Mende (2019), research on patient-based approaches remains nascent, but is of major relevance to achieve technological innovation in HC, e.g. in order to explore consequences of the imminent use of humanoid service-robots on elderly patients and service companies.

Research has shown that tensions between patients and physicians, due to conflicts of interest, negatively affect patients' wellness (Jefferies, Bishop, & Hibbert, 2019). For this reason, value co-creation and service-dominant logic (SDL) have emerged as a focus of investigations: Leonard (2004), Patrício et al. (2019) and Jefferies et al. (2019) study how participatory design approaches influence the performance of HIT. One general objective of HIT is the facilitation of information sharing among interest groups. EHR, currently representing the highest financial burden in HC (Agnihothri et al., 2020; Leonard, 2004), are especially relevant in the context of treatment of chronic diseases. With the intent to develop a national EMR system, Patrício et al. (2019) equally identify the need of participatory decision-making approaches among interest groups and find that participatory service design enables institutional HC innovation. With a specific focus on telehealth, Jefferies et al. (2019) analyze the integration of patients' perceptions and feedback on issues related to technology, bureaucracy, and professionalism in HC organizations. Based on inquiries of heart-disease patients, Jefferies et al. (2019) find functional, relational, and translational attributes that disrupt the borders between HC institutions and boundary workers.

A further stream discloses consumers' use of web-enabled solutions for health-related purposes. Cavusoglu and Demirbag-Kaplan (2017) aim to identify consumers' perceptions of health throughout a content analysis of digitized accounts on social media channels, e.g. Instagram. They develop a four-quadrant model grounded in a commercialized meaning-making processes. The authors find that meanings of health on social media are often reproduced around consumption objects, and consequently leverage conceptualizations around specific themes, namely food, fitness, fashion, and feelings. In this regard, other researchers explore the effect of online networks on elderly Spanish consumers' health-related information seeking and the impact on their interconnectedness (Sanders, Sánchez Valle, Viñaras, & Llorente, 2015). Their study outlines that the internet does not replace face-to-face consultation, but rather serves as a complementary, dispensable service. Nevertheless, little research exists on the correlation of consumers' multi-channel health information-seeking and value co-creation. Therefore, Dahl, Peltier, and Milne (2019) investigate consequences of autonomous information-seeking on consumers' health awareness and flow patterns for health service systems. Their understanding of patient empowerment discloses a transition from provider-controlled to externally-controlled digital information sources, which mainly results from patients' active engagement in networks.

More specifically, the impact of m-health technologies on disease progression is examined by Agnihothri et al. (2020) and Yousaf et al. (2020). Agnihothri et al. (2020) measure benefits according to two indicators, namely the average life expectancy, as well as the expected total lifetime earned. The latter literature review concentrates on the identification of mobile dementia applications and their assessment in terms of utility for patients suffering from dementia or Alzheimer's disease, as well as benefits for caregivers (Yousaf et al., 2020). Whereas Agnihothri et al. (2020) specifically develop a market chain to design disease progression with regard to various factors, both studies point out that the value of m-health is dependent upon factors, such as the current state of health, frequency of measurement and intervention, and caregivers' support or patterns of disease progress (Yousaf et al., 2020). Yousaf's et al. (2020) comprehensive study reveals that m-health based technologies have a positive impact on supporting patients and physicians with cognitive training, monitoring, socializing, respectively screening. Further, Agnihothri et al. (2020) observe a linear correlation between a patient's severity of medical conditions and personal benefits of m-health.

3.3.2. Cluster 2: Operational efficiencies of healthcare organizations

Technological innovations in HC influence operations and processes and research reveals various patterns in this regard. Several studies focus on the impact of HIT on operational efficiencies and value creation (e.g. Hong & Lee, 2017; Laurenza, Quintano, Schiavone, & Vrontis, 2018; Taiminen, Saraniemi, & Parkinson, 2018). Accordingly, Hong and Lee (2017) analyze the effects of HIT and supported knowledge skills on HC quality and customer loyalty. They found a positive correlation between operational innovation and patient satisfaction, which pointed to loyalty, mainly tracing back to reduced expenses and improved workflows (Hong & Lee, 2017; Rubbio, Bruccoleri, Pietrosi, & Ragonese, 2019). A further contribution to this aspect is provided by Laurenza et al. (2018) who study the influence of digital technologies on business process (BP) performance in the HC industry, throughout the case of the Italian pharmaceutical company MSD Italy. Results show that the adoption of digital technologies positively impacts quality of care by reducing the reaction time of clinicians and, generally, HC institutions due to their improved administrative processes.

Furthermore, researchers investigate issues concerning innovations in HC. An example that falls into the scope of this cluster is the measurement of operational efficiency. On the basis of design science research, Mazor, Heart, and Even (2016) address this matter in emergency departments of hospitals. The researchers develop a prototype of a digital dashboard that assesses the impact on patients' duration of stay. Simulation results of their investigations show that the average length of stay can potentially be reduced by 34%, thusly improving productivity.

Regarding performance measurement, Kohl, Schoenfelder, Fügener, and Brunner (2019) introduce Data Envelopment Analysis (DEA) as a preferred tool to examine the efficiency of hospitals. They study the utility of DEA throughout a SLR of 262 publications. Notwithstanding a high number (n = 99) of papers found on approaches to estimate operational performance, it becomes apparent that research insights have often been ignored in practice.

Another important contribution in this field is made by Taiminen et al. (2018), who investigate physicians' perspectives on value creation through digital self-services. Although results of their survey (n = 412) show that physicians agree on a positive effect on service quality, the authors state that the HC industry is too immature for a full integration of digital self-services, which is consistent with previous research assumptions. Ozdemir, Barron, and Bandyopadhyay (2011) likewise consider physicians' perspectives, but in relation to countermeasures against issues in EMR adoption and data sharing. Due to physicians' general reluctance to adopt EMR at that time, especially because of distrust in providers, the authors consider an enhancement of PHRs by legal requirements and point out the positive effects of data sharing on added value for HC providers. Physicians' support of such platforms appears fundamental, especially if the goal is to enhance the management of chronic diseases.

Sultan (2015) conceptual paper contributes to the topic from a technological point of view: he reflects on the potential of wearable technologies for health monitoring and health data access and concludes that their contribution is positive to HC quality, especially regarding health data reporting. Sultan (2015) uses the example of increased efficiencies for measuring heart rate and blood pressure with the aid of wrist-or eye-based devices, i.e. Apple's iWatch. Finally, a specific focus on operational failures and the role of DT on HC organizations' resilience is provided by Rubbio et al. (2019). Throughout a multiple-cases study with two Italian hospitals, and importantly the authors find that resilience-oriented practices lack expertise in improving patient safety. Concerning operational failures, they distinguish between workflow dysfunctions that occur from lacking availabilities of equipment, and operational failures due to incorrect usage or task execution.

3.3.3. Cluster 3: Organizational factors and managerial implications

Three studies could be identified that investigate the role of organizational factors and managerial implications (Agarwal et al., 2010; Cucciniello, Lapsley, & Nasi, 2016; Hikmet, Bhattacherjee, Menachemi, Kayhan, & Brooks, 2008). Hikmet et al. (2008) focus on the strategic, administrative, and clinical HIT adoption[3] at hospitals by testing different organizational variables. Overall, the results from their field survey with 98 hospitals in Florida show hospital size and tax status, as well as system affiliation being key influencing factors for the motivation of adopting HIT. The authors, therefore, especially recommend standardizing administrative HIT systems. In contrast, Agarwal et al. (2010) find significant research gaps in the significance of organizational factors. Their review of existing studies on HIT results in two research streams: a focus on levels and barriers to the adoption of HIT and, the impact on quality of care, operational efficiency, and financial performance. Future research opportunities could come from HIT design implementation and meaningful use for organizations, measurement of HIT return, and extension of the traditional application areas.

A specific focus on the interdependence of implementing EMR systems and organizational conditions is provided by Cucciniello et al. (2016). The latter attributes a high potential of EMR systems to secure operational processes and enhance data sharing, and thereby relate to previous suggestions of factors in their comparative study. Thus, their analysis results in two factors to be considered: first, the different levels of current expertise with HIT in the HC entity, and second, diverse change management approaches. Positive effects of EMR systems can be expected if the implementation is supported by clinical staff and managers adopt a "'bottom-up approach' marked by a participatory process starting from initial selection onwards" (Cucciniello et al., 2016, p.141). Conversely, if managers impose the implementation and medical staff is not sufficiently involved in the co-development, it negatively impacts the DT of HC entities. Finally, a valuable contribution with regards to business model transformation is made by Laurenza et al. (2018). The authors observe that IT plays a central role for BP improvement and the shift towards value-oriented HC by supporting both administrative tasks and cooperation with other stakeholders.

3.3.4. Cluster 4: Impact on workforce practices

Just two studies can be identified that build on the transformation of employees within HC organizations (Eden, Burton-Jones, Casey, & Draheim, 2019; Huber & Gärtner, 2018). In order to relate DT and workforce transformation, hospitals must first "engage in flexing, deepening and revitalizing" (Eden et al., p.16): 'Flexing' refers to the way employees and hospitals respond to external restraints and leverage HIT to gain flexibility; 'deepening' relates to employees' behavior and reconsideration of their roles as health professionals; the influence of constant disruptions on tasks and skills is described as 'revitalizing'. These three practices are interdependent and influence the strategic orientation of a firm. With regard to the bottom-up approach, Eden et al. (2019) determine the adoption of two behavioral capacities, collaborative visioning and evidence-based improvisation. A development of competences is called for around the management of tensions between revitalization efforts across all hierarchical levels. Leaders should try to achieve quick wins to keep staff motivated.

Huber and Gärtner (2018) attempt to identify the effects of Health Information Systems (HIS) on an operating room module in a medium-sized hospital in Germany. They analyze the differences between autonomy and control in normal and hectic situations of surgeons' work, and the impact of transparent management on accountability. Concerning 'normal' situations, HIS seem to facilitate daily work practices, due to the encoding of standards and complex guidelines. Regarding "'hot situations' in which unexpected events occurred and routine behavior had to be suspended" (Huber & Gärtner, 2018, p.150), the HIS was found to be too time-consuming due to a lack of clear guidelines. HC professionals, therefore, engage with the technologies to keep their professional autonomy. Digital technology increases personal exercising power and accelerates work processes. Moreover, the simple access to medical results by team members of different hierarchies leads to improved co-evaluation and understanding of dynamic situations. Finally, digital technologies are considered to impact the reallocation of working practices and shift of power, especially between physicians, radiologists, and nurses.

3.3.5. Cluster 5: Socio-economic aspects

Four remaining articles of the sample discuss social matters and mitigating financing solutions. A focus on HC market investment and the relation to technological hype is provided by Geiger and Gross (2017). Concerning the development of the European digital health market over the past 15 years, direct market investments are highly linked to socio-economic and technological promises, as well as policy initiatives. Based on their SLR, Mishra et al. (2019) construct a conceptual framework to understand opportunities and challenges of digitalization for prospects of Community Health Workers (CHWs[4]) in social services. Opportunities relate to an easy peer-to-peer communication and decision-support,

[3] For instance, clinical HIT comprise Pharmacy Information Systems, Transcription, Laboratory Information Systems; administrative HIT enclose Patient Billing, Patient Registration, E-mailing; strategic HIT cover Outcome and quality management, BI systems and Cost accounting (Hikmet et al. 2008, p.4).

[4] The WHO defines CHWs as people who are members of a community, "and pertinently trained to deal with the health problems of individuals and the community" (WHO, in: Mishra et al., 2019, p.2).

while weaknesses of digital health literacy need to be solved.

Two articles attempt to study the link between HC financialization and digital division from two different geographical viewpoints (Burtch & Chan, 2019; Seddon & Currie, 2017). In the EU, health financialization has been widely regulated by law and the demand for financial measurement is rising amongst political leaders (Seddon & Currie, 2017). The authors uncover three country groupings that result from their multivariate statistical analysis of cross-country health data and ICT infrastructure: frontrunners, followers, and laggard countries (Seddon & Currie, 2017). Referring to recent questions raised about the fairness of distributed financial resources from medical crowdfunding platforms in the US, Burtch and Chan (2019) empirically study the correlation between online medical crowdfunding platforms and personal bankruptcy. The authors report medical crowdfunding could be a complementary solution to reduce bankruptcy, if governmental authorities take measures that enable disadvantaged populations to purposefully engage with digital platforms.

Taken together, the various streams identified can be interlinked to generate a model showing how the various stakeholders analyzed by prior research exploit DT for management purposes, and ultimately, contribute more or less directly to the achievement of operational efficiency by HC service provides (Fig. 4).

4. Discussion and implications

4.1. Discussion

Looking at the resulting sample, over the past three years the increasing number of articles published emphasizes the high level of relevance that has drawn attention from more researchers. Research into HC technology appears to be important to solve major issues linked to data analytics in HC and operational process improvement through EMR systems. Moreover, the convergence of HC and IT has been found to enable patient empowerment, hence redefine customer-centeredness in HC (e.g. Gray et al., 2013; Belliger & Krieger, 2018; Mende, 2019; Patrício et al., 2019). Concerning contextual patterns, the SLR reiterates two main streams initially introduced in the course of the transition from primary to secondary HC markets (Schallmo & Williams, 2018), namely connectivity of all stakeholders throughout the value-added chain and the empowerment of patients. Moreover, the SLR has clearly shown a connection between the parameters 'digitalization' and 'HC': Thus, investigations on internal business efficiency resulted in multiple affirmations (Laurenza et al., 2018; Hong & Lee, 2017; Mazor et al. 2016; Rubbio et al., 2019) and likewise confirmed changes in business roles. In contrast, the perspective of external business development was not found to be covered in the sample, a research gap can thus be identified with regards to partnerships for HC organizations.

Regarding the connection of the primary and secondary markets, theoretically introduced by Belliger and Krieger (2018), implications for key stakeholders and advanced opportunities for the traditional HC market were comprehensively discussed in the SLR sample articles (Gray et al., 2013; Jefferies et al., 2019; Mazor et al., 2016; Ozdemir et al., 2011). The strategic positioning of hospitals and clinicians emerged as a research focus (Hikmet et al., 2008; Mazor et al., 2016; Rubbio et al., 2019), but implications and opportunities for third-party creditors and the transformation of the health insurance system remain unexplored. According to the suggested ascertainment of disruptive concepts in secondary markets (Belliger & Krieger, 2018; Commission, 2018), scholars investigate a wide range of emerged digital health concepts, such as PHD use and data-driven HIT solutions, m-health, e-health, telemedicine and telehealth, and thereby affirm that I4.0 and digitalization clearly disrupt the traditional HC system (e.g. Patrício et al., 2019; Leonard, 2004; Jefferies et al., 2019; Agnihothri et al., 2020; Yousaf et al., 2020). Nevertheless, the disruptive tendency of further digital transformative technologies, such as A.I. and robotics (Imison, Castle-Clarke, Watson, & Edwards, 2016; Solbach, Kremer, Grünewald,

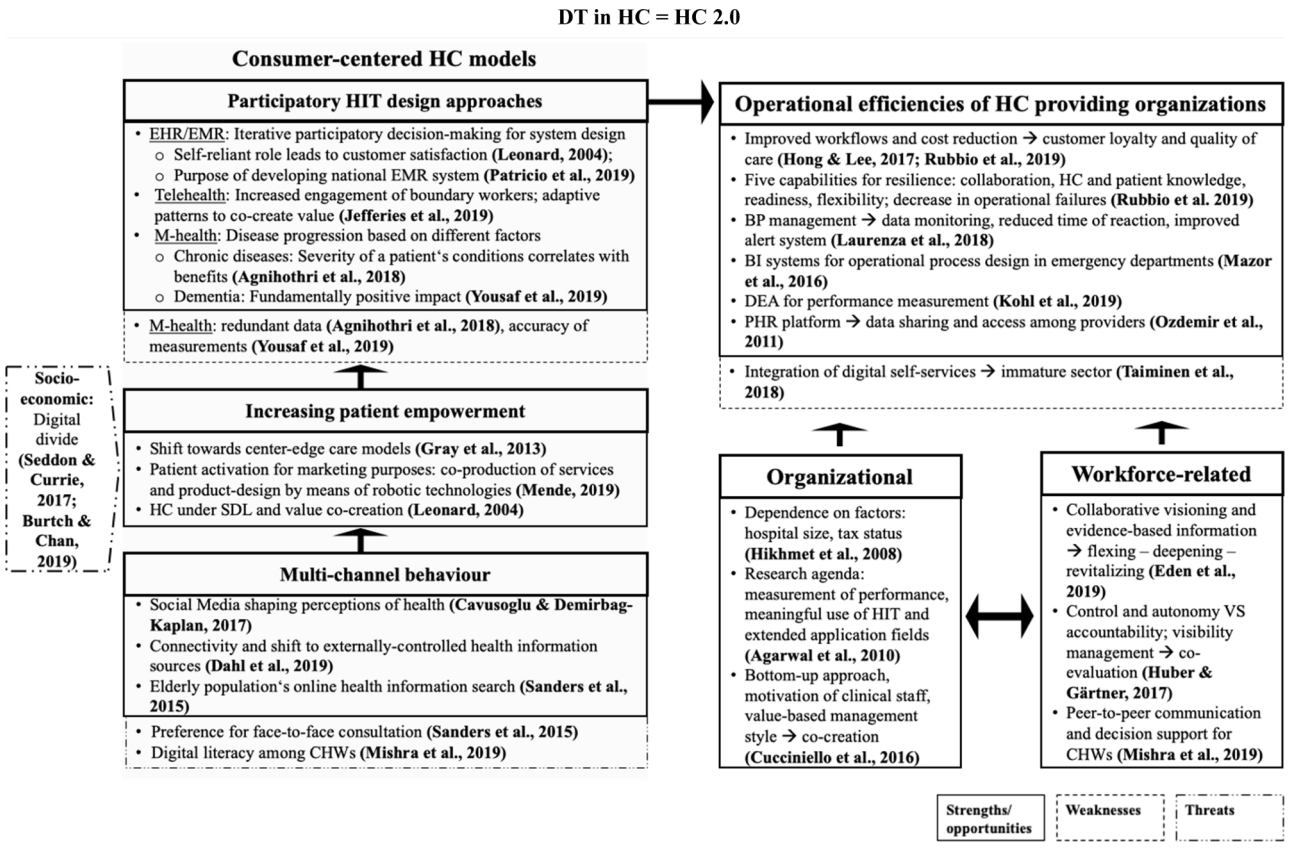

Fig. 4. Synthesis of key SLR findings (Source: Own elaboration).

& Ickerott, 2019), remain a nascent field of research.

Concerning the role of new market players, e.g. mobility and telecommunications firms, it became evident that this field has gained high interest in the practice (Deloitte, 2015; Commission, 2018; Solbach et al., 2019). A general observation is that digitalization in HC is currently a trending topic in non-peer-reviewed papers, such as consulting companies' publications, on market studies and forecast reports. In addition to the focuses on HIT, connectivity, and changes in the shifting balance of power, the literature has polyphonically addressed problems that relate to the digital divide. These have been described to especially affect disadvantaged populations that appear to be the ones most in need of care (Tuzii, 2017; Coile & Russel, 2000; Deloitte, 2015; EY, 2019). Although scholars examine potential causes, e.g. country groupings in usage of ICT or rather an unfair distribution of resources from medical crowdfunding (Burtch & Chan, 2019; Seddon & Currie, 2017), potential solutions to mitigate this complex issue cannot yet be found.

Based on the outcome of the analysis three potential answers could be found as to why the HC industry is lagging behind other sectors in its DT. Firstly, researchers refer to concerns around data security that lead to patients' rejection, as well as regulatory barriers for data use (Belliger & Krieger, 2018; Haggerty, 2017; Imison et al., 2016; Leonard, 2004). Second, although PHD is considered to enhance personalized and predictive medicine, the design and implementation of PHD-based HIT are linked to complex processes that require specific expertise in data analytics (Groves, Kayyali, Knott, & Van Kuiken, 2013; Haggerty, 2017; Manogaran et al., 2017; Solbach et al., 2019). Third, HC professionals partly hinder further patient empowerment (Agnihothri et al., 2020; Commission, 2018; Melchiorre et al., 2018; Taiminen et al., 2018), mainly because of data trustworthiness concerns and a general mistrust in TEC. Despite rapid progress in ICT and big data, stakeholders' reluctance to adopt innovative technologies will slow down the process of a DT in the sector.

Consumer-centered HC (Cluster 1) is enforced through participatory approaches for HIT design, such as EHR, telehealth and mobile applications. Current studies clearly indicate an affinity towards operational efficiencies of care-related processes (Cluster 2) that are due to higher resilience, improved workflows and BP management as well as decision-support and monitoring tools. However, considering disruptive changes, results in augmented quality of care clearly depend on transformations of organizational structures, in particular managers' and clinicians' value-based approaches (Cluster 3). A further important factor entails the adaption of new practices for workforce (Cluster 4), e.g. nursing or paramedical staff. Thus, DT requires collaborative visioning and evidence-based information exchange, which is why hospitals must engage in flexing, deepening, and revitalizing. Socio-economic aspects, e.g. investments in accordance with phases of the innovation hype cycle, or rather the digital divide, are finally found to primarily affect HC consumers (Cluster 5).

4.2. Recommendations for future research

The review of existing studies led to the identification of several research gaps about HC stakeholders and DT. These are derived from a surplus of qualitative research, a focus on hospitals as predominantly analyzed HC institutions, lacking research on business model transformation and external business development, unacknowledged questions around the digital divide, as well as financing options. Recommendations for future research should build on more different approaches. Foremost, there are important topics that would require a more impactful evidence groundwork based on tested relevant theories and hypotheses: for instance, this refers to the enhancement of EHR services as part of a SaaS business model (Ozdemir et al., 2011), or rather the adoption of 'flexing, deepening and revitalizing' work practices to achieve successful human resource transformation (Eden et al., 2019). Therefore, to get a more integrative view, deeper research based on empirical mixed and quantitative research should be conducted. Moreover, especially in early phases of HIT adoption and testing of new solutions, quantitative research is crucial to measure impacts for humans and financial returns. Whereas larger quantitative samples are needed to increase the generalizability of potential advantages and weaknesses, the adoption of qualitative methods, e.g. in-depth interviews, and multiple cases studies, would explore the operational and organizational effects for various HC institutions.

Further, a transformation of the patient experience towards e-visits or sensor pills has been suggested (Monti & Coleman, 2016; Tuzii, 2017). Future research here may consider methods to enhance participatory HIT design approaches, by integrating measurable user experience and insights from digital marketing analytics. One specific potential topic would be participatory design approaches of service robots for elder care for purposes of social interaction and cognitive disabilities. Accordingly, referring to forecasts for budget shifting patterns towards preventive medicine within the next eleven years (Solbach et al., 2019) and to the concept of '4P medicine', research is needed to identify comparable and measurable determinants that allow the deployment of personalized and predictive care.

With regard to operational efficiencies through the use of digital technologies, one specific topic for future research would be the potential dangers and costs of emergent innovative drivers, in particular A.I. for automation of cognitive processes and dialogue systems for remote services, or rather robotic applications in medicine, such as neurosurgical assistance, medical transportation, or sanitational purposes. In the future, scholars should likewise address trustworthiness issues of A.I. solutions that are of utmost importance in HC. Further, the analyzed HIT in the sample were found to affect administrative processes and productivity in hospitals (Laurenza et al., 2018; Mazor et al., 2016; Rubbio et al., 2019). Although operational efficiencies constitute the backbone of quality of care, the impact of medical innovations on physicians' decision making and knowledge management principally seems to be neglected. Such medical innovations include complex molecular nanotechnologies, middleware, digital imaging, and sensors. Predictive medicine requires strong expertise in in-depth analytics of PHD and data from EHR; big-tech companies are leveraging their core business in this field of HC innovation. Since the sample review resulted in a research gap on external business development, a stronger focus is required on collaboration and coopetition strategies for HC providers with secondary market players.

Regarding organizational aspects, the SLR illustrated that most existing scholar papers dealt with technological innovations, although DT covers a wider scope. Further investigations into the management of successful business model transformation and strategic courses that allow disruptive changes may be particularly valuable. As observed throughout the SLR, the adoption of digital technologies comes along with a redefinition of the meaning of health, thus demanding a closer examination of new core value drivers (Cavusoglu & Demirbag-Kaplan, 2017; Dahl et al., 2019). Our SLR also observed that effects of DT on organizational aspects of HC providing institutions, other than hospitals, are not addressed at enough depth, thus there is a clear need to investigate opportunities for the pharmaceutical industry with regard to the expansion of market e-commerce. Equally worthwhile would be a study of how business model transformation of pharmacies impacts customer acquisition, switching costs, and customer loyalty.

Fourth, in order to upskill HC professionals and identify how nursing staff has to be trained, i.e. to make use of system integration, robots and A.I., research is needed to explore how knowledge transfer from other advanced sectors in I4.0 and IoT, such as the automotive industry, might lead to best workforce practices pursued in HC. Authors from the sample have examined digital training programmes for CHWs (Mishra et al., 2019) and clinical nurses' skills related to the introduction of HIS, but with respect to market forecasts in robotics and connectivity, further research on disruptions for geriatric nurses and community-based care seems crucial. Specifically, there could be qualitative investigations on

doctors' or nurses' needs assessment and curricula updates which would provide a sufficient scale for linking traditional clinical practice and medicine in the digital age.

Fifth, the ROI of technological progress is difficult to evaluate due to high Research and Development expenses and a complex connection of different variables. In any case, the HC industry must become transparent about costs and profits for patients, providers, and insurers. For instance, attempts to evaluate the efficiency of DEA models (Kohl et al., 2019) remain theoretical, therefore a further inquiry into hospital managers' knowledge seems necessary. Also, deeper research is needed to investigate investment strategies for how to manage costs linked to digitalization. Eventually, based on progression of health outcomes and customer experience, possibilities of measuring the performance of HIS and e-health technologies should be examined. To advance the field of pharmacogenomics, scholars should likewise consider more fully the relevance of business opportunities for pharmaceutical firms.

Finally, a last recommendation refers to the exploration of how DT in HC affects the management of intellectual capital (e.g., Huang, Leone, Caporuscio, & Kraus, 2020). For instance, researchers could analyze how healthcare listed companies can exploit the typical means of DT for the voluntary external disclosure of their intellectual assets and how such digital-based disclosure could improve their operations efficiency (Giacosa, Ferraris, & Bresciani, 2017).

4.3. Limitations

This work has three limitations that need to be acknowledged. First, there are potentially many more factors that influence DT in HC than investigated and theoretically introduced beforehand. The choice of keywords is not extensive enough to cover all associated fields with DT. This might explain why some innovation-related concepts were declared as research gaps, i.e. robotic technologies or business model characteristics in HC. Second, while the applied methodology follows a well-established practice in different fields of science, a final small sample implies limited validity and generalization of results for the HC sector. Although rigorously implemented, the methodological approach could be criticized for excluding relevant articles on digitalization of HC, thus resulting in a small sample of manuscripts as a point of departure for the analysis. Third, a limited objectivity of the analyzed findings is acknowledged: The cluster analysis is rooted in a subjective allocation of main topics in the sample texts. Therefore, the integrated concept presented in Fig. 4 may provide a fragmentary view and need further refining.

4.4. Implications for managers

The present study also offers relevant implications for the management of HC organizations. First, DT allows patients operating within a thorough multi-channel environment that gives access to medical information, education and control of the health status with the aid of A.I. Patients will be able to choose their specialists according to own preferences and communicate through mobile platforms that will constitute the core interfaces. These platforms will be maintained by a network of physicians who provide consultation and transfer to specialists. Multi-channel health information search, patient empowerment and advanced opportunities of data collection from connected devices require a rethink of sales and marketing strategies to increase insights from the patient journey.

Second, third-party payers in HC must develop capabilities and skills useful to implement data-driven approaches to offer additional smart and personalized service. To date, practitioners have paid the most attention to clinical and organizational processes, such as the HIT adoption in hospitals or the measurement of care efficiency for patients. Now, managers of HCs organizations and systems may also wish to consider how patient-data from EHR might benefit national social security systems and mechanisms of payment and reimbursement.

5. Conclusions

The aims of this article were to provide an integrative view of the state of the art of digitalization in HC literature, find the key management and business applications of DT technologies by HC stakeholders and identify a potential future research agenda. With the aim to identify potential benefits of previously introduced digital technologies for HC providing organizations and other stakeholders, the analysis produced five broad clusters; (1) patient-centeredness in HC management with an emphasis on the two sub-streams of patient empowerment and the impact of multi-channel behavior on consumers' health and well-being; (2) impact of the adoption of innovative HIT on operational efficiencies and resilience of hospitals; (3) organizational key attributes and managerial implications; (4) consequences on workforce practices; (5) socio-economic factors.

In conclusion, this article shows that the comprehension of DT in HC for the most part encompasses the digitization of information and adoption of HIT in traditional HC structures. To build a more holistic view of the DT in HC, there is a great need to conduct research on business model transformation and implications for the management of different interest groups. Finally, the combination of patient empowerment, a purposeful use of digital technologies, as well as data-driven and predictive care will allow the shift toward digital HC models, redefining experience and improving outcomes for patients, providers and insurers.

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