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Evolutionary paths and influencing factors towards digital maturity: An analysis of the status quo in Swiss hospitals

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ABSTRACT

Objective: The purpose of this study is to discuss the term 'digital maturity' based on the evidence emerging from an extensive longitudinal investigation. Further, this study provides evidence regarding evolutionary paths, influencing factors, and improvement potentials in hospitals.
Materials and methods: Based on a comprehensive multi-year (2008–2014) data set obtained from a previously developed benchmarking and maturity assessment tool, we conducted exploratory-descriptive and path analyses to detect structural patterns and alternative explanations for the digital maturity of Swiss hospitals (n = 35).
Results: Digital maturity is a relative and subjective construct that either improves or worsens over time, is bound to perceptions of health professionals, and seldom reaches a final stage. We found that hospitals have a strong internal focus, and that digitalization is conducted in a reactive way. Since digital maturity is constantly in flux, the health information technology (HIT) appraisal of hospitals suffers from temporal variances due to several factors, such as enhancements in the eco-system, changes in the user base, or unforeseen/unprepared system adaptations.
Conclusion: Although there are different ways to influence the perceived digital maturity of a hospital, the most promising way is to invest in hardware and software because investments in personnel development or enhancements of operations and maintenance services did not show a significant relation. In conclusion, digital maturity is a hospital's organizational asset that needs to be maintained and nurtured over time.

1. Introduction

Government agencies as well as public and private healthcare providers have operated under the assumption that investments into health information technology (HIT) usually translate into favorable outcomes in terms of increased quality of medicine (Bates and Gawande, 2003; Miller et al., 2005), greater productivity (Eastaugh, 2012; Thouin et al., 2008), and cost reduction of health administration (Cutler et al., 2012; Hillestad et al., 2005). Building upon this premise, U.S. Congress appropriated almost U.S. $20 billion for facilitating the implementation of electronic health record systems (United States Congress, 2009). Likewise, in Western Europe the modernization of the healthcare sector will generate a growth in HIT spending from U.S. $13.2 billion in 2013 to U.S. $14.6 billion in 2018 (IDC, 2015).

While these budgets reflect high hopes, there have also been contradictory voices proclaiming that healthcare is facing the "productivity paradox" (Devaraj and Kohli, 2000; Hebert, 1998; Jones et al., 2012; Lapointe et al., 2011), a phenomenon which has previously been observed in the manufacturing industry describing an overall negative correlation between productivity and IT investments (Brynjolfsson, 1993). A growing number of studies have therefore been dedicated to seek the real impacts of digitizing healthcare on quality of care, costs, and work processes (Chaudhry et al., 2006; Sabherwal and Jeyaraj, 2015; Williams et al., 2017) and to offer explanations for this paradoxical observation (Kohli and Grover, 2008; Thatcher and Pingry, 2007).

In the face of the digitalization of ever more areas of our private and business lives, however, the question whether to invest into HIT or not seems to be ill-defined. Instead, it would be all the more important for decision-makers to have a concise understanding of the current situation, for example to know which technologies are 'white spots' (i.e. missing or poorly adopted) in the hospital's HIT architecture. Second, although productivity certainly is important, also other relevant aspects of healthcare may be enhanced by digitized services, such as patient safety (Kaelber and Bates, 2007), well-being (Luxton et al., 2011), empowerment (Samoocha et al., 2010), or other soft factors which are hard to measure. Consequently, the measure 'digital maturity', broadly intended as a measure of how well an entity – in our case, a hospital – is

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making use of digital technology to attain better performance, is often used as proxy for capturing the overall impacts of HIT, particularly on the quality of health services delivery (Flott et al., 2016).

Although consultants and technologists, frequently without substantial facts, describe healthcare as 'lagging behind' in the race towards fully digitized industries (Gandhi et al., 2018), we would omit such a generalization and take the discussion to a different direction, rather focusing on the clarification of 'digital maturity' as a concept and its function as decision aid for the enhancement of a local, or even regional or national HIT architecture. With this paper, we seek therefore to obtain a more in-depth understanding of the evolutionary paths and influencing factors towards digital maturity. Particularly, the following research questions will be explored in this study: (a) what is digital maturity in the context of hospitals, (b) how can digital maturity *pragmatically* be assessed, and (c) what can be learned from a longitudinal perspective?

To answer these questions, we first clarify our understanding of the two concepts *HIT* and *digital maturity* by providing a review of the extant literature. In the next section, we then render the necessary contextual background and explanations concerning our hypotheses, study variables, and analysis procedures. Based on empirical findings, we then discuss the main influencing factors towards digital maturity and provide possible explanations for different evolutionary paths. We conclude by highlighting the practical contributions of our study and their implications for continued research in the area of maturity assessments in healthcare.

2. Background

2.1. A definition of health information technology and scope of this study

Literature dealing with the investigation of IT productivity and digital maturity in healthcare frequently entails a high-level understanding of HIT. In fact, the HIT literature spans many disciplines and adopts various standpoints for defining its purpose and scope. Most frequently, HIT is referred to as "[…] *medical* IT-applications for facilitating the management and delivery of healthcare" (Pagliari et al., 2005), such as for storage and exchange of clinical data (e.g. electronic medical records, electronic health records), inter-professional communication (e.g. secure e-mail and direct messaging), computer-based support (e.g. clinical decision support systems, computerized physician order entry), patient-provider interaction and service delivery (e.g. patient referral and handover systems), and education (e.g. surgery simulators). To a lesser extent, existing literature also considers the crucial *administrative* role of HIT, for instance, as a facilitator of revenue increases (Mindel and Mathiassen, 2015) or for lowering the bureaucratic burden (Abraham et al., 2011).

Most research implicitly ties HIT with the use in primary care (e.g. family doctors, medical specialists), secondary care (e.g. hospitals, clinics), or medical research facilities. However, due to overall changes in the availability of and interaction with technology (Wang et al., 2018), some authors propose to take a broader view considering systems that may be used beyond care and research facilities as a means for community-based health promotion and policy making (Mettler and Raptis, 2012; Sarkar et al., 2011). Notwithstanding this broad definition, in this paper, we focus our attention on systems that are used in the *hospital environment* for the support of both medical and administrative operations. We do so because (i) most studies related to the productivity paradox concentrate on hospital IT investments as it often captures the largest share of governmental HIT spending (Agarwal et al., 2010; Kohli et al., 2012) and (ii) previous efforts in hospitals have been fraught with difficulty and failure (Waring, 2015). To our view, it is therefore a reasonable starting point for developing a more contextually nuanced view on HIT (Chiasson and Davidson, 2004).

2.2. Digital maturity and the different simultaneously existing notions of the digital hospital

Like the divergent conceptualization of HIT, there is also no commonly agreed definition for the concept of 'digital maturity'. Maturity can be generally described as the "state of being complete, perfect, or ready" (Simpson and Weiner, 1989). However, since technology continuously evolves and in seldom cases reaches a stage of ultimate perfection, we put forward to comprehend digital maturity as a *relative* concept with regard to both the surrounding working environment and time. In fact, the digital maturity of a hospital usually evolves and changes over time (i.e. thanks to new hardware and software acquisitions or dismantling) and place (i.e. from one site to another) (Gastaldi et al., 2018). Digital maturity is therefore a "learned" characteristic of an entity that represents its ability to respond to the environment in an appropriate manner (Kane et al., 2017). In this respect, digital maturity is the result of a continuous and ongoing process of adaptation to a changing digital landscape.

Anticipating the results of our literature analysis, we consider digital maturity as a *subjective concept*, describing to which extent stakeholders perceive that their work environment shows high uptake of electronic services and/or provides contemporary support for their tasks. To explore this relativity and subjectivity, and to better understand extant connotations and meanings of the concept, we searched PubMed, ISI, and Scopus for published articles in the last 25 years (1990–2015) conceptualizing "digital maturity" and/or containing "digital hospital" as central topic (see Fig. 1; for a detailed list of reviewed articles see Appendix A).

We included peer-reviewed articles describing new research and applications, as well as non-reviewed case reports, editorials, and perspectives papers written in the English language. As of August 2016, our search yielded 108 articles out of which 54 were duplicates. After screening the titles and abstracts of the remaining 54 articles, we excluded 14 papers, and after reading the full-texts another 15 papers were excluded, because there was no clear relation to either digitalization in healthcare or the hospital environment. Based on an abductive analysis approach (Tavory, 2016), we identified four different, simultaneously existing notions of digital maturity in the context of hospitals, which are summarized in Table 1 and which we detail next.

Not surprisingly, almost a third of the reviewed articles (28%) recognize digitalization as the transition from paper to electronic methods of working in hospitals (e.g. replacement of paper-based radiology equipment by digital imaging and archiving solutions). Following the understanding in these papers (Baldwin, 2009; Burbridge and Bell, 2004; Habal, 2004; Hewlett-Packard Company, 2006; Hruby et al., 1992; Hruby et al., 1996; Kramer, 2006), a high level of digital maturity is reached when a hospital can be run (almost) entirely paperless or where great part of the interaction between different stakeholders (e.g. physicians, administrative personnel, patients) is facilitated by a digital medium.

Most papers (44%), however, go beyond this notion of a digitally mature hospital and emphasize the importance of standardized and integrated services (i.e. data and process integration). Based on the majority of publications (Chang et al., 2003; Gao et al., 2011; Jeong et al., 2015; King et al., 2003; Li and Gao, 2014; Lu et al., 2005; Pavlopoulos and Delopoulos, 1999; Peng et al., 2000; Ricke and Bartelink, 2000; Weiss, 2002; Yoo et al., 2014), not only the mere existence of HIT (e.g. picture archiving and communication system, laboratory information system) characterizes a high digital maturity, but also the level of integration, data quality, and adherence to governance principles within the hospital.

In some articles (16%) these aforementioned conceptualizations are criticized because of a too strong focus on health professionals, respectively the negligence of comprehending digitalization as an opportunity for improving the experience of patients. Therefore, not only digital services for improving the working conditions of health