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## A Maturity model for hospital information systems

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## ABSTRACT

In the last five decades, maturity models have been introduced as guides and reference frameworks for information system (IS) management in organizations within different industries and sectors. In the healthcare domain, maturity models have also been used to address a wide variety of challenges, complexities and the high demand for hospital IS (HIS) implementations. The present paper describes a research project focused on the development of a comprehensive maturity model applied in the HIS context. The outcome of this research is the HIS maturity model (hereafter referred to as HISMM), which includes six stages of HIS growth and maturity progression. The HISMM has the peculiarity of congregating a set of key maturity-influencing factors and respective characteristics, enabling not only the assessment of the global maturity of a HIS, but also the individual maturity of its different dimensions.

## 1. Introduction

The rapid development of the information and knowledge society, and consequently the rapid advancement of information and communication technologies (ICTs), has revolutionized the way in which we interact with each other (Martin, 2017). The convergence between the acceleration capabilities of computers, the range and expansion of the Internet and the increase in the ability to capture and leverage the knowledge in a digital format are key drivers for the technological revolution that we live in today. The current information society has the true potential to revolutionize healthcare (Wager, Lee, & Glaser, 2017), as it could change the relationship between the patient and the professional, providing valuable opportunities for health professionals to deliver healthcare services effectively through the use of information systems and technologies (ISTs) to their patients, while providing them easy access to relevant (clinical) information. The possible side effects of this major information society development, as well as major demographic shifts, the lack of qualified health professionals and the high expectations and demands among patients, local administrators or health insurers, could hinder the fulfilment of this mission (Fitterer & Rohner, 2010). Healthcare systems around the world are, at present, facing considerable pressure to reduce costs, enhance and improve service efficiency, and expand access, while maintaining or even improving the quality of health services provided (Ahtonen, 2012; Jha et al., 2009; Ludwick & Doucette, 2009). This is also, in part, due to the fact that healthcare is a critical social and economic component of

modern societies, with the adoption and effective use of health ISTs being crucial to its success (Buntin, Burke, Hoaglin, & Blumenthal, 2011; Haux, 2010; Hendrikx, Pippel, Van de Wetering, & Batenburg, 2013; Ludwick & Doucette, 2009). As such, there are strong expectations that a wider adoption of ISTs in the health field will contribute to the process of improving the health of individuals and the performance of providers, yielding improved quality, cost savings and greater engagement by patients in their own healthcare (Blumenthal, 2010). However, there is evidence that the implementation of ISTs, without any adaptation of the relevant structures, as well as the strategic and organizational processes behind it, will not necessarily generate the expected benefits (Mettler, 2011). Several studies emphasize the importance of facing this challenge by finding appropriate models for use in the facilitation, evaluation and measurement of the success rate of projects in the field of health systems (Van Dyk & Schutte, 2013). Maturity models fall perfectly within this framework.

## 2. Maturity models

The concept of maturity models is increasingly applied in the IS field, both as an approach needed for continuous improvement (Paulk, Curtis, Chrissis, & Weber, 1993) and for its evaluation (Fraser, Moultrie, & Gregory, 2002). Since its initial conception in the early 1970s (Gibson & Nolan, 1974; Nolan, 1973), a number of different instances has been developed in science and practice. However, as organizations face constant pressures to achieve and maintain competitive advantage by

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inventing and reinventing new products and services, while reducing costs and time to market, as well as improving quality at the same time, there is a continuing need to develop new maturity models, since they help decision makers to achieve these goals (Mettler, 2009). On the other hand, through the incorporation of formalism into the improvement of activities, decision makers within organizations can determine whether the potential benefits are being achieved or not. In addition, “Conflicts of interest can be avoided by using a measurement model developed externally to the organization” (p. 97) (Fraser & Vaishnavi, 1997).

During the last five decades, several maturity models have been proposed, which differ not only in terms of the number of stages, maturity-influencing factors and intervention fields (Rocha, 2011), but also with respect to their quality and applicability (Pöppelbuß & Röglinger, 2011). These constituent factors each identify the characteristics that typify the focus of every maturity stage; that is to say, these factors act as descriptors or variables of reference for the characterization of each stage, while providing the necessary criteria to reach a specific maturity level (Becker, Knackstedt, & Pöppelbuß, 2009). In other words, maturity models facilitate orientation through an evolutionary process, incorporating the procedures for improving activities (Mettler & Rohner, 2009b). Although, there currently is no holistic understanding of the relevant principles of form and function maturity models as design products should meet (Pöppelbuß & Röglinger, 2011).

Maturity models are available to respond to many different challenges. These models provide information for organizations to address the problems and challenges in a structured way, providing both a reference point to assess the capabilities and a road map for improvement (Caralli & Knight, 2012). In general, the ‘typical’ IS maturity model is commonly applied within organizations in order to assess the as-is and to-be situation, which in turn relates to the associated improvement activities (Iversen, Nielsen, & Norbjerg, 1999).

### 3. Problem and objectives of research

Healthcare institutions, and hospitals in particular, in conjunction with government organizations, are starting to realize that the reasons behind a certain inability to properly manage health processes are directly related to the limitations of technological infrastructures and the lack of efficiency in their management (Freixo & Rocha, 2014; Sharma, 2008). An analysis of the health context clearly shows the size and importance of the technological transition problem (Sharma, 2008). In addition, IT operations have grown in complexity to meet the requirements of this area of activity. This increase in complexity, in turn, has led to the introduction of many new systems, procedures, processes and approaches to business integration, as well as the emergence of new companies offering innovative services in this field. As a consequence, many products and services are too immature to be consumed by a HIS, which is in a state of change and requires, as always, a level of performance and effectiveness that meets their needs. Based on this scenario, it is difficult to assess whether the management of such changes and progress in monitoring them on an ongoing basis is carried out effectively. Moreover, it is not easy to manage systems, their interactions and interrelated processes that are in constant motion, as it is not easy to manage the impact of low interoperability, security, reliability, efficiency and effectiveness.

It should be noted that the benefits of modern technology in the health field, supported by better methods and better tools, cannot be obtained through undisciplined and chaotic processes (Gonçalves & Rocha, 2012; Gonçalves, Silveira, & Rocha, 2011). For this reason, we believe that IS management in health organizations can benefit from the use and adoption of IST maturity models.

Various maturity models have been proposed over time, both for the development of individuals and for the general evolution of organizations or the particular evolution of the IS management function. These models mainly differ in terms of a number of stages, variables of

evolution and focus areas (Mettler & Rohner, 2009a; Rocha, 2011). Each of these models identifies certain characteristics that specifically target the objectives of the next stage of growth. These types of model can be applied situationally within healthcare in order to strategically plan for IST maturation, based on the degree of alignment between the hospital strategy and the selected growth path, as well as associated investments and improvement activities (van de Wetering et al., 2011; van de Wetering, Batenburg, & Lederman, 2010).

Within the healthcare domain and other organizations in the health field, several maturity models have been proposed, although these models are still at an early stage of development (Mettler & Rohner, 2009a; Rocha, 2011). Studies show that maturity models in the health field are not comprehensive, lack detail, do not provide tools for determining maturity and are without any characteristics relating to maturity stages, as structured by maturity-influencing factors.

Moreover, the very concept of maturity models is not exempt from criticism. For example, Pfeffer and Sutton (1999) argue that the purpose of these models is to identify a gap that can be closed by subsequent actions for improvement. However, many of these models do not describe how to effectively perform these actions, as demonstrating how to close the gaps can be very difficult to do. The most important point of criticism about maturity models, however, concerns their poor theoretical basis (Becker et al., 2009; Biberoglu & Haddad, 2002; Mettler & Blondiau, 2012). Most models are based on “best practices” or “success factors” associated with the projects of organizations that have demonstrated positive results. Thus, although these practices are compatible with maturity models, there is no guarantee that an organization can succeed. There is no consensus on the “true path” to ensure a positive outcome (Montoya-Weiss & Calantone, 1994). According to de Bruin, Freeze, Kulkarni, and Rosemann (2005), the reasons for these sometimes ambiguous results from maturity models stem from insufficient investment in testing models in terms of validity, reliability and generalization, as well as in the limited documentation about how to develop and design a model of this type.

On consulting the extant and current literature, it was found that, as far as it was possible to establish, there is no model in the health field that is sufficiently comprehensive and detailed to assess the HIS maturity in its various aspects. In fact, a performed content analysis on scientific articles, guides, white papers, reports and websites, all of which contained information on maturity models in the health field, also revealed the lack of maturity models with maturity dimensions or maturity-influencing factors, taking into account the weighting of their importance.

#### 3.1. Research questions

Given these constraints, it was appropriate to develop a research project that would contribute to an increase in the knowledge of healthcare maturity models, in order to facilitate an improvement in the practice of assessing and promoting the maturity of IS in this setting. Based on the problem description, the following research question was formulated:

*“Is there a comprehensive model, which consists of several maturity-influencing factors and maturity stages, that can also be applied to HIS management?”*

From this research question, the following “sub-questions” were proposed:

RQ1 - Which influencing factors are associated with the maturity stages that are considered to be the most important by IS managers in the health field?

RQ2 - Can the maturity for each maturity-influencing factor be assessed in the context of the maturity stages of a HIS?

RQ3 - Can a HIS take on different maturity stages, taking into account the different maturity-influencing factors?

RQ4 - Can a comprehensive maturity model be used in the

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