

# Development of a Maturity Model to evaluate Information Systems in the Portuguese hospital context

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## Abstract

Maturity models have been introduced as reference frameworks for the management of Information Systems within organizations. Within the Healthcare domain, maturity models have been used to address a wide variety of challenges, complexities and the high demand for Hospital Information Systems (HIS) implementations. This dissertation aims to analyze hospital information systems through the development of a maturity model taking into account the bases of the reviewed practices and to apply it to a set of Portuguese hospitals, assessing the current state in five key domains. The results obtained allow managers of the areas to have a better vision in relation to the levels at which the hospital information systems are. On the other hand, they may serve as indicators as to which processes need to be revised.

**Keywords:** Maturity Models, Health, Healthcare Information Systems, Hospitals, Management

## 1. Introduction

Healthcare performance has been an issue of great relevance in several countries, including Portugal. Health care performance can be divided into two concepts, effectiveness and efficiency. The first is related to the ability to provide the best health care to the population. The second concerns aspects related to waste reduction and/or volume of service provided to the population ignoring social aspects.

The concept of quality has been used in different areas of knowledge in order to ensure a better quality of life for society. The ISO 9000 standard defines quality as "the degree to which a group on inherent characteristics meets the requirements". To state that a service or product is of quality, an evaluation must be carried out, which allows the level of deviation from the expected characteristics to be known, so that the causes can be analyzed and preventive or corrective actions can be taken.

Quality in health care can be seen as the fusion of three categories: structural quality (related to infrastructure and equipment), process quality (related to care service delivery), and outcomes (related to the effects that outcomes will have on patients' lives). There has been some controversy by some authors in the use of measures to characterize the quality of hospitals. Some criticize the use of outcomes to characterize the quality of hospitals, others use only process quality to character-

ize quality, or use all of them together to characterize quality. There are few cases in which structural quality and outcomes variables are used. As an example, two categories of outcome and process quality can be identified: appropriateness of care and clinical safety. The adequacy of health care is related to the capacity to provide patient-centered care; clinical safety is related to the prevention of preventable deaths. Regarding access, four dimensions can be considered: service availability (hospital resource per inhabitant), personal barriers (need for specialized service), financial barriers (cost, distance between home and hospital unit), and organizational barriers (long waiting lists). The National Health Service (NHS) must provide fair and partly free health care services to all citizens, that is, no one can be excluded, and access must not depend on the ability and willingness to pay (Ferreira and Marques, 2019).

According to (Carvalho et al., 2019), the current technological revolution has an influence on health care, changing the relationship between patient and health professionals, that is, resources have been created for health professionals to provide technologically effective health services to their customers and also providing ways to access all the information they need. However, health systems are under pressure to reduce costs while maintaining quality of service, which is difficult given the many factors that prevent this goal from

being achieved. It is expected that the adoption of more generalized information system (IS) and information technology (IT) will contribute to cost reduction and better quality (Mettler and Blondiau, 2012).

According to (Laudon and Laudon, 2015), information systems (IS) can translate into a set of interrelated components that collect, process, store and distribute information to support decision making and control in an organization. IS contains information about, people, places and things within an organization or in an environment around it. Information is data that has been configured in a way that is useful to humans. In contrast data is raw facts that represent events that occur in organizations before being organized and arranged in a way that people can understand and use. Information systems in the hospital setting are developed to collect, process, store and manage health data. They are used by everyone from patients to physicians for decision making. Some examples of information systems used in healthcare organizations: (1) Electronic Medical Records (EMR) and Electronic Health Records (EHR), (2) *Practice Management software*, (3) *Master Patient Index*, (4) Patient Portal and (5) *Remote Patient Monitoring (RPM)*. IS are used in Public Hospitals as well as in Private Hospitals. Since Private Hospitals are more recent compared to Public Hospitals, when they are created their entire information technology (IT) structure is already designed, they are more autonomous. Public hospitals generally have an old IT structure and reduced autonomy, which leads them to be the focus of our study. According to the Shared Services of the Ministry of Health (SSMH), Health Information Systems allow for cooperation, knowledge and information sharing, and the development of service provision activities in the areas of information and communication systems and technologies. They play an important role in health system reform, with the main objectives of improving accessibility, efficiency, quality and continuity of care, and increasing the satisfaction of professionals and citizens. SSMH is also responsible for ensuring the operability and security of the technological infrastructure and information systems of the Ministry of Health, promoting the definition and use of standards, methodologies, and requirements that ensure the interoperability and interconnection of health information systems among themselves, and with the information systems transversal to the Public Administration, with the aim of developing and protecting the health of citizens.

The literature regarding maturity models in hospital units is very extensive. According to (Proença and Borbinha, 2016) a maturity model is a tech-

nique that has proven to be efficient in measuring different aspects of an organization. It represents a more organized way of operating business processes in organizations. A maturity model consists of maturity levels, often five ((1) Initial, (2) Management, (3) Definition, (4) Quantitative Management and (5) Optimization), however the number of levels may vary depending on the domain of each model.

## 2. Literature Review

### 2.1. Origin and history

Maturity models represent theories about how the capabilities of organizations evolve step by step through maturity. This is the reason why maturity models are known as, growth stage models, stage models or stage theory (Poeppelbuss et al., 2011).

This phase model was first applied by Richard L. Nolan, who in 1973 published the growth phase model for IT organizations (Caralli et al., 2012). After conducting a study of Information Systems (IS) in major US organizations, (Carvalho et al., 2019) references (Nolan, 1973) which suggests an initial model consisting of four stages, and later with the intention of improving the first proposal adds two more stages to the initial model (Nolan, 1979).

Nolan's phase hypothesis prompted several studies that led to inconclusive and contradictory results regarding its empirical validity. However the phase model was found useful for academics and practitioners, and led to the emergence of several maturity models centered on a sequence of (Pöppelbuß and Röglinger, 2011) levels.

Given the controversy created in the scientific community, numerous researchers presented studies that on the one hand validated Nolan's model, but on the other, proposed additions. (Carvalho et al., 2016b) references (McKenney and McFarlan, 1982; King and Kraemer, 1984; Huff et al., 1988; Earl, 1989; Galliers and Sutherland, 1991) as examples researchers who have developed new models.

The further evolution of the phase theory was carried out by Sullivan, Earl and Galliers. The theories of these authors as well as Nolan's have gone through several versions over time. The initial approach taken by these authors was by combining the perspective of Nolan and McFarlan, but then they developed their own perspectives.

According to (Khoshgoftar and Osman, 2009), maturity models are useful for identifying the strengths and weaknesses of an organizational environment when applied, as well as for collecting data through *benchmarking*. In general, maturity can be defined as a state of being complete, perfect or ready (Mettler, 2009). It is a state in which one decides not to do anything else given certain conditions.

## 2.2. ISO 330xx and CMMI Maturity Models

### 2.2.1 ISO 330xx

In the early 1990s the *International Standardization Organization (ISO)*, established a study group that described the needs and conditions for a standard for *software process evaluation*. With the large growth of evaluation processes and with it the increased need for measurement measures, a set of evaluation standards was developed: ISO/IEC 15504, this was born as *Software Process Improvement and Capability Evaluation (SPICE)* in 1993 (Proença and Borbinha, 2018).

In the late 1990s the first sets of standards were published as technical reports and validated through testing phases. Between 2003 and 2006 a set of international standards applicable to any type of process regardless of the size and type of organization was created. The ISO/IEC 15504 standard was subsequently updated in accordance with ISO regulations, and is now known as the ISO 330xx family of standards first published in 2014. Several parts of ISO/IEC 15504 have been removed and new ISO 330xx standards have been published, and there are 10 published standards in relation to the ISO 330xx family, and with several more in development (?).

The emergence of process assessment within the ISO 330xx family enables the use for evaluation of process quality characteristics such as, safety, efficiency, effectiveness, integrity and sustainability as well as capability as defined in ISO 15504. ISO 330xx seeks consistency of principles across all measurement frameworks following a scientific method of (Jung et al., 2014) development steps.

### 2.2.2 Capability Maturity Model Integration (CMMI)

Capability Maturity Model Integration is the combination of several capability maturity models that includes process best practices. There are 25 process areas in the CMMI model. Process areas are a set of practices in specific areas, which when applied together satisfy a number of objectives.

The goal of CMMI is to provide guidance to organizations in order to improve their processes and capability to manage the development, acquisition, and maintenance of products and services. CMMI is integrated through tried and true processes into a system that allows the organization to assess its organizational maturity or process area capability as well as establish improvement priorities and their implementation (Dayan and Evans, 2006).

The creation of CMMI appears in response to the development of several improvement models to address different areas, as an example, organizations that seek to use improvement processes but

lack maturity and capacity to identify which types of processes to use in order to meet the needs; and organizations that implement several models simultaneously, leading to a greater consumption of time and high costs. Thus, the CMMI was created, a more integrated model that was able to answer this question.

### 2.3. Principles of maturity model design

For the design development of the maturity models (Becker et al., 2009) and (De Bruin et al., 2005) suggested procedural models (Pöppelbuß and Röglinger, 2011).

The principles of maturity model design are differentiated into:

- **Comparisons (1):** was created as a comparison method. It is used to assess the maturity of an organization against a set of parameters.
- **Descriptive (2):** a maturity model serves a descriptive purpose when applied for current state assessments by evaluating the existing capabilities of the entity under investigation against a set of criteria.
- **Prescriptive (3):** a maturity model is descriptive when it is used to classify optimal maturity levels, and provides guidance for improvement measures.

These principles serve as an aid to evaluate maturity models, and are only affected during the development of maturity models. The design principles should be organized in such a way that, the basic principles are considered regardless of the purpose of their use, the descriptive principles should conform to the basic principle, and finally the prescriptive principles should satisfy the descriptive and basic principles.

### 2.4. Methods for developing maturity models

Maturity models have proven to be an important tool as they allow better positioning of the organization and help to find better solutions for change. In recent years hundreds of maturity models have been developed for various areas. However, all the information regarding the methods and procedures for developing the models has been presented in a simplified form. Through a scientific approach, criteria have been developed for the development of maturity models.

According to the definition of (Hevner et al., 2004) seven guidelines for the development of maturity models were considered. The adoption of these criteria is not exclusive, that is, it is not intended to exclude the possibility of other paradigms assigned for the development of maturity models. According to (Becker et al., 2009) eight criteria (C1-C8) are considered:

- **(C1) Comparison with existing maturity models:** The development of maturity models is justified through comparison with existing models, or with the improvement of existing models.
- **(C2) Iterative procedure:** Maturity models should be developed iteratively.
- **(C3) Evaluation:** The principles, ideas, usefulness, quality, and effectiveness of maturity models should be evaluated in an iterative manner. One method to verify the usefulness of the model, is by implementing the model in a real environment in order to verify that the model's results are valid.
- **(C4) Multi-method procedures:** A diversity of research methods are used in the development of maturity models, where the use needs to be well-founded and adjusted.
- **(C5) Identifying the relevance of the problem:** The relevance of the proposed problem solution to practitioners and/or researchers should be demonstrated.
- **(C6) Problem definition:** The scope of application, as well as the conditions for its application and the benefits must be determined before it is designed. From this definition the objective can be understood.
- **(C7) Presentation of results:** Models and maturity should be presented according to their application and user needs.
- **(C8) Scientific documentation:** The design of the maturity model should be documented in detail, thus considering each phase of the process, the methods used as well as the parties involved. This documentation is important so that the target audience can understand the need for the creation of the model, as well as understand how the maturity model can evolve into a tool for maturity assessment within organizations.

(Mettler, 2009), has the same approach only explained in a different way, which is structured from two perspectives, the developer perspective, and the application perspective of the maturity model. It argues that the development of the maturity model is intrinsically linked to the application phase, so it should not be considered separately. The developer's perspective focuses on the development of maturity models, which consists of a cycle of four phases, (1) defining scope, (2) model design, (3) model evaluation, and (4) observation of evolution. For each of these phases are associated

decision parameters and characteristics that developers must choose.

## 2.5. Maturity assessment methods

Evaluations are used by organizations as a means of obtaining feedback regarding their performance or possible issues that impact performance. Evaluations become crucial for the reason that organizations are continually trying themselves but are not always successful. Organizational assessments are conducted to better understand what organizations can or should do to improve the way they do business. Assessments can help organizations collect data about their performance, identifying crucial characteristics that help or hinder the achievement of desired results, and comparing their performance to that of other organizations.

### 2.5.1 SCAMPI A evaluation method for process improvement

The SCAMPI A method is used to identify strengths, weaknesses related to evaluation reference models. The method includes good assessment practices, building on characteristics of already existing methods (Team, 2011, p. 13). This method was developed to provide benchmark quality indices relative to Capability Maturity Model Integration (CMMI) and Capability Maturity Model (CMM). SCAMPI is an appropriate method for benchmarking, for example, sponsors who want to benchmark improvements against other organizations can have a maturity level determined as part of the assessment process. As a benchmarking method, it is based on the aggregation of information, which is collected through objective evidence. This objective evidence contributes to the processing of information, which is then evaluated by the assessment team.

### 2.5.2 ISO/IEC 33030 assessment method

The ISO 33030 assessment method is an alternative for maturity assessment. The ISO 33030 document is an exemplary evaluation process, it includes the minimum characteristics for process evaluation. This process applies to all types of organizations, and can use an extensive variety of methods and techniques. The evaluation process is defined by the following activities, (1) Initiate the evaluation, (2) Plan the evaluation, (3) Inform stakeholders, (4) Collect data, (5) Validate the data, (6) Determine the results, and (7) Describe the evaluation. The only difference between these two methods is only in the terminology used, SCAMPI uses *appraisal* when talking about evaluation and ISO/IEC 15504 uses *assessment*. Despite the difference in terminology both methods

have the same meaning.

## 2.6. Improvement Methods

Improvement methods are a means of how organizations can improve their organization and process management, and may also involve improving existing processes.

### 2.6.1 IDEAL: Software Process Improvement (SPI)

This method provides process improvement managers with a generic description of steps for SPI (McFeeley, 1996, p. 1). The method is described by five activities, each phase consists of certain tasks that are performed during the implementation of SPI. There is also a sixth activity that provides program management oversight. The activities that define this method are (1) initiation phase, (2) diagnostic phase, (3) establishment phase, (4) action phase, and (5) leverage phase.

### 2.6.2 ISO 15504-4 - Guidance on use for process improvement and process capability determination

ISO 15504 provides the minimum requirements for conducting an assessment. The assessment is applicable in the following situations (ISO, 2004, p. vi): (1) When an organization, or on behalf of another organization, wants to know about its own improvement states; (2) When an organization, or on behalf of an organization, wants to know about certain processes of another organization, or to determine the capability of its own processes for a given requirement.

#### Process Improvement

The goal of process improvement is to increase productivity and performance over time by ensuring that the processes in use are consistent with business needs (ISO, 2004, p. 2).

#### Process capability determination

The goal of process capability determination is to identify the strengths, weaknesses, and risks associated with a specific requirement (ISO, 2004, p. 3).

## 3. Methodology

The research method to be followed in the paper is based on the Design Science Research Method (DSRM), described by (Peffer et al., 2007). Within DSRM, the development method that will be used is method described by (Becker et al., 2009). The DSRM method focuses on designing solutions to solve problems, as opposed to following the more descriptive paradigms. For this research the entry point will be Problem-Centered-Initiation. In the figure 1 are the six steps of the DSRM model (Peffer et al., 2007):

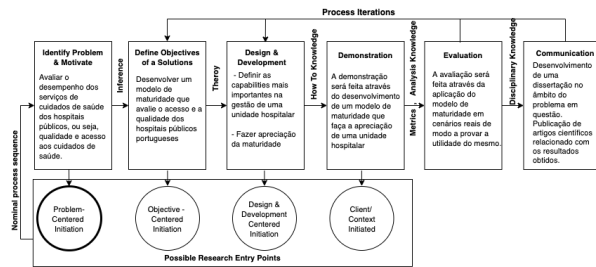


Figure 1: Process Model DSRM  
Source: (Peffer et al., 2007)

Regarding the development method described by (Becker et al., 2009), it follows a methodical procedure. This method is supported by a Design Science Research (DSR) method, and is described through eight C1-C8 criteria (Becker et al., 2000).

## 4. Model Development

### 4.1. Hospital Information System Capabilities

Healthcare organizations are increasingly realizing that the lack of ability to manage healthcare processes may be related to limitations of the technological infrastructure as well as to poor efficiency in their management. The mistakes that are made by Hospital Information Systems (HIS) managers usually come from the natural growth of organizations and that can be result to bring the organization to the current maturity (Carvalho et al., 2016a).

- **Funding:** Represents the need to invest in information systems. Healthcare institutions along with government organizations are beginning to realize that there is a certain inability to manage healthcare processes (Carvalho et al., 2016a). This inability to manage may be associated with a lack of financial resources, or mismanagement of them.
- **People:** Represents the importance that people have come to have in healthcare and the differentiation factor they represent. According to (Carvalho et al., 2016b) healthcare organizations are increasingly pushed for innovation when it comes to people management.
- **Information Technology (IT) Infrastructure:** Represents the importance of a hospital making use of IT infrastructure, and information and technology systems as support for all activities in a hospital environment as well as with healthcare partners (Carvalho et al., 2016b). According to (Becker et al., 2009) innovative IT systems offer great opportunities to improve the competitiveness of companies.
- **Electronic Medical Record (EMR):** Represents the importance of organizing and storing electronic medical records electronically. Electronic medical records are intended to better

handle patient information and make it available at the point of care (Carvalho et al., 2016b). The integration of EMRs allowed to centralize all patient information that is dispersed in several locations (FERREIRAabd et al., 2007).

- **Cooperation:** Represents the importance of having cooperation within the hospital, between hospitals and other institutions.

#### 4.2. Maturity Levels

The goal will be to develop a maturity model that evaluates hospital information systems in which it increases when it moves from a lower maturity level to a higher maturity level. In order to advance to a subsequent level (N+1), all requirements/features of the previous level (N) must be met. This approach leads us to the well-known stage model. For each capability levels are defined, from 1 to 5, where 1 shows the initial maturity phase and level 5 shows the fully mature and optimized phase. The levels were based on the SEI CMMI (Team, 2010), since these are well known and tested. At maturity level 1 (Initial), information systems are ad hoc and chaotic. The organization generally does not provide a stable environment to support processes. At maturity level 2 (Managed), procedures for information systems in the hospital setting have ensured that procedures are planned and executed according to locally defined policies. At maturity level 3 (Defined), processes are well characterized and understood, and are described in standards, procedures, tools, and methods. At maturity level 4 (Quantitatively Managed), the organization and projects establish quantitative targets for process quality and performance and use them as criteria in project management. At maturity level 5 (Optimizing), an organization continuously improves its processes based on a quantitative understanding of its business goals and performance needs. The organization uses a quantitative approach to understand the variation inherent in the process and the causes of the results.

### 5. Hospital Evaluation

#### 5.1. Preparing and conducting the interviews

Initially, we tried to obtain a diversity of hospitals, from different regions of Portugal and of different sizes in order to have a sample that includes different working environments, different practices used by hospitals and, consequently, different solutions for changes that may be used among hospitals. The main objective is to carry out the interviews with the purpose of obtaining information about the different capabilities, thus leading us to a more rigorous evaluation of the capabilities of each hospital, as well as of the hospital itself. In order to

achieve the greatest possible rigor, it would be necessary within our sample to have several professionals at different levels in order to have a greater view at the organization level. Since it would be difficult to get this variety of professionals, we tried to make sure that the professionals who answered the questionnaires were the most appropriate considering the defined capabilities. Given the context of the COVID-19 pandemic and the locations of each institution, it was not possible to schedule the interviews in person, which led to conducting them online by filling out a Google Forms form. One participant per hospital was considered, as this is sufficient to make the study feasible.

### 5.2. Results

In the first phase of the analysis, the goal was to go to each of the hospitals and identify the less mature capabilities with regard to the information systems that have a greater impact on the organizations, so that the necessary measures can then be taken to lead to the overall improvement of the capabilities.

#### 5.2.1 Results Analysis

In Figures 2, 3 and 4 we can get a better visualization of the maturity levels in each capability for each of the Hospitals. In Hospital 1 the maturity levels range between 2-4, in Hospital 2 they range between 3-4, and in Hospital 3 they range between 1-3. In Hospital 1 People, EMR and IT are the least developed capabilities being at level 2. Consideration should be given to the measures to be adopted according to their degree of importance. Hospital 2 is where maturity levels show higher values in more than one capability, EMR and Cooperation being at level 4, while the remaining capabilities are at level 3, that is, they are in a stage characterized by well-defined processes. Hospital 3 is where the maturity levels are the lowest where only the EMR capability is at level 1 and People, IT and Cooperation are at level 2. For this reason it would be necessary to improve first the capability that is at level 1 before improving the capabilities that are at level 2.

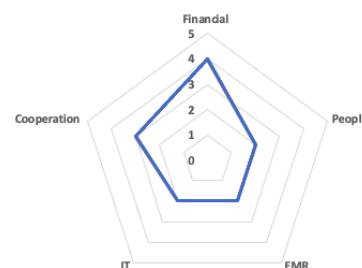


Figure 2: Hospital 1

**Table 1:** Global maturity levels

Levels	Hospital 1	Hospital 2	Hospital 3
2	60%	0	60%
3	20%	60%	20%
4	20%	40%	0
5	0	0	0



**Figure 3:** Hospital 2



**Figure 4:** Hospital 3

Observing the Table 1 that presents the percentage of the capabilities in each level, we can state that none of the hospitals presents a very good, or very bad maturity, which is in line with the results that were obtained from the global maturity of the hospitals, which ranged from 1-3. Hospital 2 was the one that achieved the best results with 100% of its capabilities classified as level 3 or higher, compared to Hospital 3 that achieved the lowest values with 80% classified as level 2 or lower.

It can be seen that most hospitals have the highest percentage in level 2 (Hospital 1 and Hospital 3), which indicates that these should be the first to be resolved in order to reach maturity level 3. The importance of reaching this level is due to the fact that it is considered an intermediate level between Ad hoc and chaotic states, and the lack of procedures that are characteristics of level 1 and 2, and the establishment of quantitative objectives and continuous improvement of processes that are characteristics of levels 4 and 5. Maturity level 3 portrays processes that are well characterized and understood, using the processes to establish consistency across the organization.

## 6. Conclusion

### 7. Overview

This dissertation aimed to develop a maturity tool that would help Portuguese Hospitals to evaluate the performance of Hospital Information Systems, seeking to follow a systematic path that would contribute to the necessary evolution of capabilities. It was sought to follow the methodological procedures in order to guarantee its value, through the objectives defined in the previously.

#### 1. Define and contextualize the problem at hand;

This dissertation started by defining the performance of health care systems in Portugal and its importance for hospital organizations. The importance of tools that allow hospital organizations to prioritize the areas of improvement should be highlighted, in this way, maturity models may appear as a simple tool to understand, which establishes a gradual progress path for the several hospital organizations.

#### 2. A literature review, as complete as possible, of the main capabilities and dimensions relevant to performance evaluation in the context of hospital services;

The literature review was as thorough as possible and started by giving an introduction to maturity models. These models were first applied in 1973 by Richard L. Nolan who applied the growth stage model to IT organizations. These models have had a constant evolution reaching their peak when CMMI and ISOs were created. The main basis for building new maturity models is the DSR and for this it was imperative to review articles that followed the same methodology. The process for designing the model is advisable if the problem is clear and well defined and what is the importance of studying this model for the market in question. This model must go through several iterations that are implicit in the model design, and can be comparative, descriptive, or prescriptive. Finally it is necessary to go through a process of evaluation and improvement until no more changes are needed. Evaluation methods are used by organizations as a means of obtaining feedback regarding their performance or possible issues that impact performance. The evaluation methods suggested for this study were SCAMPI and ISO/IEC 33030. Improvement methods are related to the means by which organizations can improve their processes. The improvement methods addressed in this study were SPI and ISO/IEC 15504.

**3. The collection of data relevant to the Portuguese context;**

The data collection for this maturity model was based on a one-iteration process. Through an elaborate questionnaire that included essential questions based on the maturity table criteria, in total only data from three organizations was collected, which was considered acceptable for the study. This questionnaire was carried out by filling out a form and Google Forms. The evaluation process followed the methodology of the evaluation methods considered in this study, SCAMPI and ISO/IEC 33030.

**4. The development for each set of assessment dimensions and maturity level a set of assessment criteria for the development of a maturity model for assessing the capabilities of a healthcare facility, considering objective and subjective factors;**

First, it was necessary to interpret the problem at hand in order to define a starting point. Hospital information systems are currently showing more and more their importance. There is increasing pressure to reduce costs, increase and improve the efficiency of services, and expand access while maintaining or even improving the quality of health services provided. This statement served as a starting point to begin doing research on hospital information systems today, their importance and their effects on health services. Some studies already conducted and developed in this field were found, which made it possible to arrive at the capabilities used. Once these capabilities were defined, the criteria used came from the context of the study. A search was conducted in order to obtain the criteria that were most appropriate considering the scope of the study. Once the capabilities, levels, and criteria were defined, the work that was carried out was to associate each of the criteria with the levels taking into account the definition of each level. A new five-phase maturity model has been developed for Portuguese public healthcare. This maturity model provides a framework where it is possible to assess what state the organization is currently in in the context of hospital information systems, and how it can progress to higher levels of maturity through the five capabilities considered for this model. These are: Financial, People, EMR, IT and Cooperation. An organization can only progress to a later stage based on methods that have been established previously, and therefore when it reaches all the criteria established in previous stages in each

capability.

**5. Demonstration and application of the proposed maturity model to three healthcare units with identification of the respective improvement plans and discussion of results;**

The first stage of the analysis was to identify in each hospital which are the least mature capabilities that could have a greater impact on the organization. There is no pattern with regard to capabilities, but it can be noted that none of the hospitals has Financial among the least developed capabilities. In this way, an attempt was made to address the weaknesses of each capability in order to lead to an overall improvement of the organization. The hospitals under study were ranked between 1 and 3, and Hospital 3 can be highlighted as a poor performance since it is at level 1 in the overall maturity, and is the hospital with the lowest maturity level capabilities. Hospital 1 can also be classified as a poor performance since it is at level 2 of overall maturity, being one of those that has the highest percentage of capabilities at maturity level 2. With this tool it is possible to identify the most critical areas allowing some simple ideas for improvement to be presented. In conclusion, this study provides managers with several insights, both at the process level and which documents or methodologies to follow, as well as providing an indicator at the global level for decision makers to have a notion of the general level of information systems in the hospital context.

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