

Improving the Use of the Electronic Health Record using an Online Documentation Manual and Its Acceptance through Technology Acceptance Model

Carina Martins, Júlio Duarte, Carlos Portela and Manuel Santos
Centro Algoritmi, Universidade do Minho, Portugal

Keywords: Technology Acceptance Model, Electronic Health Process, Delphi Method, Agency for Integration, Archive and Diffusion of Medical Information, Electronic Medical Record Adoption Model, Online Documentation Manual.

Abstract: To a human it's very complicated to access all the information correctly without a technology to help. The healthcare information systems (HIS) preserves all the information related to a patient and the hospital. In order to be able to share between different HIS, there must be a platform to integrate and share all the information. In Hospital Center of Porto (CHP), the platform used is the AIDA-PCE. This article proposes to make a prototype of an online documentation manual for the platform used and evaluate its acceptance, through a questionnaire with 28 questions. This acceptance was guided by the constructs of the technology acceptance model and the Delphi method. Through bench-marking was chosen the most appropriate tool for creating this manual. The purpose is to enumerate potential improvements to the platform, to reduce and optimize the time of its use and to increase the acceptance of this manual by the professionals.

1 INTRODUCTION

The hospital Center of Porto (CHP) is a central hospital and school that aims at excellence in all its activities. This article proposes improvements to the electronic health process (EHR) so that CHP can optimize the time of use of this technology, preventing the care of the patients.

The EHR replaced the health process on paper, recording all relevant information about the patient and the hospital in a hospital information system (HIS). This allows the exchange of information between different entities, internally or externally to the hospital. One platform that allows this sharing is the Agency for Integration, Archive and Dissemination of Medical Information (AIDA). In CHP, the platform used is AIDA-PCE.

The focus of this article is to evaluate the acceptance of the documentation manual prepared for the AIDA-PCE platform by the health professionals. The CHP was sub-mitted to the classification of EMRAM (Electronic Medical Records adoption model), which evaluates the maturity of the PCE and its functionalities in eight different levels. It was proposed to investigate whether the human dimension influences the

fulfilment of the requirements of these levels. Analyzing all levels, it was found that users influence directly or indirectly some requirements of mostly all levels. The technique used to try to optimize the use of the platform by the professionals was the creation of an online documentation manual.

Trough a search for tools to create an online documentation manual, a prototype of this was made in a CHP instance. To evaluate the acceptance, questionnaires were made using the technology acceptance model 3 (TAM 3) and the Delphi method. The data collected in these questionnaires were analyzed and dashboards were made to be more elucidative of the results withdrawn.

2 BACKGROUND

2.1 Electronic Health Record

Electronic Health Record (EHR) can be defined as the recording of all patient clinical data (Haux, 2006). These data are inserted in an electronic system, which allows the registration, maintenance and storage and sharing of clinical information,

which is fundamental for monitoring the health status of each patient and for other purposes, such as cost management (Duarte et al., 2011).

The Artificial Intelligence Group (GIA) of the University of Minho has developed the Agency for Integration, Archive and Dissemination of Medical Information (AIDA), a multi-agent system that integrates, disseminates and archives all information, which allows the sharing of information with all information systems (Duarte et al., 2011), (Marques et al., 2010).

The GIA Group implemented a PCE, called AIDA-PCE, which is in operation at the CHP, which operates as an HIS subsystem in this hospital unit.

2.2 Electronic Medical Records Adoption Model

The Healthcare Information and Management Systems Society (HIMSS) Analytics has developed an evaluation model for EHR, the Electronic Medical Records adoption model (EMRAM). This model classifies and evaluates the level of functionalities of a PCE, and can be used as a guide to improve it (HIMSS, 2017).

This model incorporates methodologies and algorithms that automatically measure all hospitals in relation to their capabilities (Analytics, 2017). In order to submit a hospital to this model, a questionnaire must be filled out with the respective information.

Table 1: Levels presented in EMRAM.

Stage	Electronic Medical Record adoption model
7	Complete EMR; External HIE; Data Analytics, Governance, Disaster Recovery, Privacy And Security.
6	Technology Enabled Medication, Blood Products, And Human Milk Administration; Risk Reporting; Full CDS
5	Physician Documentation Using Structured Templates; Intrusion/Device Protection
4	CPOE With CDS; Nursing And Allied Health Documentation; Basic Business Continuity
3	Nursing And Allied Health Documentation; EMAR; Role-Based Security
2	CDR; Internal Interoperability; Basic Security
1	Ancillaries - Laboratory, Pharmacy, And Radiology/Cardiology Information Systems; PACS; Digital Non- Non-DICOM Image Management
0	All Three Ancillaries Not Installed

Upon completion, HIMSS Analytics software analyzes these data and generates a score between 0-7000, which indicates the hospital classification. After this classification, the PCE is framed in one of the eight levels of EMRAM, with levels 6 and 7 being the most prestigious. At the end, when the final result is delivered, a report detailing the current gaps for the hospital to achieve higher stages is also provided (HIMSS, 2017). Table 1 shows the eight levels presented in the EMRAM.

2.3 Technology Acceptance Model

Information technologies are increasingly linked to the success of an entity. But its design and implementation are not crucial, the evaluation of a certain technology is essential to understand if it is fit for a given environment and to measure the level of satisfaction of its users (Aguiar et al., 2013).

The purpose of technology acceptance model (TAM) is to present an approach that analyzes the effects of external variables on users' beliefs, attitudes and intentions (Chooprayoon and Fung, 2010), on the internal factors of each individual (Dillon and Morris, 1996).

This model is fundamentally based on two constructs: the Perceived Usefulness (PU) and the Perceived Ease of Use (PEOU). PU is the degree to which the individual believes that using the system will be useful to their work, increasing productivity and effectiveness. PEOU is the degree to which the individual believes that the system does not require much effort and is easy to use. These two factors are influenced by external variables and have a major impact on an individual's Attitude in using them. The Behavioural Intent (BI) of using the system is modelled by Attitude and PU, and determines the Actual Use of this (Dillon and Morris, 1996).

In 2008, Viswanath Venkatesh and Hillol Bala, adapted the TAM 2 and the model of the determinants of perceived ease of use, developing an integrated model of technology acceptance, Technology Acceptance Model 3 (TAM 3), which compared with the models above, adds some variables that can influence PEOU (Aguiar et al., 2013), (Venkatesh and Bala, 2008). The variables that influence the PEOU are divided into: anchors and adjustments. The first type can be split in the computer self-efficacy, perceptions of external control, computational anxiety and computer playfulness. The second type defines the perceptions of enjoyment and real usability (Venkatesh and Bala, 2008).

2.4 Delphi Method

The Delphi method is seen as a procedure to obtain a reliable opinion from a group of experts, through a series of questionnaires scattered with their feedback (Dalkey and Helmer, 1963).

Initially, this method suggests the formulation of the questions in the questionnaire. Next, the specialists are selected, who have to follow four requirements: knowledge and experience in the problem, capacity and willingness to participate in the process, time available to participate and good communication skills (Adler and Ziglio, 1996). Subsequently, the first round of questionnaires are developed and analyzed, to formulate the second round of questionnaires and send to the specialists. After the dispatch and resolution by the specialists, the answers are analyzed, and a third round of questionnaires is elaborated, that after answer, they are analyzed again (Skulmoski and Hartman, 2007). This process continues until stability between expert responses (Rowe and Wright, 1999). After this step, the results are analyzed, and a document is drawn up with these results.

3 ONLINE DOCUMENTATION MANUAL

The tool chosen for creating the online documentation manual was Dr. Explain, because it allows to integrate the documentation manual into the AIDA platform, allows to take automatic screenshots and allows the collaboration of different users in the creation.

The manual features an intuitive and easy-to-work interface. On the left side there is a side menu that shows all the contents inserted. On the right side there is a bar to search for specific contents. For each task, were created the following steps to make the tasks more efficiently. This manual also clarifies relevant concepts to eliminate inconsistencies in completing forms.

4 TECHNOLOGY ACCEPTANCE MODEL APPLICATION IN THE MANUAL

The purpose of the assessment is to determine whether users are satisfied or not with the manual implemented, conducting a qualitative research

through questionnaires. The questionnaires were designed to evaluate the technical and functional characteristics of the manual, in terms of the constructs of the technology acceptance model 3 (TAM 3).

The questionnaire contains 28 questions and is divided into two types of questions: scale response and open response. Scale response questions were developed according the Likert Scale (from one to five). This scale is widely used because it permits a small dispersion of results and a level of agreement that short and long scale options do not allow (John, 2010). It should be noted that 1 means “disagree strongly” and 5 means “agree strongly”. Open responses are beneficial for getting feedback from respondents.

The questionnaire was developed in an online platform, Google Docs, which allows the creation and editing of documents and was shared with 6 CHP health professionals. Since they were experts in the subject under study and there was credibility in the answers, the sample was enough to get results.

Table 2 lists how many questions each construct evaluates.

Table 2: Number of questions of each construct.

Constructs	Number of questions
PU	12
PEOU	12
BI	12
UB	11

5 DATA ANALYSIS

Figure 1 is based on the TAM 3 construct analysis. The four constructs were evaluated, plotting the mean and standard deviation of the questions associated with this construct.

Analyzing the obtained answers, it was verified that when one question had of the six answers, two different, the value of the standard deviation was superior to 0,5. Then, it was determined that for values higher than this there was dispersion of results in the given question.

Graph (a) concludes that the answers with lower mean were questions 2.4., 3.1. and 4.4, being the questions in which the construct was worse evaluated. More than 50% of these questions have a standard deviation higher than 0.5, which indicates that there was some dispersion in the answers given. On the other hand, all questions on average were evaluated with a value of 4, which explains that, in general, respondents believe that the documentation

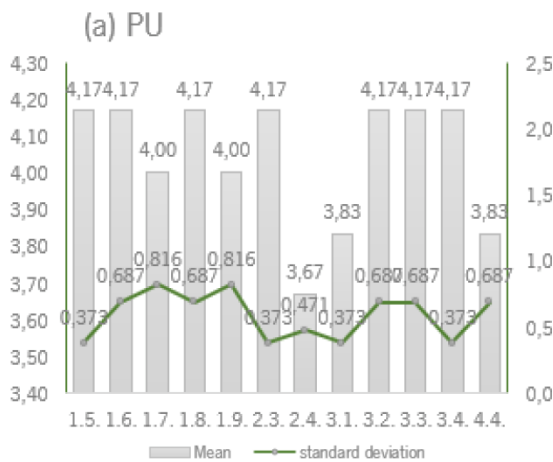


Figure 1: (a) Analysis of Perceived Usefulness.

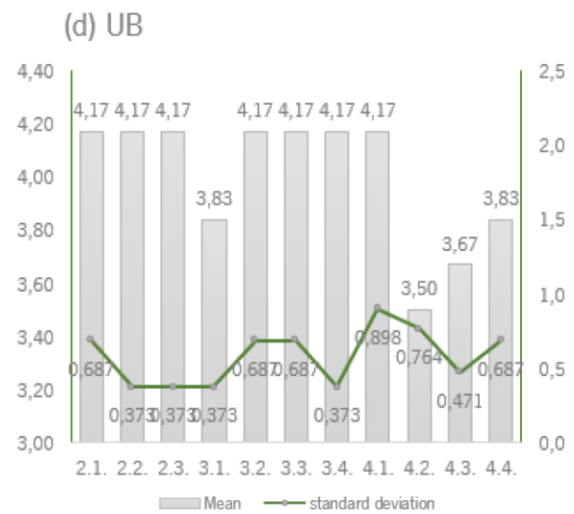


Figure 1: (d) Analysis of User Behaviour.

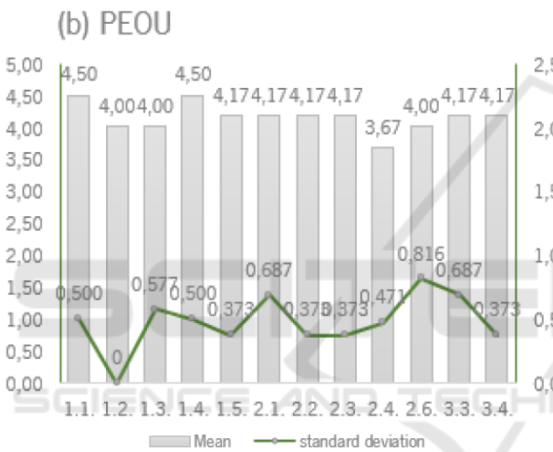


Figure 1: (b) Analysis of Perceived Ease of Use.

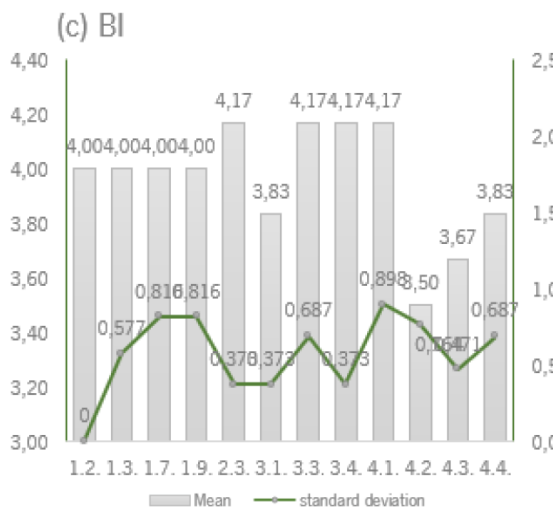


Figure 1: (c) Analysis of Behavioural Intention.

manual is useful for their work.

Graph (b) settles that the question on which the construct was worst evaluated was 2.4. Half of the questions present the value of the standard deviation less than 0.5, which indicates that in this construct, in general, there is not much variation in the professionals' responses. On the other hand, in conclusion, all questions, on average, were evaluated with a value of 4, which makes it possible to affirm that health professionals believe that the manual is intuitive and easy to use.

Graph (c) shows that the two responses with the lowest mean were 4.2 and 4.3. More than half of these questions have a standard deviation greater than 0.5, indicating that there is a wide variation in the answers given. Finally, it is concluded that all the questions that evaluate this construct were evaluated, on average, with the value 4, allowing concluding that health professionals intend to use the documentation manual.

Graph (d) shows that the two responses with the lowest mean were 4.2 and 4.3. Approximately half of these questions have a standard deviation greater than 0.5, indicating that there is a large dispersion in the responses given. Finally, it is concluded that all the questions that evaluate this construct were evaluated, on average, with the value 4, allowing concluding that the health professionals intend to really use the manual.

In summary, Table 3 was constructed, which shows the general mean of each construct.

Although the overall averages of each of the constructs are quite similar, the PEOU is viewed as having the best mean. This can be considered as advantageous because this construct influences/pre-

dicts PU.

Table 3: General mean of each construct.

Constructs	Number of questions
PU	4,042
PEOU	4,139
BI	3,958
UB	4

6 CONCLUSIONS AND FUTURE WORK

One of the first conclusions drawn from the study of the Electronic Medical Records adoption model (EMRAM) was that users of a system have a major impact on their success. Therefore, for a good evaluation of the electronic health record (HER) and to be able to reach a prestige level in the studied model, a good formation and support to the use of these systems is essential.

Acceptance of the respondents was very positive (between 3 and 5 values) in the four constructs evaluated. The conclusion to be drawn from the data obtained by the questionnaire responses is that, in general, health professionals are satisfied with the manual.

It was possible to identify some factors that influence the behaviour of health professionals in the use of this manual, being: easy use, not requiring much mental effort for use, being advised by co-workers and being intuitive and appealing.

One of the major obstacles encountered is the poor adherence to its use by health professionals, perhaps because the benefits of its use are little shown.

In short, the documentation manual should be seen as an added value because it brings improvements to the system, favouring the use of AIDA, such as, eliminates some inconsistencies of the platform, clarifying concepts and defining the steps to follow in the elaboration of specific tasks; brings benefits to the work of healthcare professionals, thus brings direct or indirect benefits to the patient, makes the use of AIDA more efficient and effective and provides a unique support to the system through the implementation of the manual within the platform.

The results obtained were very encouraging for a subsequent continuation of the development and improvement of this documentation manual. For this, it is fundamental to continue the realization of the prototype and until its effective implementation in the PCE. For a better analysis of the acceptance of this manual, it would be necessary to continue the

rounds of questionnaires in order to clarify some inconsistencies in the interpretation of the previous questionnaire and that respondents may be able to re-evaluate their responses. It would be important that the next sample be broader so that more concise results can be drawn.

ACKNOWLEDGEMENTS

This work has been supported by FCT – Fundação para a Ciência e Tecnologia within the Project Scope: UID/CEC/00319/2019.

REFERENCES

- Haux, “Individualization, globalization and health – about sustainable information technologies and the aim of medical informatics” *Int. J. Med. Informatics.*, p. 75:795-808, 2006.
- J. Duarte, C. F. Portela, A. Abelha, J. Machado, and M. F. Santos, “Electronic health record in dermatology service,” *Commun. Comput. Inf. Sci.*, vol. 221 CCIS, no. PART 3, pp. 156–164, 2011.
- J. A. Marques, A. J. G. Correia, L. Cerqueira, J. Machado, and J. Neves, “Archetype-based semantic interoperability in healthcare,” 2010.
- HIMSS, “EMRAM | HIMSS Europe,” 2017.
- H. Analytics, “Electronic Medical Record Adoption Model,” *Himss Anal.*, 2017.
- J. Aguiar et al., “Pervasive information systems to intensive care medicine: technology acceptance model,” 2013.
- Vasin Chooprayoon and C. C. Fung, “TECTAM: An Approach to Study Technology Acceptance Model (TAM) in Gaining Knowledge on the Adoption and Use of E-Commerce / E-Business Technology among Small and Medium Enterprises in Thailand,” *E-commerce*, pp. 31–38, 2010.
- A. Dillon and M. G. Morris, “User acceptance of new information technology: theories and models,” *Annu. Rev. Inf. Sci. Technol.* Vol. 31, vol. Vol. 31, pp. 3–32, 1996.
- V. Venkatesh and H. Bala, “Technology Acceptance Model 3 and a Research Agenda on Interventions,” *Decis. Sci.*, vol. 39, no. 2, pp. 273–315, 2008.
- N. C. Dalkey and O. Helmer, “An experimental application of the Delphi Method to the use of experts,” *Manage. Sci.*, vol. 9, no. 3, pp. 459–468, 1963.
- M. Adler and E. Ziglio, *Gazing into the oracle: The Delphi Method and its application to social policy and public health*. London: Jessica Kingsley Publishers, 1996.
- G. J. Skulmoski and F. T. Hartman, “The Delphi Method for Graduate Research,” *J. Inf. Technol. Educ.*, vol. 6, no. 1, pp. 1–21, 2007.

- G. Rowe and G. Wright, "The Delphi technique as a forecasting tool: issues and analysis," *Int. J. Forecast.*, vol. 15, no. 4, pp. 353–375, 1999.
- R. Johns, "Likert Items and Scales," vol. 1, no. March, pp. 1–11, 2010.

