

Personal Characteristics of Physicians Influencing A Faster Adoption of Innovations: A Study Based on Diffusion of Innovations Attributes

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Abstract

This article comprises the results of a survey with 221 physicians located at Santa Casa de Misericórdia de Santos – SCMS, in the state of São Paulo, Brazil, regarding the use of Electronic Medical Record, based on their perception of Diffusion of Innovations attributes, defined by Everett Rogers. The method was based on a questionnaire specially developed for this study based on the literature review. The results show that younger and newer physicians have greater perception of those attributes, what leads them to a faster adoption of Electronic Medical Record. The research also identified that gender and amount of training do not influence the perception of attributes leading to adoption, but the familiarity with informatics, mandatory use, professional ties and academic preparation for the use of Electronic Medical Record are factors that influence its adoption. Although some findings are obvious, as with similar studies, others, such as: amount of training and professional ties can be useful in planning training programs conducted by IT staff prior to the implementation of innovations.

Keywords: Electronic Health Record, Diffusion of Innovations, Information Technology adoption, Sociological behavior, Physicians characteristics.

Introduction

Although physicians have been gradually adopting Electronic Medical Record – EMR, a survey done in 2015 in Brazil indicated that 36% of hospitals with up to 50 beds and 17% of hospitals with more than 50 beds still work only with paper-based records. (1)

Neumeier (2) reports that, despite the benefits gained with EMR, its adoption has been slow and highlights that there are many potential barriers to its implementation, with the most notable being the ones related to the change management.

This article aims to present the results obtained in a survey performed on the physicians working at Santa Casa de Misericórdia de Santos - SCMS, in the state of São Paulo, Brazil, to gather their perception regarding the use of EMR, based on their personal and conjunctural characteristics correlated to the attributes of Diffusion of Innovations theory.

EMR is the innovation in this particular case, but the principles of this theory can be applied to Clinical Decision Support Systems, Artificial Intelligence, Internet of Things and any other systems or devices that can be recognized as innovations by health professionals.

Diffusion of Innovations

The Diffusion of Innovations theory was developed by Everett Rogers and explains that diffusion is the process in which an innovation is communicated through certain channels over time among members of a social system. It is a special type of communication, in which the messages are concerned with new ideas.

(3)

This theory indicates the existence of four main elements for the diffusion of a new idea: the innovation itself, the communication channels, the time and the social system. Rogers defines innovation as an idea, practice or object that is perceived as new by an individual or other adoption unit. The adopters are the minimal study unit, generally they are individuals, but can also be professional categories, departments or companies. The communication channels are the means enabling the transference of information from one adoption unit to another. The time is the period between the appearance of the innovation and its eventual full adoption and the social system is the combination of internal and external influences which the adopting units may receive over the adoption process: (3)

Rogers points out also that the innovation adoption process goes through five stages: knowledge, persuasion, decision, implementation and confirmation. The stage denominated knowledge happens when an individual or other adoption unit learns of the innovation existence and gains some understanding of how it functions. Persuasion is the stage in which the individual forms a favorable or unfavorable attitude toward the innovation. The decision stage is the one in which it is defined the implementation or not of the innovation. The implementation is the stage of use properly, and the confirmation is the stage of evaluation of gains and losses over time related to the adopted innovation. (3)

The theory also highlights six attributes an innovation must have, that lead people to adopt new ideas and methods: relative advantage, compatibility, complexity, trialability, observability and flexibility or “reinvention”. Each of these factors has the following definitions according to Rogers: (3)

- Relative advantage: the degree to which an innovation is perceived as better than its predecessor.
- Compatibility: the degree to which an innovation is perceived as consistent with existing values, needs and past experiences of the potential adopters.
- Complexity: the degree to which an innovation is perceived as difficult to understand and use.
- Trialability: the degree to which an innovation can be experienced before adoption.
- Observability: the degree to which the results of an innovation are visible by the organization.
- Reinvention (or Flexibility): the degree to which an innovation can be adapted before its definitive adoption.

These attributes are the focus of this study because, considering that, according to Rogers, the greater the perception of these attributes by the physician, the faster is the adoption of EMR.

Finally, Rogers classifies the adopters in five groups (Figure 1) according to the speed they adhere to the innovation: Innovators, Early Adopters, Early Majority, Late Majority and Laggards. (3)

Figure 1 - Adopters classification according to Diffusion of Innovations Theory (Rogers, 2003)

Objectives

This study aims to identify the perception of physicians at SCMS regarding to the six attributes of Diffusion of Innovations: Relative Advantage, Compatibility, Complexity, Trialability, Observability and Flexibility. SCMS was founded in 1543 and is the largest hospital in its metropolitan region. It receives patients from the nine cities that compose the region and also from adjoining cities; it has about 660 beds; more than 3,600 professionals and a clinical body of 480 medical doctors, being a reference in traumatology, cardiology, nephrology and ophthalmology. (4)

This hospital was chosen for this study due to its characteristics and its similarity with other healthcare facilities linked to the Brazilian Confederation of Santas Casas de Misericórdia, Philanthropic Hospitals and Entities – CMB, which includes about 1,787 institutions with similar characteristics and which may benefit from the obtained results.

The Electronic Medical Record system was adopted in February, 2006 and its use became mandatory from August of the same year. Currently it is available for all the hospital departments, although not all the functionalities are fully in use.

Materials and Methods

This explanatory study aims to identify the correlations between the variables: age, gender, time from graduation, time working at the hospital, degree of familiarity with informatics, mandatory usage, professional ties, length of training, instructors involved and academic preparation, and the attributes of Diffusion of Innovations theory, by means of a quantitative approach, in order to discover if the perception of physicians using EMR towards these attributes, are influenced by the mentioned variables.

The 480 medical doctors included in the official listing of the SCMS clinical staff received a printed questionnaire and, among them, the ones who had an e-mail registered in the organization, received also an invitation to respond to the questionnaire, alternatively, on the Web. Banners were distributed to the places highly frequented by the physicians and, one month before the collection deadline, the Clinical Director sent out an official communiqué urging the physicians who still had not taken part, to participate on the final stage and fill the questionnaire. With these actions the response rate was 46% (221).

The questionnaire was elaborated with multiple-choice questions based on variables collected on the literature review. Divided in three parts, the first one serving to identify the respondent (4 questions), the second part was directed to the doctors who self-identified as users (18 questions) with the goal of characterize them and identify the facilitating and hindering factors perceived by these professionals in the use of the system, and the third part was directed to the ones who self-identified as non-users of the EMR (4 questions).

The questions of the second part were formulated affirmatively and graduated on the Likert scale in a numerical range from +2 (full agreement) to -2 (full disagreement).

After the 120 days of data collection period, the data went through a preparation that consisted on: 1. Complementation of information left blank; 2. Data entry and consistency check with the returned envelope count, and age and gender totals; 3. Preparation of data, due to requirements of the software used for analysis.

Once the data was prepared, the study advanced to the data analysis phase, considering first the identification of normal distributions for the definition of tests to be used. This first step was performed based on the Shapiro-Wilk normality test, which results ($p < 0.05$), led to the use of non-parametric tests for the analysis of correlations between variables.

Therefore, Spearman Correlation tests were used to verify the relationships between quantitative variables, such as: age, time from graduation, time working at SCMS, degree of familiarity with informatics, length of training and the attributes of Diffusion of Innovations. The tests resulting in p -value < 0.05 indicated the existence of the correlation between variables and attributes. The Spearman "S" complemented the results indicating if the correlation is positive, that is, the higher the characteristic indicator for the doctor, the higher the perception of the attribute.

For the verification of correlation between quantitative and qualitative variables with two groups, to wit: gender (male or female), mandatory usage (voluntary or mandatory) and instructors (yes or not), the Mann-Whitney test was used and the groups median indicated which of them tends to each end of the Likert scale. Finally, the Kruskal-Wallis test was applied for the verification of relationships between the quantitative and qualitative variables with three or more groups, to wit: professional ties (residents, outsourced personnel and employees) and academic preparation (at least one class or lecture, one class along one semester, no classes and "I don't remember"). The result was also measured based on p -value < 0.05 , indicating the existence of a difference between the groups and the tendency for each group was examined based on multiple comparisons of p -value.

Results

Among the 221 respondents, 169 (75.47%) was self-identified as EMR users and 52 (23.53%) as non-users. The physicians that made up the sample are, on average, 48 years old, have 22 years since graduation and have worked at SCMS for 19 years. The majority (76%) are hired as freelancers or outsourced personnel, began to use the system voluntarily as soon as it became available (76%), after a single training session (67.4%) headed for the most part by the internal IT team.

A noticeable piece of data is that 72.7% of the physician users reported not having received even one class or lecture about EMR in their graduate or postgraduate training, which is not surprising, since Meade *et al.* (2009) remind that most of the current crop of physicians graduated before the arrival of this kind of system and graduation courses usually take a relatively long time to adapt to the needs of the marketplace. (5)

It's important to highlight that, since the relative advantage attribute can be measured considering various aspects of the EMR usage, three requisites were considered for this item: ease of use of the system, time to fill in the treatment information form and quality of the patient care, all of them in comparison with paper records.

Analysis of Correlation between Physicians Characteristics and Diffusion of Innovations

Attributes

It is important to remember that Rogers pointed out that the greater the perception of one or more attributes, the higher the speed of adoption, therefore, the table below (

Figure 2) shows the attributes that can be considered more relevant to physicians adoption of EMR.

Figure 2 - Influence of physicians' characteristics on Diffusion of Innovations attributes perception

The correlation analysis between age and Diffusion of Innovations attributes identified that younger physicians have a higher perception of the relative advantage, low complexity, compatibility and experimentation attributes ($p < 0.05$). Similarly, the ones with less time since graduation and less time working at SCMS perceive the factors low complexity, compatibility and experimentation in a more intense way than the more veteran ones and perceive the relative advantage factor in the same way, but only when comparing time to fill in the information and treatment quality ($p < 0.01$).

Regarding gender, no correlation was identified to any of the Diffusion of Innovations component variables ($p > 0.05$), meaning that doctors of both genders perceive the attributes in a similar way.

Analyzing the correlation between degree of familiarity with informatics and Diffusion of Innovations attributes, was observed that the most familiar users with informatics have a higher perception of relative advantage, on the aspects of time for filling in and perception of low complexity ($p < 0.01$).

The question related to mandatory use indicated that the ones who started using the system voluntarily have a higher perception of relative advantage, compatibility, experimentation, observability and flexibility ($p < 0.05$).

On the professional ties item was identified that residents, outsourced personnel and employees perceive in different ways the attribute relative advantage, related to the ease of use and treatment quality requisites, compatibility and flexibility ($p < 0.05$). Comparing the averages for each kind of contract, it was observed that residents have a higher perception of these attributes than outsourced which, by turn, have a higher perception than employees.

The length of training variable also has not presented significant differences between the ones who received one, two, four or more training sessions related to the Diffusion of Innovations variable perceptions ($p > 0.05$).

Regarding the item related to the responsible professionals for the training of the physicians, led to different perceptions: physicians trained by the internal IT team presented higher perception of relative advantage (ease of use) and compatibility (average scores of the trained personnel higher than the average of the ones not trained by the internal team), doctors trained by fellow doctors presented lower perception of compatibility (average scores for the ones who received this training is lower than the average scores for the ones not trained by colleagues) and doctors trained by nurses presented higher perception of experimentation (average scores = 1.50).

When the academic preparation for using an EMR system variable was analyzed, it was observed that the physicians surveyed who received any information, in the form of class or lecture about electronic medical records, during graduation or post-graduation, perceived the attributes in a different way than the ones who didn't receive information during that period. Comparing the averages of the positions obtained on the Kruskal-Wallis test, it can be observed that those who had at least one class or lecture about the electronic records theme have a higher perception of relative advantage (ease of use and treatment quality) and observability than the ones who didn't have any information during their graduation or post-graduation

Discussion

In this survey, as previously mentioned, significant differences between genders were not observed, however, a study by Ma and Yuen (6), regarding the perception of ease of use and usefulness by professors of both genders reported that women are influenced by both attributes in a balanced way, while men are more strongly influenced by the usefulness attribute.

With a lesser degree of similarity to this study, since it was based on the Theory of Planned Behavior, different results were gathered in a survey by Morris, Venkatesh and Ackerman (7), in which the authors detected that the differences between men and women in the technology acceptance process accentuate with age.

Rogers (2003) highlighted the attributes relative advantage and compatibility as the most relevant for explaining the adoption rate of an innovation, and Perez and Zwicker (8), in a study using an adaptation of the Rogers model, made by Moore and Benbasat, concluded that these same attributes, as well as the result demonstrability (observability), contributed positively to the adoption of EMR in an university hospital in São Paulo, Brazil. The present study confirmed that, with the exception of the variable gender and length of training, all the others influence the perception of the relative advantage and compatibility.

Length of training, in particular, presented as little relevant for the perception of these attributes, which does not mean that training is unnecessary, but just that the number of sessions has little influence on the perception, corroborating therefore study performed by Morton and Wiedenbeck (9) who also used Diffusion of Innovations and TAM as a theoretical basis for their survey and detected the influence of the training variable on the perceptions of usefulness and ease of use is not statistically significant.

Also reporting low or no statistical significance in the correlation between training and perception of ease of use and usefulness, Gadd and Penrod (10), in a survey with doctors after six months from the implementation of an EMR system.

Another study performed in two hospitals, one in Brazil and the other in Spain, by Farias *et al* (11), detected that the higher the knowledge of informatics of the professional, the higher the chance for adaptation to the use of EMR. This result was confirmed by van der Meijden *et al* (12), who identified the previous experience with informatics as a determining factor for the acceptance of an EMR system. In the present study, considering that the perception of the relative advantage and low complexity were more strongly observed by the users with higher degree of familiarity with informatics, it's possible to infer that these users tend more strongly to adhere to the use of this kind of system than the ones who do not have this perception.

Rogers observes also that the interpersonal communication channels are more effective when people in the same socio-economical and educational level exchange ideas about an innovation (3), although, in this survey it was observed that physicians trained by peers have a lower perception of compatibility of EMR with the work method of paper records.

Conclusions

Health institutions that had not yet implemented EMR, will certainly have no such difficulty as the first ones, but have to consider Diffusion of Innovations principles to ease its way. Those institutions where

EMR are fully implemented, have now another challenge: implementation of innovations resulting from the possibility of use of databases or technical features of this EMR, like clinical decision support system, data originated from wearables devices, suggestions from artificial intelligence systems and similars.

Looking at these factors that mostly influence the perception of Diffusion of Innovations attributes and, consequently, can facilitate innovations adoption, there are some steps that can be followed by the IT Team in any organization that is in the process of EMR implementation:

1. Give a different treatment to physicians by age and time of working at organization;
2. Use those who have more familiarity with informatics as influencers, as well as those who voluntarily began to use EMR and, also, residents and outsourced personnel;
3. Integrate nurses to the IT team as trainers and, if possible, also physicians.

Also of note is the length of training, which results, evidenced the fact that it does not interfere on the physicians' perception towards any of the Diffusion of Innovations attributes, but it cannot be dismissed. Considering that the current study used as reference a single healthcare institution, its findings are limited to that institution. Nevertheless, since the beginning of the work it was known that other institutions are assembled in the Brazilian Confederation of Santos Casas de Misericórdia, Philanthropic Hospitals and Entities, as well as other hospitals in Asian and Africa who still works with paper-based patient records and it is expected that the results obtained may serve as a reference for these entities, at the time of introducing electronic medical records.

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