Psychological, Social and Technical Factors Influencing Electronic Medical Records Systems Adoption by U.S. Physicians: A Systematic Model

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Research article

Keywords: EMR adoption, EHR adoption, innovation adoption, technology acceptance, intentions of physicians, influence of policy

Posted Date: July 1st, 2020

DOI: https://doi.org/10.21203/rs.3.rs-36849/v1

Abstract

Background: Wide adoption of electronic medical records (EMR) systems in the United States can lead to better quality medical care at a lower cost. Despite the laws and financial subsidies by the U.S. government for service providers and suppliers, the adoption has been slow. Understanding the EMR adoption drivers for physicians and the role of policymaking can translate into increased adoption rate and enhanced information sharing between medical care providers.

Methods: Physicians across the United States were surveyed to gather primary data on their psychological, social, and technical perceptions toward EMR systems. This quantitative study builds on the Theory of Planned Behavior, the Technology Acceptance Model, and the Diffusion of Innovation theory to propose, test, and validate an innovation adoption model for the health care industry. 382 responses were collected and data were analyzed via linear regression to uncover the effects of 12 variables on the intention to adopt EMR systems.

Results: Regression model testing uncovers that government policymaking or mandates and other social factors have little or negligible effect on physicians' intention to adopt an innovation. Rather, physicians are directly driven by their attitudes and ability to control, and indirectly motivated by their knowledge of the innovation, the financial ability to acquire the system, the holistic benefits to their industry, and the relative advancement of the system compared to others.

Conclusions: A unidirectional mandate from the government is not sufficient for physicians to adopt an innovation. Government, health care associations, and EMR system vendors can benefit from our findings by working toward increasing the physicians' knowledge of the proposed innovation, socializing how medical care providers and the overall industry can benefit from EMR system adoption, and solving for the financial burden of system implementation and sustainment.

Background

The United States relies on the national diffusion of electronic medical records (EMR) systems to benefit from efficiencies that can both reduce health care costs and improve quality of care. However, even with policymaking and substantial governmental financial investment, the feasibility of a national electronic health patient records system, backed by interoperability and data sharing with and between all medical practices, remains unproven. Since 1996, the U.S. government has supported the wider adoption of health information technology and electronic medical data exchange. The Health Insurance Portability and Accountability Act of 1996 established national standards for electronic health care transactions and national identifiers for health care providers. The American Recovery and Reinvestment Act (ARRA) of 2009, a stimulus package also known as the Recovery Act, allotted over $19 billion out of $145 billion for health care spending to modernize health information technology systems. However, the adoption rate and health information exchange are still considered low reaching only 53% for basic systems [1] and just 12% for systems that could meet the government's criteria [2].

In this article, the term adoption will mean either implementing an EMR system for the first time or upgrading the current state of the EMR system by introducing advanced capabilities. The anticipated benefits of EMR system adoption include real-time data access, clinical decision support, enhanced monitoring, computerized medication orders, and simplified administrative and billing work [3, 4]. A higher rate of adoption and a wider spread of EMR systems can mean better medical care for the patient [5]. Efforts have been made by researchers to understand the reasons behind the low adoption rate [6, 7, 8, 9]. What is still missing is a comprehensive model that compares different categories of factors so efforts can be focused on those that make the biggest impact on adoption.

The innovation implementation process in the U.S. health care industry is lengthy and complex, requiring multi-stage system setup and adoption [2, 10, 11]. The industry is composed of sponsors and providers of both public and private sectors. All bear responsibility for EMR system development and advancement. As a public health care sponsor, the U.S. government supports the adoption of EMR technologies to achieve cost and quality benefits and has achieved a reduction in Medicare expenditures [12]. However, the intentions of medical care providers haven't been clear. Physicians and clinicians have divided opinions regarding EMR system's advantages [13], and there is no consensus on how to achieve EMR system benefits across the U.S. health care system as a whole [9]. Furthermore, and contrary to the government's expectations, convenient access to tests, including electronic imaging results, seems to encourage physicians to increase their testing and imaging ordering, rather than reduce them [14].

System adoption and implementation has been easier at larger institutions compared to smaller practices, especially solo practices and non-primary care specialties [15], due to their greater access to resources and management capacity [11, 16]. Physicians, whether they are part of larger institutions like hospitals or of smaller practices, make up a large EMR system user group [17]. Their attitudes and perceptions shape the long-term success. Therefore, our research question is: What factors influence physicians to adopt innovations such as EMR systems? And what impact do government policy and mandate have on the adoption?

Understanding the influence and interaction between the psychological, social, and technical perspectives is required in order to know the deep dynamics of an innovation and, in turn, measure its success [18, 19]. To investigate our research question, we researched the theoretical foundation of behavioral and technology acceptance theories, constructed a model, formed hypotheses, and invited physicians around the United States to participate in a quantitative Qualtrics survey (Sect. 2). In Sect. 3, we state the results and which hypotheses were supported. In Sect. 4, we discuss our key findings. Finally, in Sect. 5, we present our conclusions and highlight the practical implications of the findings. We conclude that a government directive is not enough to get physicians to support an innovation, like EMR systems, in health care. Social factors in general have low effect. In turn, we suggest the development of educational programs to increase system knowledge, clarify industry benefits, pinpoint relative advancement, and facilitate financial support to drive positive attitudes and perceived behavioral control among physicians.

Methods

The Behavior of Adoption

Rogers' Diffusion of Innovation (DOI) theory [20], Davis's Technology Acceptance Model (TAM) [21], and Ajzen's Theory of Planned Behavior (TPB) [22] are key technology adoption and behavioral theories to employ. Combining more than one theoretical model usually leads to a better understanding of an adoption phenomenon [23]. Thus, our model for EMR innovation adoption integrates technical, social, human, and psychological factors from different theories and models, which is in line with what Jian et al. [24] did for uncovering the EMR adoption factors in Taiwan. Our research question focuses on identifying the drivers behind physicians' adoption of an innovation. The DOI theory [20] describes the spread of technical innovations, such as EMR systems, through an innovation-decision process [20]. This process is a series of stages that a decision maker follows to reach a decision that can be favorable (to adopt) or not favorable (to reject).

The decision for EMR system adoption can be modeled as a rational behavior in the framework of the TPB [22]. The rational planned behavior is mainly a function of the individual's intention to engage in the behavior, which is the indication of an individual's readiness to perform the behavior. The TPB variables can "capture unique variance in intention" (p. 178) [25]. Although the individual's intention to act is not actual behavior, "there is considerable evidence that intention to perform a behavior predicts actual behavior" (p. 174) [25].

Intention Drivers

Per the TPB model [22], the intention to engage in a certain rational behavior is directly influenced by the attitude toward the behavior, the subjective norms, and perceived behavioral control. Attitude is the individual's mental state, including feelings, values, and dispositions toward the behavior, and subjective norms are the collection of social pressures and beliefs that important others (e.g., peers or government) expect particular behavior [22]. Perceived behavioral control corresponds to the self-efficacy theory developed by Bandura [26], who defined it as the conviction by someone about his or her ability to successfully execute a behavior required to produce the expected result.

Ajzen [22] noted the TPB is intended to provide a general guideline of what determines or influences a behavior. The researcher is expected to creatively identify the main factors affecting a behavior that are relevant to a situation or setting. Hypotheses 1a and 1b are two of the hypotheses on predicting intention:

*Hypothesis 1a: **Attitude** toward adoption has an effect on the **intention** to adopt.*

*Hypothesis 1b: **Perceived behavioral control** over adoption has an effect on the **intention** to adopt.*

Subjective Norms Factors

Subjective norms' social pressures can be coercive, mimetic, or normative [23]. Coercive pressure is practiced by a source of power to force conformity to demand or expectations; mimetic pressure is what makes an individual imitate others; and normative pressure is the tendency to behave in a manner that is deemed to be acceptable or approved by others [22, 23]. Social interferences are generally expected to play a positive role during and after the adoption of a new technology [27, 28]. Therefore, identifying the factors of the subjective norms helps to assess their impacts on the intention to adopt EMR.

The medical industry has tight networks that provide forums for peer knowledge and opinion sharing. Peer preference is the individual's perception of what medical peers, colleagues and associates think about EMR systems. Having similar or congruent perspectives among physicians and associating with medical care professionals, is an important factor of behavior [11]. According to Bramble et al. [29], physicians who know other physicians supporting EMR systems enhance their desire to adopt these systems themselves. Peer preference exerts a mimetic pressure and is a main component of social norms. Hypothesis 1c is an additional hypothesis on intention:

*Hypothesis 1c: **Peer preference** has an effect on the **intention** to adopt.*

According to Watkins et al. [30], governments have been known to "play a central orchestrating role in the generation and diffusion of innovation in a national economy" (p. 1408). This orchestrating role is clearly visible in the U.S. government's regulations, policies, and mandate requiring the adoption and use of EMR systems. This exerts coercive pressure on physicians who feel that their decisions should meet the expectations of the government and other influential organizations [23]. Hence, hypothesis 1d is proposed:

*Hypothesis 1d: The **government policy and mandate** for adoption have an effect on the **intention** to adopt.*

More recent literature shows that intermediary industry associations have an increasing involvement in cooperative relations between government and industry aimed at influencing an innovation's diffusion, adoption, training, and standards [30]. These associations create and set industry protocols and common best practices to which physicians are driven to adhere. Lack of standardization is the biggest challenge according to Rathert et al. [2]. We expect physicians to take the normative pressure of meeting industry standards into consideration when adopting technologies, and this is reflected in hypothesis 1e:

*Hypothesis 1e: **Industry standards** for adoption have an effect on the **intention** to adopt.*

Attitude Drivers

Hypothesis 1a posits that attitude has an effect on intention. In this section, factors that influence attitude are considered. Complex innovation integration, like EMR systems, requires knowledge creation and diffusion [18, 31]. Knowledge is the extent to which the individual is aware of the innovation and its purpose, structure, components, requirements, benefits, and impacts. According to Rogers [20], knowledge

is the first stage of the innovation-decision process by which a decision regarding the adoption of innovation matures prior to being made. Knowledge leads to physicians' persuasion to adopt the system [20].

Having such knowledge helps promote persuasion and attitude formation. This definition supports hypothesis 2a:

Hypothesis 2a: ***Knowledge*** *of innovation has an effect on the* ***attitude*** *toward adoption.*

Ultimately, successful adoption of EMR systems in the United States and the nationwide diffusion of shareable electronic records should yield measurable benefits. Several studies associate the acquisition and adoption of technology innovation with enhanced performance, increased efficiencies, and improved quality [9, 32, 33]. The more the adopters believe they can achieve higher performance, efficacies, and quality, the more positive psychological feelings they will have toward it. The TAM [21] posits two determinants of user's attitude toward acceptance of a technology system: perceived usefulness and perceived ease of use. Davis [21] defined perceived usefulness as the extent to which a person believes using a system will enhance the individual's job performance. However, regarding benefits, an innovation can be differently useful to the user than it is to the overall industry. Thus, a distinction between perceived usefulness for the individual and perceived benefits for the industry is needed. While perceived usefulness is a behavioral belief, perceived industry benefits is an outcome evaluation [25]. Both are factors of attitude [25]. Hence, hypotheses 2b and 2c are as follows:

Hypothesis 2b: ***Perceived industry benefits*** *have an effect on the* ***attitude*** *toward adoption.*

Hypothesis 2c: ***Perceived usefulness*** *has an effect on the* ***attitude*** *toward adoption.*

Perceived ease of use, the second determinant of technology acceptance, is defined by Davis [21] as the degree to which a person believes using the system would be free from effort. Perceived ease of use can influence attitude and is stated in hypothesis 2d:

Hypothesis 2d: ***Perceived ease of use*** *has an effect on the* ***attitude*** *toward adoption.*

Perceived Behavioral Control Drivers

Researchers, such as Boonstra and Broekhuis [34], Bramble et al. [29], Felt-Lisk et al. [3], Häyrinen et al. [35], Hillestad et al. [4], and Mostashari et al. [36] discussed and identified existing and potential control barriers to EMR system adoption. The two main identified factors are first, not having the financial ability for adoption, and second, the negative impact EMR system adoption has on workflow and operations. Financial ability is having the necessary funds to support the initial setup and ongoing maintenance of the system. The impact on workflow is the extent to which the EMR system benefits or disrupts operations. These factors are what Ajzen [22] calls control beliefs. They affect behavior through their impact on the trust in self and the perception that one is feasibly able to adopt and use an

innovation. Two of the hypotheses of factors impacting perceived behavioral control are as follows (hypotheses 3a and 3b):

Hypothesis 3a: ***Financial ability*** *to adopt has an effect on the* ***perceived behavioral control*** *over adoption.*

Hypothesis 3b: ***Workflow benefits*** *from adoption have an effect on the* ***perceived behavioral control*** *over adoption.*

Additionally, understanding how much exposure to EMR systems physicians have, may help to assess the role in their willingness to adopt and use the system, especially when this adoption comes with a financial or patient-care related advantage over other competing offices. Also, there are early adopters [20] who jump on opportunities to use an innovation before others in order to be differentiated. Relative advancement is the perception of how much more or less current the setup at the physician's facility is compared with others. It is also related to the trialability and observability attributes of Rogers' DOI theory [20], where people's willingness to adopt an innovation is higher if they had the opportunity to experience it; thus, we propose hypothesis 3c:

Hypothesis 3c: ***Relative advancement*** *of adoption has an effect on the* ***perceived behavioral control*** *over adoption.*

Finally, Ajzen [22] showed that attitude and perceived behavioral control have respective effects on each other. So, we hypothesize (hypotheses 2e and 3d) that our results will show:

Hypothesis 2e: ***Perceived behavioral control*** *over adoption has an effect on the* ***attitude*** *toward adoption.*

Hypothesis 3d: ***Attitude*** *toward adoption has an effect on* ***perceived behavioral control*** *over adoption.*

Figure 1 illustrates the constructs, the hypotheses, and the overall model to be tested. The model combines the TAM and the TPB. Both are a specialization and derivation of the Theory of Reasoned Action (TRA) [37]. A unification of the TPB and the TAM combines compatible models and is therefore natural and possible. The predictive power of both the TAM and the TPB is empirically about the same [25], so that cannot guide the modeling. It is possible to use the TAM constructs perception of usefulness and ease of use as direct antecedents of intention to implement a higher level of EMR, or to use the TPB for that goal. Both have been done in the literature. The TPB is preferred here because industry-wide outcome evaluations, like benefits for the whole industry, are a part of attitude in the TPB. This and behavioral control, a natural and direct part of the TPB but not of the TAM, are (as established in the pilot phase below) necessary to understand the reason behind the intentions of the decision makers. Using the TPB as basis is therefore "the more suitable theoretical framework" (p. 961) [37] because it leads to a deeper understanding of the voluntariness of the decision maker. These considerations lead directly to the model of Figure 1.

Survey Creation and Distribution

A structured survey questionnaire targeting a large group of physicians was developed for the purpose of this study. The final survey questions were prepared to operationalize the variables

and test the hypotheses shown in Figure 1. There were 13 variables (see Table 1). Responses to the questions were collected using Likert scales. Invitations to complete the survey were sent via direct mail, email and social media advertising. A total of 2,012 mailings were sent to a network of Michigan physicians who were associated with groups such as Beaumont Hospital and Henry Ford Health Systems. In addition, 55,177 emails were sent to selected groups of physicians nationwide. Facebook and LinkedIn advertisements reached 5,978 physicians specifically by using the segmentation and audience targeting tools offered by both social platforms. Although three methods were used to disseminate the invitation, the survey itself was distributed digitally using Qualtrics software. An easy-to-access web address (www.adoptingEMR.com) was shared with invitees to link them to the survey. The distribution and collection of answers took approximately 10 weeks.

Table 1 Variables and their descriptive statistics

Variable	N	Mean	Std. Dev.	Std. Error Mean
Intention	208	5.05	1.830	0.127
Attitude	230	5.13	1.876	0.124
Perceived Behavioral Control	230	4.74	1.781	0.117
Peer Preference	220	4.40	1.678	0.113
Government policy and Mandate	343	4.99	1.855	0.100
Industry Standards	343	4.46	1.791	0.097
Knowledge	378	3.62	0.945	0.049
Perceived Industry Benefits	360	3.54	1.814	0.096
Perceived Usefulness	334	4.08	2.040	0.112
Perceived Ease of Use	332	3.60	1.710	0.094
Financial Ability	217	4.21	2.054	0.139
Workflow Benefits	331	3.25	1.737	0.095
Relative Advancement	342	5.25	1.329	0.072

The constructs of the conceptual model and their descriptive statistics of the mean, standard deviation and standard error mean. Responses were gathered on a Likert scale (1=negative, 7=positive), except for Knowledge (1=negative, 5=positive). N = Total received responses for that question.

The study was done in accordance to the Rules and Regulations of Grenoble Ecole de Management (GEM) Doctoral School (Grenoble, France) and was approved by GEM's Ethics Review Board, which

adopts the Academy of Management (AOM) Code of Ethics. The invitation had a clear description of the purpose of the study and all participants consented digitally to using the data and results for academic and scholarly purposes as a condition for entering the Qualtrics survey online.

Results

Response Conversion and Distribution

The email campaigns received a 12% opening rate (6,690 out of 55,177). Of the 6,690 people who opened their emails, 437 clicked on the survey, for a conversion rate of 7%. Of the 5,978 people who viewed the social media ads, 143 clicked to access the survey, for a conversion rate of 2%. The conversion rate for direct mail could not be measured, but assuming an industry rate of 3.5%, 70 people would have visited the survey from direct mail. Therefore, a total of 650 (437 + 143 + 70) people overall opened the survey. The final survey was completed by 382 participants (59% of those who visited it). Only 43 people (11%) left one or more questions unanswered. Of the 382 respondents, 71% (271) were male and 29% (111) were female physicians. They were spread across 47 different U.S. states with 54% (206) private practitioners and 46% (176) associated with larger institutions like hospitals or public clinics.

Hypotheses and Model Testing

Descriptive statistics for the 13 variables are in Table 1. Three linear regression tests were run, one for each of the independent variables: intention, attitude, and perceived behavioral control, as driven by the hypotheses of the conceptual model in Fig. 1. The Statistical Package for the Social Sciences (SPSS) was used and SAMPL guidelines [38] were followed. We began by using the backward method for each regression, treating missing values with listwise. Then, we ran forward and stepwise regressions, also with listwise, to secure that the solution with the highest R^2 was found. The tests were two-tailed. The histogram and the P-P normal probability plots verified normal distribution for each test. The results of the three models, which represent 95% confidence interval, are in Table 2, and Fig. 2 illustrates the significant relations (at $p < 0.01$ level) and their coefficients.

Table 2
Regression Results of Final EMR Adoption Models

Model	R^2	F()	Predictors	B	β	p
Intention	0.56	F(3,185) = 77.18	Attitude	0.51	0.55	< 0.001
			Perceived Behavioral Control	0.33	0.32	< 0.001
			Government Policy and Mandate	0.13	0.14	0.007
Attitude	0.40	F(3,192) = 41.80	Knowledge	0.56	0.28	< 0.001
			Perceived Industry Benefits	0.45	0.46	< 0.001
			Perceived Behavioral Control	0.17	0.17	0.008
Perceived Behavioral Control	0.39	F(3,184) = 39.29	Financial Ability	0.21	0.25	< 0.001
			Relative Advancement	0.44	0.36	< 0.001
			Attitude	0.25	0.26	< 0.001

Summary of the results of the three linear regression tests showing the dependent variables, their predictors, and the coefficients of the significant relations at $p < 0.01$ level.

Five variables attitude, perceived behavioral control, peer preference, government policy and mandate, and industry standards were used as independents to measure their impact on the dependent variable intention. Two of the five variables were removed: peer preference ($p = 0.29$) and, industry standards ($p = 0.13$). A model with three significant relationships was reached explaining 55.6% of the variance ($R^2 = 0.56$, $F(3,185) = 77.18$, $p < 0.001$). The three predictors of intention are attitude ($B = 0.51$, $p < 0.001$), perceived behavioral control ($B = 0.33$, $p < 0.001$), and government and mandate ($B = 0.13$, $p = 0.007$).

For predicting attitude, we began the regression testing with the following five independent variables based on the hypotheses in Fig. 1: knowledge, perceived industry benefits, perceived usefulness, perceived ease of use, and perceived behavioral control. Two of the five variables, perceived usefulness ($p = 0.16$) and perceived ease of use ($p = 0.47$), were excluded as non-significant. Three predictors remained in the model explaining 40% of attitude's variance ($R^2 = 0.40$, $F(3,191) = 41.80$, $p < 0.001$). Attitude can significantly be predicted by knowledge ($B = 0.56$, $p < 0.001$), perceived industry benefits ($B = 0.45$, $p < 0.001$), and perceived behavioral control ($B = 0.17$, $p = 0.008$).

Finally, perceived behavioral control is hypothesized (Fig. 1) to be affected by financial ability, workflow benefits, relative advancement, and attitude. After entering those independent variables in the regression test, one of the four variables, workflow benefits ($p = 0.67$), was found non-significant. Three of the four predictors were significant and can explain 39% of the variance of perceived behavioral control ($R^2 = 0.39$, $F(3,184) = 39.29$, $p < 0.001$). Financial ability ($B = 0.21$, $p < 0.001$), relative advancement ($B = 0.44$, $p < 0.001$), and attitude ($B = 0.25$, $p < 0.001$) can predict perceived behavioral control.

Model Verification

Table 3 includes a summary of the hypotheses results. The final structural model in Fig. 2 represents nine significant relationships. The direct relations with intention support the TPB [22]; however, the relevance of this model is not its support of Ajzen's TPB [22]. Rather, it is the presence of variables such as knowledge, perceived industry benefits, financial ability, and relative advancement and the strength of their impact on the constructs of intention, attitude and perceived behavioral control that make it valuable.

Table 3
Hypotheses Results

No.	Hypothesis	Supported
1a	**Attitude** toward adoption has an effect on the **intention** to adopt.	Yes
1b	**Perceived behavioral control** over adoption has an effect on the **intention** to adopt.	Yes
1c	**Peer preference** has an effect on the **intention** to adopt.	No
1d	The **government policy and mandate** for adoption have an effect on the **intention** to adopt.	Yes
1e	**Industry standards** for adoption have an effect on the **intention** to adopt.	No
2a	**Knowledge** of innovation has an effect on the **attitude** toward adoption.	Yes
2b	**Perceived industry benefits** have an effect on the **attitude** toward adoption.	Yes
2c	**Perceived usefulness** has an effect on the **attitude** toward adoption.	No
2d	**Perceived ease of use** has an effect on the **attitude** toward adoption.	No
2e	**Perceived behavioral control** over adoption has an effect on the **attitude** toward adoption.	Yes
3a	**Financial ability** to adopt has an effect on the **perceived behavioral control** over adoption.	Yes
3b	**Workflow benefits** from adoption have an effect on the **perceived behavioral control** over adoption.	No
3c	**Relative advancement** of adoption has an effect on the **perceived behavioral control** over adoption.	Yes
3d	**Attitude** toward adoption has an effect on **perceived behavioral control** over adoption.	Yes
Summary of the results the 14 hypotheses shows that nine were supported and five were not.		

Following Baron and Kenny's [39] method for mediation, we analyzed three regression tests to verify the structure of the model. The first was whether the four independent variables of knowledge, perceived industry benefits, financial ability, and relative advancements have direct effects on intention. The results of the first backward regression test did show a significant model ($R^2 = 0.28$, $F(3,170) = 21.79$, $p < 0.001$) with three predictors after the exclusion of financial ability ($p = 0.43$). The second test was to verify if the mediators of attitude and perceived behavioral control have a direct effect on intention. The model of the second test was significant ($R^2 = 0.55$, $F(2,203) = 123.54$, $p < 0.001$) showing direct effects by attitude and perceived behavioral control

on intention per the results in Table 2 after the exclusion of government mandate. Lastly, the third test was to see if the four independent variables and the mediators together predict intention. The results of

the third test showed a significant model ($R^2 = 0.44$, $F(3,169) = 45.03$, $p < 0.001$) with only attitude and perceived behavioral control as significant predictors of intention. All the effects of the other four independent variables dropped out, which validates the model in Fig. 2 and proves there is complete mediation by attitude and perceived behavioral control on the effects of knowledge, perceived industry benefits, financial ability, and relative advancements on intention to adopt.

Discussion

This research contributes to the research community by exposing the specific and unique drivers of health care providers' behaviors: we built on the TPB [22], the TAM [21], as well as Roger's DOI theory [20], and proposed, tested, and validated an EMR adoption model for measuring the intention to adopt innovation technology specifically in the health care industry.

We found social factors have a very limited effect on the intention to adopt. Peer preference and industry standards show no effect, and the effect of government policy and mandate is negligible. It was expected that government laws and mandates, constituting its policy, would impose social pressure and affect the intention to adopt heavily. However, this is not the case. Government policy and mandate's effect is the weakest of the three intention predictors ($\beta = 0.14$, Table 2). At the theoretical level, this result does not contradict the potential role played by governments as orchestrators of the generation of innovation in a national economy, as proposed by Watkins et al. [30], but it does question government's role and effectiveness in the diffusion of innovation in settings comparable to national health care systems.

Attitude has the strongest effect on intention to adopt an innovation in health care ($\beta = 0.55$, Table 2), and it mediates the two effects of knowledge and perceived industry benefits. Physicians regard the industry's well-being highly and require witnessing tangible benefits before forming a favorable opinion toward the innovation. Attitude is influenced by the outcome evaluation of the industry's well-being. As for the role of knowledge, this argument is aligned theoretically with the many studies advocating that knowledge is required to diffuse innovation [18, 20, 31]. Our study empirically shows the effect of knowledge on attitude and intention and quantifies its strength.

Perceived behavioral control over adopting an innovation in health care by physicians has the second strongest effect on intention ($\beta = 0.32$, Table 2) and it is driven by financial ability and relative advancement. To have confidence in the innovation, physicians seek financial support and clarity around the value such investment has relatively to their current approach and the differentiator from other practices.

In comparing the strength of the effects on intention, we conclude that physicians do not respond favorably to pressures, whether they are coercive, mimetic, or normative. They seem to rise above influences from authoritative power and do not respond to peer pressures. They trust in their own judgement on how to act and behave when it comes to introducing innovations and information technologies in their practice. This judgement is the product of internally formed psychological beliefs

and attitudes and rational assessment of the implementation feasibility. Their attitudes are built on the available knowledge and facts they have gathered on the subject and its true benefits or perceived outcome evaluation of the health care industry. Also, they are keen on requiring a financial model capable of sustaining the monetary burdens needed by the innovation, along with an unbiased proof that the innovation can bring a clear advancement over the current state or other practices. All this presents difficulties for the government to carry out its policies.

Limitations

This research has some limitations. It focused on physicians because they comprise a large actor group. However, using the same model framework, there are other key actors, such as nurses, medical administrators, insurance companies, pharmacists, vendors, providers, and patients, in EMR system adoption.

Another limitation is the research assumed physicians' offices and practices either do not have any form of EMR system adoption or that they are undergoing - or need to undergo - an advancement of their adoption. It did not include the drivers and interests of those who have achieved full adoption, nor is full adoption truly defined. Drivers and behaviors at that stage may include adoption sustainment factors and can very well differ from those at prior levels of adoption.

Conclusions

The limited effect of the government policy and mandate suggests that going forward, the traditional method of making policies to govern the adoption of innovation in industries may not be enough by itself. The case of the health care industry has demonstrated this. Collaboration between payers and providers, of public and private sectors, is needed to encourage nationwide EMR system adoption, and complement - or becomes more prominent than - the method of passing laws. Specific roles and responsibilities must be identified and defined, and then, each group should be made aware of and experience the tangible benefits from the adoption of technology in health care. A proven balance between medical expenditure reduction, medical care quality improvements, and end user's needs is required to attain and sustain a national patient health system diffusion with an interoperability model.

The U.S. government can benefit from our findings and observations by softening their stance on EMR system adoption. Instead of a position as a relative authoritative policy maker, maybe a position as a sincere orchestrator between the many stakeholders of the EMR innovation would be fruitful in terms of adoption. This requires acknowledging that the decision to diffuse electronic records is not held by the government or any one party. Rather, governments can work on converging the needs of all payer, provider, public, and private groups, especially physicians, and bridging the gap between their needs and expectations. This benefit can also extend to other organizations, outside governments, who may or can hold that role of an orchestrator with unbiased interests from the adoption.

There is a need for increased education on EMR systems, their role, their benefit, and the value they bring to the future of health care to facilitate and expediate adoption. Medical networks and educational institutions can benefit from this by taking ownership of developing enriching curriculums and training programs for current and upcoming physicians. Physicians require knowledge and perceived industry benefits to form a positive attitude on an innovation. Should those two items have been present and available, the rate of adoption may have been higher and the pace to national diffusion and record sharing would have been faster. Physicians need greater awareness on the innovation and want to know what it is, what purpose it aims to achieve, and how the overall industry gains from it.

EMR system vendors have a practical benefit by knowing that the lack of financial ability holds physicians back from supporting its adoption. Thus, vendors should work to keep costs of system setup and implementation manageable in order to attract adopters. Concurrently, they should develop and communicate the return on investment story and how adopting their EMR product will help practices gain relative advancement over competition or improve their current situation. Financial institutions interested in health care investment may also facilitate access to funding for practices looking to implement EMR systems to help with the financial burden.

Abbreviations

AOM
Academy of Management
ARRA
American Recovery and Reinvestment Act
DOI
Diffusion of Innovation theory
EHR
Electronic Health Records
EMR
Electronic Medical Records
GEM
Grenoble Ecole de Management
SAMPL
Statistical Analyses and Methods in the Published Literature
SPSS
Statistical Package for the Social Sciences
TAM
Technology Acceptance Model
TPB
Theory of Planned Behavior
TRA
Theory of Reasoned Action

Declarations

Ethics approval and consent to participate

The study was done in accordance to the Rules and Regulations of Grenoble Ecole de Management (GEM) Doctoral School (Grenoble, France) and was approved by GEM's Ethics Review Board, which adopts the Academy of Management (AOM) Code of Ethics. We attest that no harm was done to the subjects. Physicians received invitations with clear description of the purpose of the study and all participants consented digitally to using the data and results for academic and scholarly purposes as a condition for entering the survey online.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analysed during this study are included in this published article and its supplementary information files.

Competing interests

The authors declare that they have no competing interests associated with this publication.

Funding

There has been no financial support for this research, and it did not receive any specific grants from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

RE set the research question, designed the research, developed survey, gathered results, and tested the model. LK validated the testing, the analysis, the model, and the results. VS structured the manuscript, and directed its background, discussion and conclusions. All three authors read and approved the final manuscript and confirmed the order of authors listed. There are no other persons who satisfied the criteria for authorship.

Acknowledgements

Not applicable

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Figures

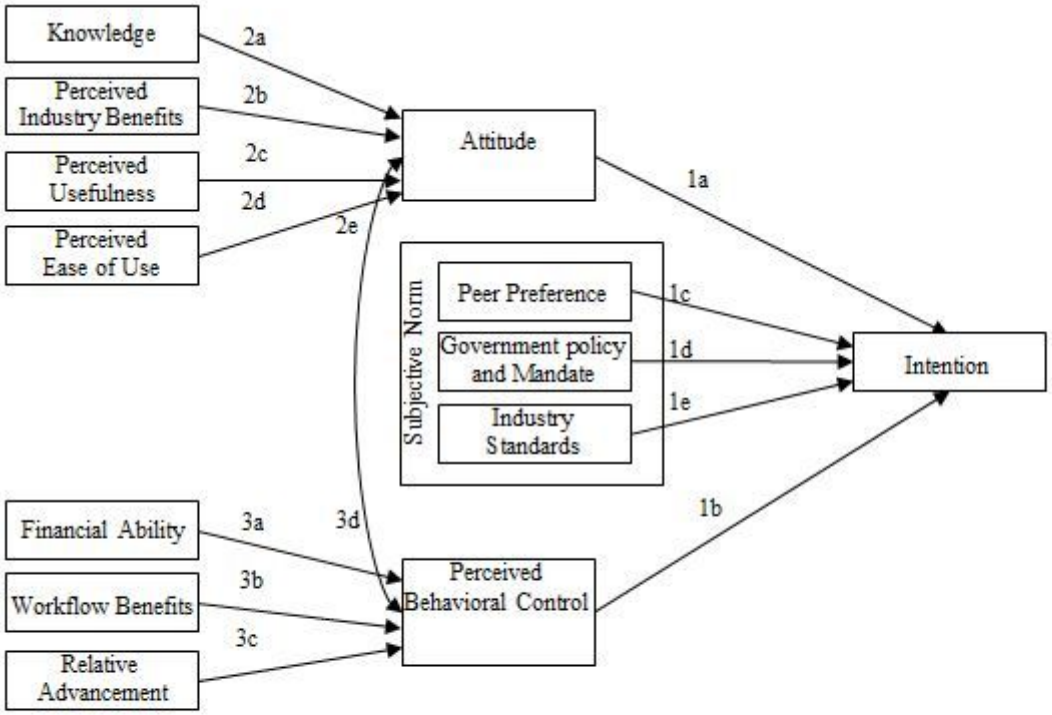

Diagram of the hypotheses to be tested where the boxes are the variables and the arrows are the directional effect of one variable on the other

Figure 1

Conceptual EMR Adoption Model and Hypotheses – Diagram of the hypotheses to be tested where the boxes are the variables and the arrows are the directional effect of one variable on the other. Available in the supplementary file EMR Adoption

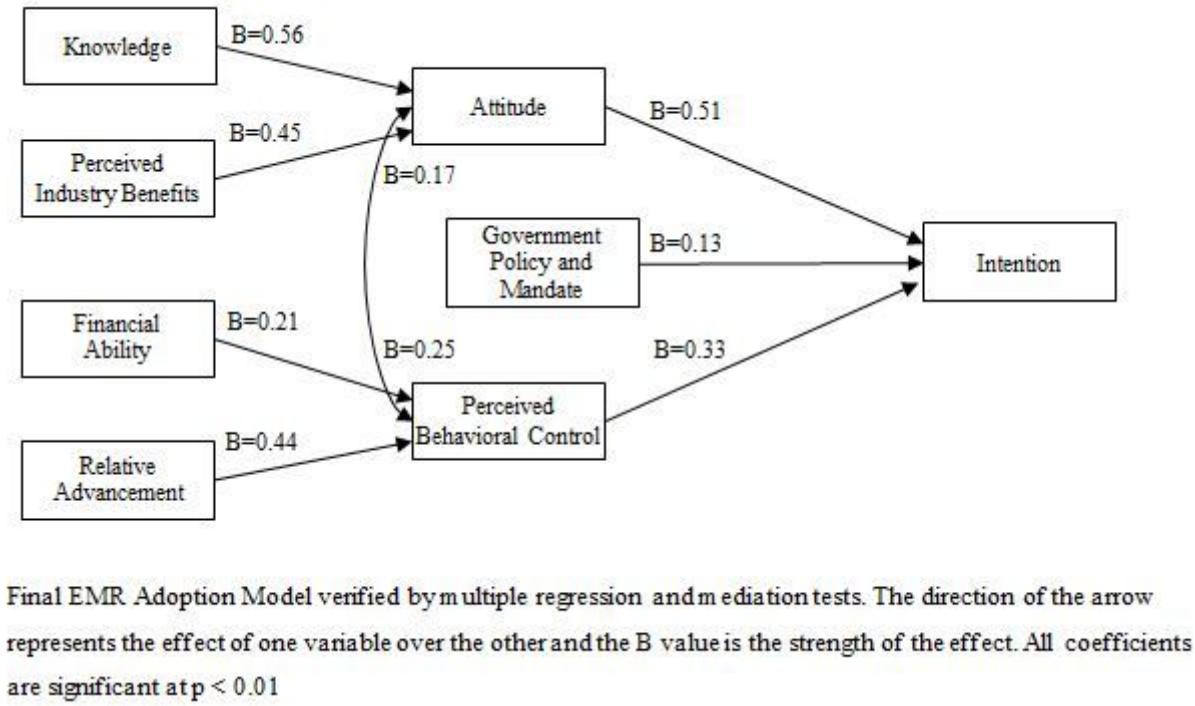

Figure 2

EMR Adoption Model – Final EMR Adoption Model verified by multiple regression and mediation tests. The direction of the arrow represents the effect of one variable over the other and the B value is the strength of the effect. All coefficients are significant at p < 0.01. Available in the supplementary file EMR Adoption - BMCHSR

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- EMRAdoptionData.xlsx
- EMRAdoptionBMCHSRSAMPLChecklist.docx
- EMRAdoptionBMCHSRSurveyQuestionnaire.docx