Explaining physicians' use of EMR systems and performance in the shakedown phase

Tracy Ann Sykes,[1] Viswanath Venkatesh,[2] Arun Rai[3]

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[1]Australian National University, College of Business and Economics, Canberra, Australia
[2]Department of Information Systems, Walton College of Business, University of Arkansas, Fayetteville, Arkansas, USA
[3]Center for Process Innovation and Department of Computer and Information Systems, Robinson College of Business, Georgia State University, Atlanta, Georgia, USA

Correspondence to
Dr Tracy Ann Sykes, Australian National University, College of Business and Economics, Canberra, ACT 0200, Australia; tracy@tracyannsykes.com

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ABSTRACT

Objective This work seeks to complement and extend prior work by using a multidisciplinary approach to explain electronic medical records (EMR) system use and consequent performance (here, patient satisfaction) among physicians during early stages of the implementation of an EMR.

Design This was a quantitative study, with data obtained from three distinct sources: individual-level and social-network data from employees; use data from EMR system logs; and patient satisfaction data from patients and/or authorized decision-makers. Responses were obtained from 151 physicians and 8440 patient satisfaction surveys over the course of a 1-year period at the shakedown phase of an EMR system implementation.

Results Physicians who were better connected, both directly and indirectly, to their peers—that is, other physicians—for advice on their work, used the system less than those who were less connected. In addition to such social network ties, demographic characteristics (gender and age), three personality characteristics (openness to experience, agreeableness and extroversion) and a key technology perception (perceived usefulness) predicted EMR system use.

Conclusions For hospital administrators and other stakeholders, understanding the contributors to, and the relative importance of, various factors in explaining EMR system use, and its impact on patient satisfaction is of great importance. The factors identified in this work that influence a physician's use of EMR systems can be used to develop interventions and applications that can increase physician buy-in and use of EMR systems.

INTRODUCTION

Electronic medical records (EMR) systems organize and store medical records electronically. The various benefits of using EMR systems that have been identified include: (a) increased speed in patient encounters, documenting treatments and obtaining patient histories; (b) greater security and better access to medical records; and (c) helping pharmacies, specialists and other groups access information quickly and reliably and reducing adverse drug events in in-patient settings and ambulatory settings.[1–3] Just as much as there could be benefits of using EMR systems, there are problems, such as slowing down patient encounters at least in the early stages of implementation.[4] Despite being available since the 1990s and their potential benefits, EMR systems are not widely used in hospitals and medical practices in the USA[3] and are used to varying extents in other countries, including some European countries.[5] For example, a recent report revealed that 67% of medical offices in the USA with four or more physicians do not use EMR systems.[6] It is thus important to predict not only physicians' EMR system use but also how such use relates to physicians' performance.

Studies on the success of information systems note that actual system use is the key mechanism to realize IT benefits.[7] Hence, owing to limited use of EMR systems, their benefits are not reaped. Prior research, especially in the field of medical informatics, has identified some of the barriers to EMR system adoption among physicians.[3 8] A survey of physicians found that the reasons cited most often for physicians not to adopt an EMR system were: start-up costs, continuing costs and loss of productivity.[8] While the costs of the technologies are likely to decrease over time, the phase of the implementation when productivity loss occurs is critical to study. This work seeks to use a multidisciplinary approach to explain EMR system use and consequent performance impacts among physicians during the early stages of EMR implementation. The early stage of the implementation, often referred to as a shakedown phase, was chosen because it is when loss in productivity and disruption in processes occur and when technological systems may be abandoned.[9] The shakedown phase refers to the period from 'going live' until 'routine use' has been achieved and can typically last anywhere from 6 months to a year. In our context of EMR system adoption and use by physicians, the shakedown phase is likely even more critical, as it sets the tone for their future interactions with the system.

RESEARCH MODEL

We present a holistic model (figure 1) to explain physicians' use of EMR systems and consequent performance impacts during the shakedown phase of the system implementation. We consider how physician's EMR system use is affected by the following three sets of factors: individual (physician characteristics), system (physicians' perceptions of the new EMR system), and interactions among physicians (the social influence of other physicians on EMR system use). We also expect EMR system use to affect physician performance.

We leverage psychology research to examine the influence of physicians' traits, both demographics and personality, on physicians' EMR use. We also draw on research in health informatics and management information systems (MIS), and include physicians' perceptions about the new EMR system. Finally, we draw on sociology research, particularly social-networks research, as interpersonal interactions are crucial in the case of physicians' work in a hospital setting, and can be expected to influence physicians' EMR use.

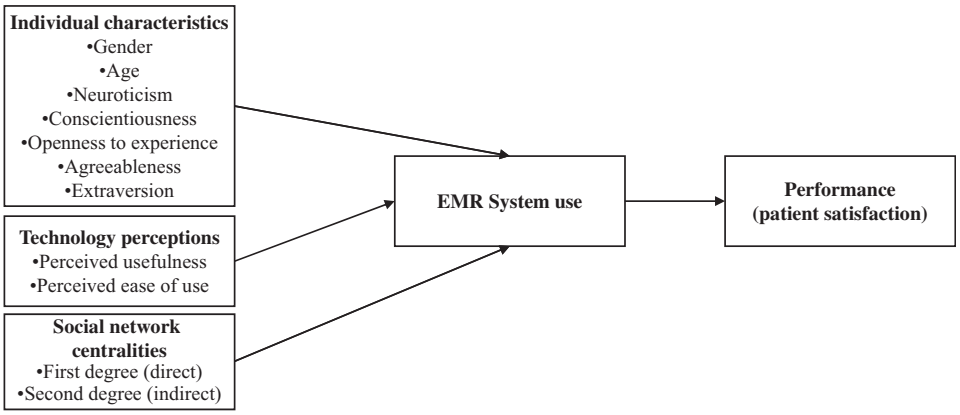

Figure 1 Research model. EMR, electronic medical records.

Psychology research has widely used individual's demographic and personality characteristics as predictors of human behavior.[10 11] Demographic variables, namely gender and age, have been shown to influence the use of new technologies.[12] The Big-5 personality traits inventory has been shown to influence a variety of behaviors. The traits are neuroticism (sometimes referred to as emotional instability, this expresses the tendency of an individual to experience negative emotions); conscientiousness (the trait exemplified by individuals who are painstaking and careful, and have a need for achievement); agreeableness (relating to getting along with others); openness to new experiences (categorized by imagination, curiosity, and a drive to seek out new experiences); and extraversion (a trait regarding how an individual relates to others).[13]

We draw on the health informatics and MIS research to identify two technology perceptions that should explain physicians' EMR system use: perceived usefulness (defined as the extent to which an individual believes using an EMR system can enhance their job performance) and perceived ease of use (defined as the extent to which an individual perceives using an EMR system will be free of effort).[12 14]

A physician's workplace setting involves significant interactions with fellow physicians for a variety of matters, ranging from job-related questions to social support to general socializing. The importance of such interactions is underscored by the high stress nature of a physician's job. Therefore, a social network lens, which focuses on individual interactions within a workplace or social context, can serve as an important basis to explain behavior.[15] Of the variety of social networks, we focus on advice networks that describe the nature and flow of work-related information among employees.[16] Centrality is one of the most important constructs in the context of advice networks, as it represents both power and influence wielded and experienced as well as access to resources.[17] Direct ties are between the focal individual and people they interact with directly, and second-order (or indirect) ties are those of individuals that interact with one's direct ties. An example of second-order ties is thus advisors of an advisor.[17]

Behavior so determined typically has performance impacts. Use of systems, for example, EMR systems, is typically expected to influence performance positively.[18 19] In this case, EMR system use can be expected to contribute positively to physicians' performance.[3] While there are several metrics of physicians' performance, we focus on patient satisfaction, defined as the extent to which a patient or a patient's authorized decision-maker is pleased with the overall medical care received,[20] which has been shown to relate to the technical quality, communication, time spent, and related aspects of the care.[21]

The online appendix (available at www.jamia.org) details the rationale underlying why each of the different factors is expected to influence EMR system use.

METHOD

Context, system, and participants

The study was conducted in a private hospital that was implementing a web-based enterprise-wide healthcare solution that included a component for electronic medical records. The institutional review board approval for the use of human subjects included the study of technology use in a variety of settings. The implemented EMR system had the following modules: CPOE, encounter information recording, decision support, support for all eight of the departments in the hospital (via specialty modules), compliance with physicians' quality reporting initiative (PQRI), and access to records for patients. Further, the system included advanced security features to protect data and authenticate access. This EMR system was part of the solution available to the physicians and is the focus of our study. The hospital, which had about 800 beds, provided a variety of healthcare services, including emergency care. We were provided with a list of all employees in the hospital and their contact information. The list of physicians, that is, the sampling frame, showed 244 physicians working at the hospital, with about 20% of them being contracted (1–2 days per week) as needed. For performance assessments, independent patient surveys were conducted by the hospital and mapped to each physician.

We excluded the contracted-as-needed physicians from our analysis as they had minimal interaction with other physicians and knew very few of the full-time physicians. Of the 200 full-time physicians surveyed, 151 returned complete and usable responses for a response rate just over 75%. In order to assess non-response bias, we compared the respondent demographic profile with the non-respondent profile and found them to be statistically equivalent.

All patients received a survey to assess their satisfaction with the care they received at the hospital. Although the exact number of surveys mailed was not shared with us, a total of 8440 patient and/or authorized decision-maker responses, which rated physicians, nurses, and administrative personnel (our survey only includes physicians' data), were received. Each physician had, on average, about 40 patients providing an evaluation in the 9-month period following the introduction of the EMR system. This allowed us to obtain an overall average (mean) rating for each physician.

We conducted a pilot study in a small medical practice implementing an EMR system. This was done because we did

not want to taint the actual sample prior to data collection. Also, given that it was important to collect data from all members in the network, we could not use a subsample of the doctors in the hospital. The pilot study results revealed our multi-item scales to be reliable and valid.

Procedure

The timeline for the major activities and data collected is shown in table 1. Our questionnaire was combined with the questionnaire being administered by the hospital. The hospital hired an independent research firm to collect the data. Such an approach helped employees to be comfortable with sharing information honestly and helped ensure the privacy and confidentiality of responses. The hospital administration emphasized to the physicians that the survey was a critical forum for input related to the EMR system in particular and the entire IT solution in general.

Measures

The online appendix (available at www.jamia.org) provides the questions used in the survey that are specific to the paper. It also supplies greater detail about the measures used.

Survey of physicians

The physicians were given the option to complete the survey either online or on paper. As our survey questions were embedded within a larger survey employed by the hospital, there were many other questions that could be considered as filler questions, thus reducing demand characteristics. Further, since the dependent variables were coming from different sources, biases are further reduced. The survey of physicians measured various individual characteristics—that is, demographics and personality—technology perceptions and social network ties. The social network data, focused on advice networks, were gathered using a roster-based approach.[22 23] While there are many centrality measures, we used a form of degree centrality quantifying each physician's first-degree (direct connections) and second-degree (indirect connections or the connections of their direct connections).

Archival logs of EMR system use

EMR system use was measured using archival system logs. As the system logged out idle users after a specified 10 min, biases due to inflation of use were minimized.

Survey of patients

Overall patient satisfaction was measured by adapting the *Patient Satisfaction Questionnaire* III (PSQ III). One of the key differences in the way this particular hospital used the PSQ III was to gather data about each physician who dealt with a patient. The patient and/or authorized decision-maker responded to various questions based on their experiences with each physician. The mean score of overall patient satisfaction was calculated. Thus if a physician received ratings from 50 patients or authorized decision-makers, the average (mean) on overall patient satisfaction provided the performance metric for the particular physician.

RESULTS

We analyzed these data using partial least squares (PLS). PLS allows for the use of formative indicators[24] without imposing constraints on model specification and for the violation of distributional assumptions made in OLS regressions.[25] SmartPLS was the tool used to estimate the measurement and structural models.[26] The descriptive statistics, correlations, reliabilities and average variance extracted (AVE) are reported in table 2. The results provide evidence of the reliability and validity of the measures: all multi-item scales had good reliabilities (ICR >0.70) and had high loadings (>0.70) and low cross-loadings (<0.35), and the square roots of the AVEs were greater than the correlations. It should be noted that neuroticism was fairly low, and conscientiousness was very high, and both exhibited very low standard deviations—both of these findings are not particularly surprising and likely due to the context, as physicians are expected to exhibit high conscientious and low neuroticism. Most correlations exhibited the expected pattern, with most individual characteristics relating significantly to EMR system use, network centrality (direct and indirect) relating negatively to EMR system use, and both centralities (direct and indirect) and EMR system use relating positively to patient satisfaction.

The results of our structural model are shown in figure 2. Individual characteristics, technology perceptions, and social network centralities together accounted for 40% of the variance in physicians' EMR system use. Gender, age and three (of the five) personality characteristics—that is, agreeableness, openness to experience, and extraversion—predicted EMR system use. The non-significance of two predictors, that is, neuroticism and conscientiousness, was likely due to the low SD of these two constructs, as noted earlier. Perceived usefulness was a significant predictor of EMR system use. Although perceived ease of use was positively correlated with EMR system use, it was not a significant predictor. This is likely because perceived ease of use is correlated with some constructs, especially use, that are significant predictors of EMR system use. Both first-degree (direct) and second-degree (indirect) centralities negatively influence EMR system use. EMR system use had a positive impact on physician performance in terms of patient satisfaction and, together with preimplementation patient satisfaction, explained 15% of the variance in terms of this measure of physician performance. It is worth noting that it is possible that our sample size could have resulted in some null hypotheses not being rejected. A power analysis suggested that we would have detected medium effects.[27]

DISCUSSION

This research offers important contributions to research and practice.

Table 1 Data-collection timeline

T_0: pretraining	T_1: month 1	T_2: months 2–3	T_3: months 4–12
Archival measures of preimplementation patient satisfaction	Training takes place over a 1-month period	Electronic medical records system is installed and available on all computers	Use over this period is obtained from system logs
	Survey of physicians to collect individual characteristics, technology perceptions, and social-network data		Archival measures of postimplementation patient satisfaction

Table 2 Descriptive statistics, correlations, internal consistency reliabilities, and average variances extracted

	Internal consistency reliability	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Gender (1: men)	NA	NA	NA	NA													
2. Age	NA	41.20	14.40	0.20***	NA												
3. Neuroticism	0.71	2.20	0.40	0.04	0.04	NA											
4. Conscientiousness	0.75	6.20	0.38	0.05	0.13*	0.04	0.75										
5. Agreeableness	0.73	3.28	1.13	−0.12*	−0.12*	0.05	0.08	0.73									
6. Openness to experience	0.70	3.51	1.20	0.14*	−0.15*	0.00	−0.07	−0.12*	0.75								
7. Extraversion	0.71	4.13	1.14	−0.13*	−0.10	0.03	−0.13*	−0.07	0.12*	0.78							
8. Perceived usefulness	0.87	4.10	1.31	0.16**	−0.16**	0.01	0.10	0.04	0.19**	0.08	0.83						
9. Perceived ease of use	0.85	3.87	1.51	0.15*	−0.16**	0.04	0.07	0.03	0.15*	0.10	0.19**	0.82					
10. Preimplementation performance	0.75	4.49	1.29	0.07	0.23***	0.02	0.06	0.08	0.17**	0.14*	0.07	0.01	0.71				
11. Centrality (direct)	NA	32.30	21.60	−0.17**	0.19**	−0.02	0.09	0.15*	0.21***	0.24***	−0.22***	−0.15*	0.28***	NA			
12. Centrality (indirect)	NA	21.22	14.20	−0.19**	0.14*	−0.01	0.04	0.12*	0.17**	0.20***	−0.19***	−0.12*	0.26***	0.33***	NA		
13. Electronic medical records system use	NA	7.35	4.20	0.13*	−0.24***	−0.04	0.04	0.18**	0.20***	−0.22***	0.23***	0.16*	0.13*	−0.39***	−0.34***	NA	
14. Postimplementation performance	0.80	5.08	1.01	0.08	0.21***	0.01	0.09	0.12*	0.17**	0.17**	0.13*	0.10	0.32***	0.30***	0.25***	0.29***	0.78

*p<0.05; **p<0.01; ***p<0.001.
Diagonal values are the square roots of average variances extracted.

Theoretical contributions

The key contribution of this work is the development of a comprehensive model of EMR system use. By examining factors from psychology, health informatics, MIS, and sociology, we understand their relative importance for EMR system use. It is clear that despite some positive individual characteristics and technology perceptions, the overwhelmingly strongest drivers are physicians' advice ties. Interestingly, the better-connected physicians tend to use the system less. While advice ties typically foster behavioral performance,[28] here, better connected physicians avoid using the system, likely due to the pressures and support from their ties. Physicians' social networks provide them with a substitute mechanism to access some of the information that is available via an EMR system and, consequently, results in lower use. Physicians with high centrality (direct or indirect) have greater access to this alternate channel that decreases their need to use an EMR system. Physicians with high centrality are also likely to be subject to greater pressure from peers to conform to prevailing norms and practices. As such, their being subject to such social influence to maintain the status quo is likely to be a deterrent to their use of an EMR system. Thus, a major implication is that EMR systems may not be used to their fullest potential by physicians with high centrality and, worse yet, may even be actively resisted by them. This requires the need for training programs in the shakedown phase of an EMR system implementation to demonstrate the advantages of EMR systems relative to accessing information from physicians' social networks and existing fragmented systems that are in place. It also requires the change management process to recognize that resistance to EMR systems will be greater among physicians with high centrality. As a result, resources and tactics to reduce such resistance should be particularly targeted at these physicians.

Another important contribution of this work is to health informatics. While research on health informatics has argued and presented evidence on the benefits of EMR systems to hospitals and patients, they have also identified physicians' adoption and use of such systems to be slow. By presenting a holistic model of physicians' EMR system use, our work complements prior work. Likewise, this holistic model complements prior work explaining EMR system adoption and use by physicians that has used a single theoretical perspective.[8 18] Our results provide compelling support for the importance of all three sets of factors—that is, individual, technology-related and social networks—as determinants of EMR system use. Each of these sets of factors represents distinct sources of influence of EMR system use and has different implications for the management of the shakedown phase of EMR system implementation. First, there are distinct individual forces that influence the propensity of physicians' use of EMR systems. These individual factors must be considered both prior to rolling out EMR systems to physicians and also while evaluating the success of a rollout across a group of physicians who are asked to use the system. Second, with respect to technology factors, our study reveals that perceived usefulness is a key factor that influences the physicians' use of EMR systems. Interestingly, perceived ease of use is not a significant predictor of EMR use, suggesting that direct experience and training can be used to overcome the mechanistic hurdles associated with using a system for instrumental purposes. It is also possible that the perceived usefulness of systems deteriorates if they are difficult to use, a viewpoint that is consistent with the literature on technology acceptance[29] and with the positive correlations

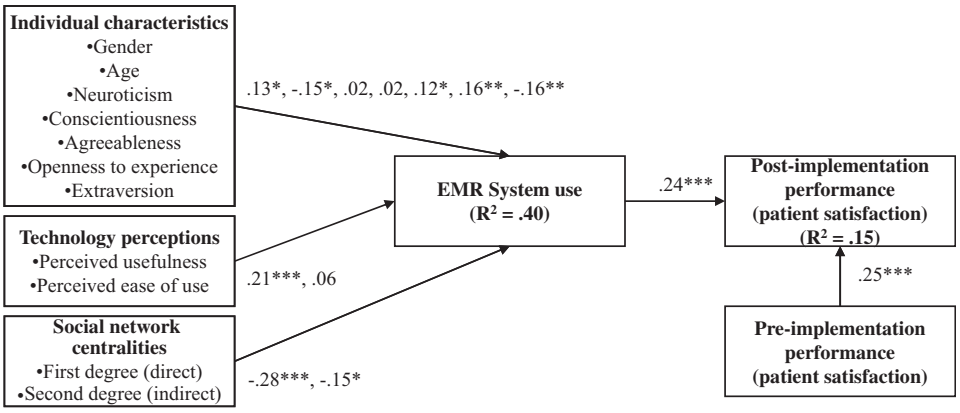

Figure 2 Results. EMR, electronic medical records.

between perceived ease of use and perceived usefulness that we observed in these data. Third, with respect to social networks, our study reveals that the use of EMR systems by physicians is embedded in a social context that is well described by the centrality of their direct and indirect ties to other physicians. The structure of a physician's ties, then, becomes an alternate conduit for some information that is relayed through the EMR system and also for pressure to conform to established norms and practices. Collectively, our findings reveal that a focus on one set of factors and exclusion of the other two will result in an oversimplified view of the relevant forces during the critical shakedown phase.

A third contribution lies in elaborating our understanding about the impact of EMR system use on physician performance, here patient satisfaction. By systematically demonstrating the empirical relationship between EMR system use and patient satisfaction, we provide important evidence regarding the value of such systems. Of course, of concern here from a theoretical standpoint is the countervailing effect of advice network ties. On the one hand, it has a positive, direct effect on patient satisfaction (as evidenced in our post-hoc analysis). It is very likely that physicians with high centrality in advice networks also have access to knowledge from peers that can be instrumental in providing superior care to patients. They are also likely to be positioned effectively to call upon other physicians with questions or to refer patients to physicians with complementary expertise and experiences, both within and outside their own specialty. On the other hand, physicians' advice network ties have a negative effect on performance, here patient satisfaction, when operating through EMR system use. This suggests that while better-connected physicians do tend to perform better (ie, higher patient satisfaction), they do not embrace EMR systems readily. This finding poses an important scientific quandary for future research. In particular, it is important to study interventions to combat these countervailing effects—researchers should focus on interventions that will mitigate the negative forces of advice network ties on EMR system use while supporting the positive forces relating advice ties to physician performance, at least in terms of patient satisfaction. Future work should also study other aspects of the PSQ III instrument that we did not consider such as technical quality and communication. Such a study will provide a richer, more complete understanding of how EMR system use ultimately relates to patient satisfaction. It is possible that some of the other outcomes, for example, technical quality, could mediate the impact of EMR system use on patient satisfaction. More importantly, given the limitations of patient satisfaction as a quality metric, future work should focus on understanding other outcomes, such as medical errors, that are of great interest and importance to healthcare industry.

Finally, we focused on the shakedown phase because it is often the phase in which systems are abandoned, and getting through this phase is obviously important. Likewise, we focused on a specific system with certain features and functionalities. Both of these are contributions and also point to limitations. They are strengths in that the shakedown phase is important to study, and the system has a comprehensive set of features. They are limitations in that other phases of the implementation and other systems with different feature sets need to be studied to understand the boundary conditions of what we have found.

Several additional future research directions are outlined in the online appendix (available at www.jamia.org).

Practical contributions

The most important practical contribution of this work is to alert those implementing EMR systems that the better-connected physicians, who tend to be the better performing physicians in terms of patient satisfaction, will use the EMR systems the least. There are many possible intervention strategies that could be pursued to overcome these potential countervailing effects. First, it may be prudent to seek allies among physicians who are well connected so as to sway popular opinion. These physicians could be targeted to be lead users so that their viewpoints and requirements are represented, to the extent possible, in the functionalities and design of the system. Such a proactive approach can preempt resistance to the system and can even potentially lead to the grafting of opinion leaders and champions[30] who advocate the merits of EMR systems. Second, it may be necessary to design the system in ways that are more compatible with the ways that physicians are already trained and already work, rather than asking them to modify how they work. Third, it is possible that more extensive training and support that is not just a one-shot solution, as is the typical case in most hospitals, may be important to help physicians make the transition. Finally, much as junior physicians learn the trade from more senior physicians, in this case, it may be that a 'buddy system' of a junior–senior physician team could work well together in helping more senior physicians, who are likely older and likely better connected in terms of the advice network, embrace EMR systems. As such, support networks may need to be established to promote physicians' EMR system use and to overcome the negative influence of advice networks on their EMR system use.

Other types of interventions that could be pursued include far more specific things that could be done as part of the training programs that are provided. One of the potentially most

malleable drivers of EMR system use in our model is the positive impact of the perception of usefulness of the EMR system. Likewise, clearly, there is evidence that EMR system use can positively impact patient satisfaction. By designing the training such that the performance benefits are clearly and unequivocally demonstrated, it may be possible to sway physicians to use EMR systems a little more. Therefore, rather than simply turning the training session into a point-and-click training session that teaches what to do and how to do it, there could be a broader emphasis on performance benefits of various features of EMR systems and a discussion of particular case studies and stories of physicians experiencing benefits. Such a case study and story-based training may be particularly suitable and resonate well with physicians, given that medical training itself hinges heavily on such an approach.

CONCLUSIONS

This paper contributes to our understanding on physicians' use of EMR systems. Despite the potential benefits of EMR system use in increasing patient satisfaction with the physicians, physicians who were better connected, both directly and indirectly, to their peers—that is, other physicians—used the system less than those who were less connected. In addition to such social network ties, demographic characteristics (gender and age), three personality characteristics (openness to experience, agreeableness, and extroversion), and a key technology perception (perceived usefulness) predicted EMR system use. Thus, the major contribution of this work that complements prior work is the development and test of a holistic model that helps us understand the relative importance of various factors in explaining EMR system use and its impact on patient satisfaction.

Ethics approval This study was conducted with the approval of the University of Arkansas.

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Explaining physicians' use of EMR systems and performance in the shakedown phase

Tracy Ann Sykes, Viswanath Venkatesh and Arun Rai

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ONLINE APPENDIX

DETAILED RATIONALE FOR MODEL RELATIONSHIPS

Individual Characteristics

Psychology and management information systems research has found various demographic characteristics influence an individual's choice to adopt a system and use it.[1] Several studies have found that women and men differ in their perceptions of technology.[2] Men tend to be, on average, more adventurous, technology savvy and less anxious about computers and technology. This indicates that they are more likely to use an EMR system than women are. Further, EMR systems can be expected to create greater perceptions of potential effectiveness that men tend to value more than women do.[3] Therefore, we postulate that male physicians will use the system more than female physicians. Age has also been shown to influence individuals' technology adoption decisions.[1] Older individuals tend to be less open to change,[4] more likely to distrust new technologies, and more anxious regarding new technologies than younger individuals are.[1] This suggests that younger physicians will explore and use EMR systems more so than their older counterparts.[5] Older physicians are likely to avoid using EMR systems as it is likely to be more foreign relative to the medical practices and methods they learned and have grown accustomed to following, while younger physicians are more likely to have come into contact with EMR systems and similar technologies during their professional training, thus giving them more familiarity with such technologies.

Psychology research has shown that the basic personality of an individual influences his or her behaviors.[6] As noted earlier, we use the big-5 personality conceptualization that comprises neuroticism, conscientiousness, agreeableness, openness to new experiences and extraversion.[7] Neuroticism is a personality trait, sometimes referred to as emotional instability that expresses

the tendency of an individual to experience negative emotions.[7] Conscientiousness is a personality trait exemplified by individuals who are painstaking, careful and have a need for achievement.[7] Agreeableness, the third trait in the big-5, relates to getting along with others. Agreeable individuals tend to be more cooperative, helpful and willing to compromise their own interests in order to achieve social harmony.[7] Openness to new experience is the fourth trait of the big-5 and is categorized by imagination, curiosity, and a drive to seek out new experiences—it is sometimes referred to or correlated with intellect.[7] Extraversion is the last of the big-five traits and is about how an individual relates to others. Extroverts are more externally focused, with a tendency to seek out interaction with others.[7]

Individuals who rate highly in neuroticism often have greater difficulty dealing with stress and negative emotions, and often have a more difficult time dealing with frustrations and challenges in the workplace.[8] Implementation of a new EMR system is likely to be perceived negatively by physicians who have a high neuroticism score, and that in turn will result in lower levels of EMR system use compared to those rated lower in this trait. Due to the already high stresses of a physician's job, it is likely that those higher in neuroticism will dismiss the system earlier than others as too frustrating. Physicians rating highly in neuroticism are likely to use the system less than those who score lower in this trait. Individuals who score high in conscientiousness take pride in their work and doing it to the best of their ability. They tend to be goal oriented and driven by success. While the very nature of medical school, and physician training would seem to dictate a high level of conscientiousness, physicians who rate higher on conscientiousness are more likely to use an EMR system as it is a tool that promises to enhance their performance. Individuals who are less agreeable are generally more focused on their own wants and needs, less likely to compromise, and less interested in extending themselves for

others. In the case of physicians, the role implies a certain level of philanthropy or altruism, and helping their fellow man.[9] More agreeable physicians are likely to use the system to achieve harmony with hospital administration and others who have implemented the system. Individuals who score highly in openness to new experiences are more likely to experiment with novel ideas and technologies than those scoring lower. Physicians who are more open to new experiences are more likely to use a new EMR system as a novelty relative to their day-to-day routine. Physicians who score high in extroversion are likely to use the new system less than those scoring lower as extroverted physicians will likely prefer to obtain information from other physicians and medical personnel than will introverted physicians.

EMR System (Technology) Perceptions

Perceived usefulness is defined as the extent to which an individual believes using an EMR system can enhance their job performance. Individuals who perceive a system to be useful in performing work tasks are more likely to use a system compared to those who do not think the system will help them in their work.[10] The more a physician perceives an EMR system will be helpful in performing his/her job more effectively, the more likely he or she is.[11] Perceived ease of use is defined as the extent to which an individual perceives using an EMR system will be free of effort.[10] Functionality being equal, the more difficult a system is to use, the less likely people are to use it versus systems that are easier to use.[10] Even the most useful system risks being rejected by users if the effort to use it is perceived to be too great. In the case of physicians, whose work is stressful, often requiring time-critical action, a difficult to use EMR system would impose even more stress when compared to a situation of not using the system.

Social (Advice) Network Ties

Physicians do not work in isolation, especially in today's hospitals. Thus, we draw from social network theory to incorporate ideas of the collective and its influence on physicians' EMR system use. It has long been known that our actions are influenced by those with whom we work.[1,12] The accumulated evidence suggests that physicians prefer not to use such EMR systems as it interferes with their typical routine and requires them to work in a different manner from what they were trained to do and what they are accustomed to doing.[13] Better connected physicians could experience greater pressure to not use EMR systems. One of the most important advantages of EMR systems is the access to better information that it provides. Insofar as the data and patient history aspects, physicians can often continue to rely on traditional methods of paper-based records.[14] Insofar as accessing other type of supporting information (e.g., similar cases, treatment options), better connected physicians can leverage other physicians to obtain such information rather than relying on the EMR system.

It is important to make a distinction between the direct and indirect ties of physicians. The physicians' direct connections are likely to be similar to others (the homophily principle[15]), while their indirect ties, i.e., those ties of our ties are often more varied.[16] It is likely that the more directly tied to other physicians one is, the more likely they will have access to information that is most relevant to their immediate and day-to-day job as those directly connected to them are likely to be similar to them in terms of job duties and patient profiles. The more indirect ties a physician has, the more diverse and unique information to which he or she will have access to. In sum, both direct and indirect ties will help fill physicians' information needs, thus rendering the need for and consequent use of a new EMR system to be inversely related to the number of direct and indirect ties.

EMR System Use and Performance

We expect physicians' EMR system use will positively influence their performance. We had, at the outset, presented the various benefits of implementing an EMR system, both at the level of the organization (hospital) and at the level of the individual physician. The broad range of benefits should contribute to better physician performance. Using the system should cause patient interaction time to be used efficiently and effectively, lower mistakes in prescribing treatment courses, speed up access to patients' records and have such access be more reliable, especially given the ability of an EMR system to cross boundaries between medical facilities.[17]

FUTURE RESEARCH DIRECTIONS

There are several important and interesting possible future research directions that emerge both as a result of the findings of this work and as a result of its limitations. First, although our model was quite comprehensive, there are several opportunities for extensions. It is possible to investigate other personality variables, including domain-specific variables, such as computer self-efficacy, computer anxiety and computer playfulness.[18] More comprehensive models of technology perceptions, such as the unified theory of technology acceptance and use of technology (UTAUT[1]), could be employed in lieu of the more parsimonious TAM. Such a model will also provide the opportunity to examine other moderating influences. While we focused on advice networks, other types of networks, such as friendship and hindrance, could be studied and other type of network constructs could be examined.[19]

Second, even within the scope of the current model, it is possible to examine the interplay of relationships among various antecedents. For instance, the personality variables may influence advice network ties. Likewise, advice network ties could influence how physicians perceive the technology. Further, physicians high on certain personality characteristics could in turn tend to

value certain technology or network ties more in deciding to use an EMR system (i.e., moderating effects could exist). As such, given that this was the first step in our holistic understanding of EMR system use, we necessarily focused on the main effects but future work, including our own, could investigate possible mediation and moderation effects.

Finally, the social network portion of our study focused on physicians' ties to other physicians in the particular hospital alone. There are several extensions of theoretical and practical importance that are possible here. Physicians' ties to physicians in other hospitals could be important to understand boundary spanning issues. Physicians' ties to nurses could also be relevant as a source of support or interference. Similarly, physicians' ties to administrative personnel could be pertinent. Thus, broadly speaking, future work could examine the larger social fabric within which the physicians work as such ties may also impinge on the extent to which they embrace and use EMR systems and the extent to which they experience benefits.

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Surveys

Doctors, Nurses and Administrative Personnel Survey

Gender: Male Female

Age: _____ years

Organizational tenure: How long have you worked at this hospital? _____ years

Conscientiousness (7-point agreement scale)
I keep my belongings clean and neat.
I'm pretty good about pacing myself so as to get things done on time.
I am a very methodical person.
I try to perform all tasks assigned to me conscientiously.

Neuroticism (7-point agreement scale)
I often feel blue.
I dislike myself.
I have frequent mood swings.
I panic easily.

Agreeableness (7-point agreement scale)
I have a good word for everyone.
I believe that others have good intentions.
I respect others.
I accept people as they are.

Extraversion (7-point agreement scale)
I feel comfortable around people.
I make friends easily.
I am skilled in handling social situations.
I know how to captivate people.

Openness to Experience (7-point agreement scale)
I believe in the importance of art.
I tend to vote for liberal political candidates.
I carry the conversation to a higher level.
I enjoy hearing new ideas.

Job satisfaction (7-point agreement scale)
Overall, I am satisfied with my job.
I would prefer another, more ideal job. (reverse score)
I am satisfied with the important aspects of my job.

Job performance: On the 1-10 scale used for performance evaluations at the hospital, what was your rating last year?

Perceived usefulness (7-point agreement scale)
I believe the system would be useful in my job.
Using the system will enable me to accomplish tasks more quickly.
Using the system will increase my productivity.
If I use the system, I will increase my chances of getting a raise.

Perceived ease of use (7-point agreement scale)
My interaction with the system would be clear and understandable.
It would be easy for me to become skillful at using the system.
I would find the system to be easy to use.
Learning to operate the system would be easy for me.

Social Networks
Indicate which of the following individuals are important sources of work-related advice or whom you approach if you have a work-related problem:
<Name 1>
…
<Name n>
Note: Scale ranging from 1 to 7, where 1 = never; 2 = rarely (less than once a month); 3 = a few times a month; 4 = weekly; 5 = daily; 6 = A few times a day; 7 = hourly or more.

Patient Survey (7-point agreement scale)
Overall Satisfaction with doctor:

I am very satisfied with the care I received.
The medical care I received was excellent.
The care was just about perfect.