

Effect of Electronic Medical Record Systems on Patients, Physicians, and Healthcare Businesses

Alarqam Saeed Batarfi Alkendi, Habib Khan



Abstract: Paper In the wake of a big shift of the world from the manual patient data management system to the automated process, many technologies have emerged. Needless to say that EMR is one epitome of such technological evolutions in the healthcare field. Though many hospitals as well as healthcare entities have acknowledged this and marching their services towards this change, some laggards persist. The present research tried to re-emphasize the significance of EMR by bringing the effect of EMR system on the group of stakeholders like patients, physicians and businesses from the response of hospital staff. The data, thus collected by sharing the google questionnaire to the staff of both type of branches has fetched 325 responses from the non-EMR implemented hospitals and 308 responses from the EMR implemented hospitals. It is obtained from the results that all the workflows are vital for the process of EMR implementation and are inter-dependent.

Keywords : EMR – Electronic Medical Record; EMR Effect.

I. INTRODUCTION

Globally, clinical information has become handy and safe with the breakthrough of Electronic health (e-health) system, which is the amalgamation of technology and health information. The gains of this technological advancement have left no stone unturned in the field of health. The digitalized version of patient information, Electronic Medical Record (EMR) is best the example for such an advancement [12]-[13]-[14]. EMR facilitated and redesigned medical services to make the life easier and simpler for the physicians, patients and all other stakeholders of the healthcare domain. [19]. They, not only systematize the patient information flow in the health entity, but also stands the organization on par with the international health standards and hence the most of the developing countries like Saudi Arabia have adopted EMR system across the country [15]-[16].

The five fundamental health authorities that manage the hospitals in Saudi Arabia are- Ministry of Health (manages 60% hospitals), other four authorities (around 20% of the Saudi hospitals) and private sector (rest of the 20% of hospitals)[6]-[18].

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* Correspondence Author

Alarqam Saeed Batarfi Alkendi, Department of Computer Science, The University of Liverpool, Liverpool, Liverpool, UK. Email: arqam@hotmail.com

Habib Khan *, School of Information Systems and Technology, College of Management and Technology, Walden University, USA. Email: habib.khan@mail.waldenu.edu

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In spite of the wide coverage by these authorities, many drawbacks like lack of centralized health system throughout the public and private health entities, constraints for medical insurance usage, hinder the spread as well as benefits of EMR [20]. Recognizing the benefits of EMR system, Saudi Government has been expanding & investing on IT to encourage the usage of EMR across various public and private hospitals in the country [18]. Having understood the pros and cons of EMR system for various stakeholders like patients, physicians and others in Saudi Arabian hospitals along with the development initiatives that are being implemented by the Government [2], the present study intends to assess the effect of EMR on all the key players in healthcare domain. In particular, the study aims to analyze the effectiveness and accuracy of the EMR systems in multi-branch hospital in Saudi Arabia. This research work for enhancing the effect of EMR efficiency can certainly benefit all the stakeholders in the present day health-conscious world, who are looking for erring free medication system along with faster service delivery. Hence, the study aims to evaluate the effectiveness of the manual medical records vis-à-vis EMR, analyze the utilization of EMR business models in Saudi Arabia. Simultaneously, the study intends to address the issues raised in the service quality enhancement process.

There are many types of research works carried out to explore the new dimensions in the EMR systems especially for multi-branched hospitals. The present study deals with Magrabi Hospitals and Centres in Saudi Arabia, which has 30 branches in the middle-east and hence the outcome of the study can be helpful in evaluating the effect of EMR system on physicians and patients.

II. REVIEW OF LITERATURE

EMR system rapidly replaces the paper medical records in developed countries due to numerous advantages and time efficiency. Moreover, it helps to obtain complete information about the patients at ease [19]. Much of the developed, as well as developing world is progressing with the latest technological updates in health care field and Saudi Arabia, is also following the suit. As the fraternity of clinicians in Saudi Arabia is not techno-savvy, many of them are apprehensive to use EMR systems, even in the 21st century [11]-[10].

Notwithstanding this, lack of computing skills coupled with language barrier also hinders the spread of the EMR system in the country [9]- [20]. As the dependency of the contemporary world on EMR technology is soaring, so is the contribution of researchers in Saudi Arabia [11].

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The following graph (figure-1) explains the increasing concern in EMR research (in percentage) in the country, so as to address the barriers for the spread of EMR from all the sections of society.

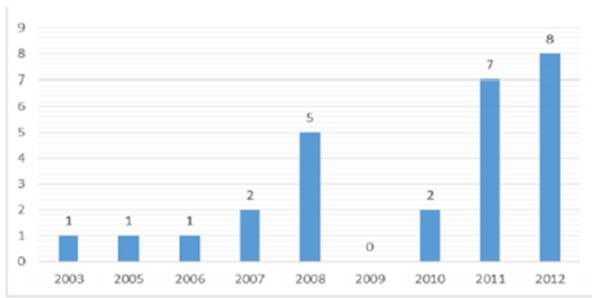


Fig.1. EMR Research percentage in Saudi Arabia (Source: [11])

A. Effect of EMR on Physicians

The EMR technology and management system provides information with apt facts and figures to the clinicians for understanding the aspects related to vital signs, weight and blood pressure that formulates the basis for evaluating the patient condition from time to time [77]-[78]. [31] conducted a survey to get the status of the newly implemented EMR system and to assess the rate of physician's satisfaction in Saudi Arabia. It is found from the research work that only 40% of the 115 physicians are satisfied with the pace of process improvement, the ascent in the operations, increase in the patient flow and hence accuracy in medical decisions. However, the majority of the physicians responded negatively about the EMR system. Not limiting to this, the scope of the EMR system aids the physicians to enhance the quality measures in a seamless manner [6]-[7]. It has also been stated that, with the support of EMR system, constant disease management as well as efficient curing can be done in a definite manner [16]-[23].

B. Effect of EMR on Patient's Safety

Global research has established that EMR plays a vital role in providing patient safety in manifold ways. That is, alerts pertaining to the health status of the patient along with the information regarding allied medical services such as the laboratory, radiology and others are sent to the hospital administrators as well as the physicians regularly [2]-[26]. In addition, the access to vital patient information, screening procedures, allied service permissions and preventive measures are managed with the EMR systems [5]-[14]-[21]-[22]. Apart from the above, many features are provided to the patients to make them a part in the holistic improvement of medical research and hence the health care entity by catering to their data needs through a point of care [4]-[24]-[25]. Thus, an effective feedback mechanism is fostered to encourage patient-centric service delivery management in hospitals [36]-[37]-[38].

C. Effect of EMR on Medical Research and Development

As in the case of other stakeholders, EMR also streamlines the process of R&D in numerous ways [39]-[40]-[41].

Through online and offline documents provided in EMR system, the structured format for reducing the medical errors is enhanced [3]. Notwithstanding this, the EMR system facilitates the requests and task assignments, which can productively engage the respective team members by sending timely reminders [2]. This kind of monitoring and evaluation makes medical research and development go by leaps and bounds [1]-[7]. Unlike the legacy systems, EMR provides remote access and appointments facility. This feature has become a curtain raiser in the medical research development arena [14]-[27]-[28]. Of late, the global shift to patient-centric service delivery in health care sectors is much bolstered by the patient portal services, which provides complete information about the patient history [29].

D. EMR Business Model

The business model proposed in this research is for the best practiced EMR system which can completely transform the quality of care delivered to patients. Unlike other EMR systems, which are designed with the intention of accessing a patient's related data, this model provides recommendations related to patient's care on the basis of clinical guidelines. This business model is effective enough to be utilized within the premises of healthcare organizations. In addition, it provides access to the patient related information from diversified destinations and ensures the accuracy of information.

Figure - 2 clearly illustrates the information flow among the health care providers with the patient medical records being systematically stored. The ultimate goal in medical practice being the ease in the retrieval of the patient's medical records whenever needed by any of the healthcare provider ensuring a quality output, the EMR system could realize it. The patient movement can be monitored and controlled through Workflow Management (WFM), which can replace the paper medical file.

Thus, the research will focus on showing the benefits of having an efficient model EMR and hence EMR system by considering the case of the private healthcare provider in Saudi Arabia, Magrabi Hospitals. The literature reviewed is synthesized in the following table-1 for enhanced understanding.

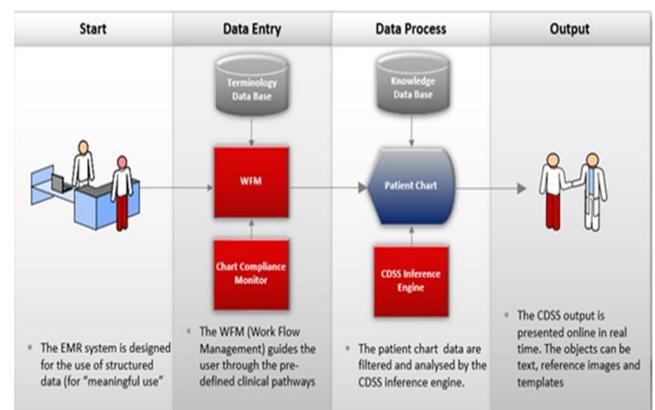


Fig. 2. Theoretical Model of EMR

Table I: Synthesized Table of Literature Reviewed

SN	Factor	Supported by	Relevance
F1	Human factors considered as a barrier in Saudi Arabia	[8]-[32]-[33] - [34]- [35]-[42]	End user's capabilities are the main barrier to have a proper EMR and maximize the EMR system in Saudi Arabia.
F2	IT healthcare investment in Saudi Arabia	[17]-[43] -[44]-[45] -[46]-[47]	The IT investments in the healthcare division allow using the advanced technology and EMR systems in Saudi Arabia
F3	Government direction to automate the healthcare business environment in Saudi Arabia	[48]- -[49]-[50] -[51]-[52] -[75]-[76]	The government in Saudi Arabia is working on automating all the public-sector hospitals and working to enforce all the private sectors. Also, having a unified medical records number for all citizens and residents.
F4	Benefits awareness of having EMR and HIS system in the healthcare systems	[53]-[54] -[55]-[56] -[57]-[58] -[59]-[60] -[61]-[62]	Healthcare vendors invest huge budget as they are aware of the benefits of the EMR and HIS solution
F5	Effect of EMR and implement fully integrated EMR system to increase the patient's quality of services.	[30] -[63]-[64] -[65]-[66] -[66]-[68] -[69]-[70] -[71]-[72] -[73]-[74]	The most significant advantage of implementing the EMR system is increasing the quality of services to the patients

Hypotheses

With the information about the cause and effect relationships (the knowledge about the EMR and its impact on the health department players), the study proposes the following alternative hypotheses, which are tested using suitable statistical tests.

H11: There is a significant difference between the mean values of the opinions of the staff belonging to the hospitals with no EMR and with EMR with respect to Process improvement.

H12: There is a significant difference between the mean values of the opinions of the staff belonging to the hospitals with no EMR and with EMR with respect to Decision making.

H13: There is a significant difference between the mean values of the opinions of the staff belonging to the hospitals with no EMR and with EMR with respect to Financial improvement.

H14: There is a significant difference between the mean values of the opinions of the staff belonging to the hospitals

with no EMR and with EMR with respect to Operational improvement.

Having the hypotheses framed, the study proceeds for the methodology section that describes the procedure adopted to test the framed hypotheses statistically.

III. MATERIAL AND METHODS

To achieve the research objective of the study, a qualitative approach along with the interview method is adopted. That is, the study tool (questionnaire) is developed to evaluate the current EMR system from the version of the medical and administrative team. Such a workout helps to ascertain the strengths and weakness along with the system controls to monitor the workflow among various medical departments. The research data collected through interviews, online survey and observation methods.

The present study considers the case of Magrabi Hospitals and Centers in Saudi Arabia because of the cost and time constraints. Magrabi is one of the leading hospital chains in Saudi Arabia. The hospital is operating nearly 30 branches founded in 1955, Magrabi Hospitals & Centers has evolved from a simple eye hospital in Jeddah “Saudi Arabia”, the first private specialized facility in the Middle East and Africa, to become the largest eye care network in the world, providing eye care to more than 1,000,000 patients and performing more than 100,000 sight-preserving surgeries annually. across the Middle East with a large number of staff as well as physicians in various specialties. Moreover, Magrabi ophthalmology team includes more than 300 physicians, 600 nurses and 40 optometrists. The facilities host 40 operating theaters and 25 Excimer laser machines “www.magrabi.com.sa”. all the branches have similar EMR system. Therefore, it can be deemed that the sample selected for the study is the true representative of the overall population. Among all the branches of Magrabi, Main branch Hospital at Jeddah, Saudi Arabia is selected for the study using purposive sampling. In order to collect the primary data to explore the impact of EMR systems on patients, physicians and medical records, the data is collected from all the cadres of the staff in an unbiased manner. The delivery model of the study, that is designed to achieve the aim of the study is given in the following figure-3.

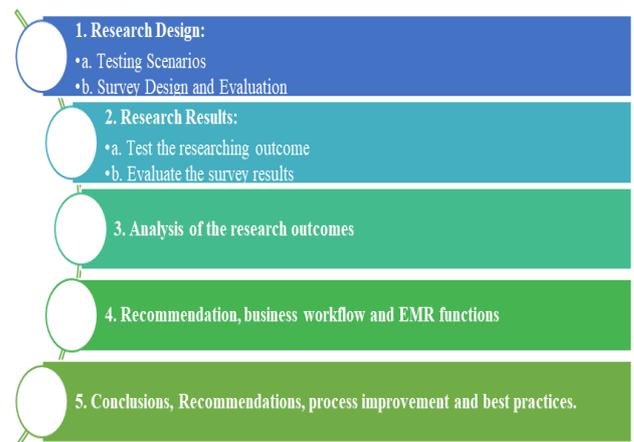


Fig. 3. Deliverable Model of the Study



Sample for the Study

The Staff of Magrabi in Saudi Arabia are approached by the research teams and are assured that their anonymity would be maintained. Required permissions are also taken from the management of Magrabi Hospitals and centers along with the ethical approval from the concerned bodies. Emails are sent to all the staff as a link to provide their answers. Thus, the opinion of participants is invited through google questionnaire with respect to the impact of four workflows – process improvement impact, decision-making impact, financial impact and operational impact. That is, the questionnaire is segregated into four sections apart from basic information of the respondent. The responses are measured on a 5-point Likert scale rated from 1 to 5 (most negative to most positive). Thus, the questionnaire consists of :

- The first section deals with questions related to process improvements such as monitoring and control on patients’ prescription, management information system, ease in completing patients’ information and others.
- The second section consists of questions related to decision making such as effective planning, reliable information about each patient and the results, standardized data management system and others
- The third section includes questions related to financial benefits such as a reduction in the gap between the estimated and actual expense, reduction in corruption, reliable inventory cost and others.
- The fourth section consists of questions related to operational improvements such as better coordination between branches, better utilization of available resources, better utilization of the facility, an increase in cooperation between the departments, etc. In particular, this information is sought from both the employees pertaining to the departments that implemented EMR and the departments that did not implement EMR. Thus, the workout can help to fetch the potential improvements in the business of healthcare organizations that accrued due to the establishment of the EMR system with respect to the above mentioned four dimensions.

IV. DATA ANALYSIS AND FINDINGS

The collated data is analyzed using advanced statistical techniques and the results are tested at 5% level of significance using the statistical package SPSS 21.0. The analysis is carried in three stages. The first stage is descriptive analysis, second is the correlation analysis and the third is the t-test for difference of means between the independent samples. During the first stage, the data is analyzed to understand the basic information about the participants. That is, the proportion of the employees participated in the study at various levels of professional hierarchy is assessed. The results are given in the following table – 2. It can be understood from the relative proportion of participants that among all, administration and operations cadre staff (with code MM002) have participated in the majority (46.7%). Similarly, the proportion of participation for medical staff is 49.5%, but top management staff has participated in a low percentage (only 4%), which is the lowest among all the level of staff.

Table II: Proportion of Respondents as per Hierarchy

Code	Level Of Hierarchy
TM001	Top Management
MM002	Administration and Operations
MS003	Medical Staff
NM004	Non-Medical Staff

Thus, the number of survey respondents from Magrabi Hospitals & Centres that implemented EMR vis-à-vis that did not implement EMR is given in the following infographic (figure-4).



Fig.4. Distribution of Respondents from Magrabi Hospitals

The cross-tabulation between the category of the employee and the status of EMR implementation in hospital is given in the following table – 3. The data reveals the distribution of the employees of various categories across the hospitals.

The values in above table explain that the proportion of participants in the survey has increased considerably for the administration and operations staff (15% to 46%) for the branches that have implemented EMR than those from the branches that did not implement EMR. But, the participation of the medical staff has come down from the former case to the latter (19% to 9%). However, it can be observed that the percentage of participation for the top management staff in both cases of EMR is just marginal. For obtaining the true picture of EMR implementation, the active participation of staff at all levels is mandatory. So, if the staff at all levels can help in the data collection, there could be a possibility for unveiling the actual impact of EMR.

Table III: Proportion of Respondents Before and After the EMR

	N o EMR	%	W ith EMR	%	T otal	% of Respondent s in Sample
Administrat ion and Operations	47	15	143	46	190	4%
Medical Staff	204	63	124	40	328	46.70%
Non-Medic al Staff	63	19	28	9	91	40.50%
Top Management	11	3	13	4	24	8.8%
Total	325		308		633	

Survey respondent proportion in hospitals that did not implement EMR as well as the hospitals implemented EMR is given individually in the above pie charts (figure-5) and together in the following bar chart (figure-6) for enhanced understanding.



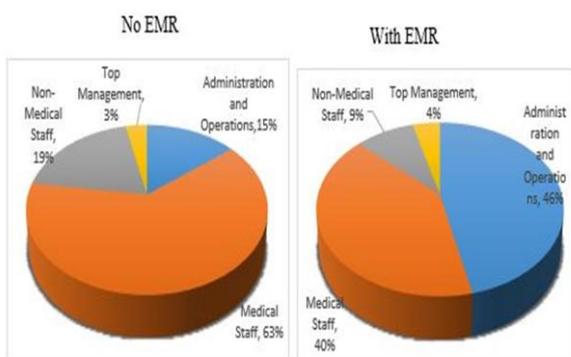


Figure 5: Proportion of Employees of The Branches that Implemented EMR and that didn't Implement EMR.

Survey respondent proportion in hospitals that did not implement EMR as well as the hospitals implemented EMR is given individually in the above pie charts (figure-5) and together in the following bar chart (figure-6) for enhanced understanding.

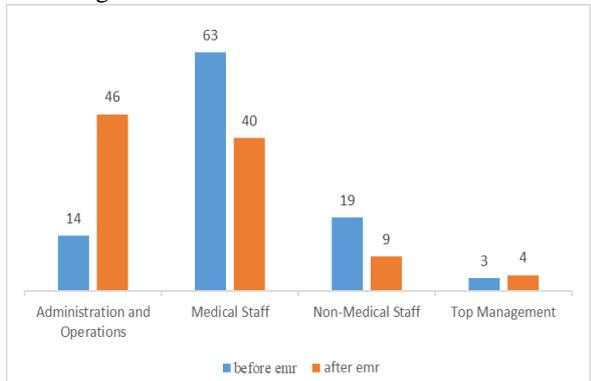


Fig. 6. % of Survey Respondents from Various Sections

With a basic understanding about the proportion of respondents as per their department classification along with the status of EMR, the second stage of analysis is performed on the collected data. That is, the data that is collated with respect to various aspects of the workflow (process improvement, decision making, financial improvement and operational improvement) is tested for correlation. The results are furnished in the following table-4. It can be understood from the correlation analysis that all the processes in the workflow are observed to be highly correlated with each other, irrespective of the status of implementation of EMR. However, decision making is found to be more correlated with all other aspects of the workflow.

Table IV: Correlation Matrix among the vital Workflows of the Study

	Process improvement	Decision making	Financial improvement	Operational improvement
Process improvement	1			
Decision making	.927**	1		
Financial improvement	.833**	.956*	1	
Operational improvement	.743**	.922*	.977**	1

** Correlation is significant at the 0.01 level (2-tailed).

The knowledge about the dominating aspect of the workflow (decision making) helps to understand the most influencing factor in the process of workflow. In the third stage, the significant difference between the two respondent groups is tested using the t-test for difference of means. The result of the t-test is given in the following tables 5 and 6. The values in the table-5 enunciate that the mean response for the process improvement of the hospitals that have EMR (4.77) is considerably higher than those with no EMR system (3.13). For decision making, the mean response is almost double for the entities with EMR (4.89 from 2.68). Similarly, with respect to financial improvement and operational improvement, a considerable difference is found in the mean rating between the entities that are without and with EMR systems. So, this result gathered from various departments of hospital staff highlights the role of EMR systems in the work flows of the hospitals.

Table V: Mean and SD of the response about the workflows

		N	Mean	Std. Deviation
Process improvement	No EMR	325	3.13	1.481
	With EMR	308	4.77	.196
Decision making	No EMR	325	2.68	.994
	With EMR	308	4.89	.134
Financial improvement	No EMR	325	2.49	.809
	With EMR	308	4.59	.112
Operational improvement	No EMR	325	2.28	.784
	With EMR	308	4.60	.196

On the other hand, the results of the Levene's test for equality of variance given in the following table-6 clearly highlights the difference between the mean values of the opinion of the staff belonging to the hospitals with no EMR and with EMR with respect to all workflows.

Table VI: Results of t-test for Independent Samples

	Levene's Test for Equality of Variances		t	df	Sig. (2-tailed)
	F	Sig.			



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Process improvement	Equal variances assumed	983.57	*	-19.32	631.00	*
	Equal variances not assumed			-19.83	335.98	*
Decision making	Equal variances assumed	1025.03	*	-38.65	631.00	*
	Equal variances not assumed			-39.66	336.36	*
Financial improvement	Equal variances assumed	338.31	*	-44.98	631.00	*
	Equal variances not assumed			-46.16	337.00	*
Operational improvement	Equal variances assumed	337.04	*	-50.48	631.00	*
	Equal variances not assumed			-51.69	366.67	*

Note: * refers to 5% significant values

V. DISCUSSION

It is widely acknowledged that EMR facilitated and redesigned medical services to make the life easier and simpler for the physicians, patients and all other stakeholders of the healthcare domain. (Alasmary et al., 2014). However, there are mixed opinions about the benefits of EMR among stakeholders. Hence, the present study evaluated the effectiveness of the manual medical records vis-à-vis EMR, analyze the utilization of EMR business models in Saudi Arabia's Magrabi Hospitals and Centres. This workout is carried out by considering the response of four levels of staff (Top Management, Administration and Operations, Medical Staff and Non-medical staff) with respect to four criteria – process improvement, decision making, financial

improvement and operational improvement. Such data, with the above-mentioned specifications has been collated from the staff of both the hospital branches that have implemented EMR and did not implement. The data thus gathered using the online questionnaire is analyzed using four stages of analysis. Though enough care is taken to obtain an equal sample from both the phases of EMR, some variation (308 from the branches that implemented EMR and 325 from the branches that did not implement) has occurred in the number of participants because of the study constraints. However, further analysis is carried in systematic way to obtain the desired output of the study. The results in the first level of the analysis revealed the relative proportion of participants in the study. The level of active participation of medical staff in both the phases of EMR (did not implement EMR and implemented EMR) is a welcoming scenario. However, among the hospital branches that implemented EMR, the participation of admin and operations staff is still higher. Though the participation of the medical and non-medical staff has decreased from the former phase of EMR to the latter, is a comparative increase in the participation of admin and operations staff as well as the top management indicates the interest of the concerned groups towards spreading a word about implementation of EMR. Further, during the next stage of analysis, the correlation values obtained helped to identify the key processes of the entities. That is, all the processes in the workflow are observed to be highly correlated with each other, irrespective of the status of implementation of EMR. The knowledge about the dominating aspect in the workflow (decision making) helps to understand the most influencing factor in the process of workflow. yet, the significant difference between the two respondent groups is tested using the t-test for difference of means. The results of the test enunciate that the mean response for the criteria, process improvement of the hospital branches that have EMR system is considerably higher than those with no EMR system. This result infers that with EMR system in place, the process improvement in the entity takes place.. Also, the mean response with respect to other workflows - decision making, financial improvement and operational improvement are observed to be higher for the entities with EMR is almost double for the entities with EMR than with the no EMR system. Finally, t-test for difference of means is executed to know the significant difference between the two sets of opinions gathered from the respondents of different levels with respect to the four work flows considered. The results underpinned the significant difference between the version of the respondents from the hospital branches that implemented EMR and did not implement EMR about the efficiency of work flows. Thus, the result obtained from the t-test infer to accept the alternative hypothesis (H11) that, there is the considerable difference between the opinion of the employees with respect to process improvement between the EMR enabled entities and their counterpart. Similarly, the p-value obtained for the workflow – decision making suggest to accept the alternative hypothesis (H12),

which states that there is a considerable difference between the opinion of the employees of EMR enabled and not enabled entities with respect to decision making. Also, the significant values of Levene's test for the workflows – financial improvement and operational improvement suggests to accept the alternative hypotheses H13 and H14 and conclude that there is a considerable difference between the opinion of the employees between the hospitals that implemented EMR and did not implement EMR. Thus, the role of EMR in hospitals can be acknowledged by the response of the staff of the entities with respect to various workflows.

VI. CONCLUSION

In the wake of significant shift of the world from the manual patient data management system to the automated process, many technologies have emerged. Needless to say that EMR is one epitome of such technological evolutions in the healthcare field. Though, many hospitals as well as healthcare entities have acknowledged this and marching their services towards this change, some laggards persist. The present research tried to re-emphasize the significance of EMR by bringing the effect of EMR system on the group of stakeholders like patients, physicians and businesses. That is the opinion of the staff of the hospitals that implemented EMR as well as did not implement EMR are gathered with respect to four vital workflows of the healthcare entities. The renowned hospital group Magrabi of Saudi Arabia is selected for this study, which has some branches that implemented EMR and some that did not EMR so far. The data, thus collected by sharing the google questionnaire to the staff of both type of branches has fetched 325 responses from the non-EMR implemented hospitals and 308 responses from the EMR implemented hospitals. The data analyzed during various stages advocated that EMR implementation can bring definite change among the process flows of the entities. Though the proportion of participation at various levels of employees varies significantly during both the stages of EMR, there is a considerable response from the staff for the study. In-depth review of the workflows and their inter-relation also established a strong dependency among them. In addition, the decision-making process is proven to be more influential and critical for any system to run smoothly. On the whole, the study could also capture the pulse of the stakeholders regarding the implementation of EMR system in the hospitals through in-depth interviews. This workout witnessed a good level of aspiration for the emerging technologies among the staff of the healthcare entities. Thus, the research not only accumulated the opinion of the staff qualitatively and quantitatively but also furnished certain theoretical as well as managerial implications in futuristic perspective.

Theoretical implications

Over the decades, many theories have evolved to establish the linkages in the process of implementation of EMR across the globe. However, the interaction with the staff of the Magrabi hospital branches that did not implement EMR so far indicates the necessity to explore the means to encourage the laggards towards the adoption process. Also, this study highlights the need for theories to encourage the employees at

all levels to respond to the development strategies. Only such initiatives can bring the expected technological ascent on all fronts.

Managerial Implications

Compared with many other studies that tried to capture the version of a particular level of staff, this study ventured to gather the opinion of the staff of all levels about the impact of EMR implementation in the hospital on the stakeholders. However, an equal proportion of participation of respondents has not become possible. This is due to two reasons – lack of awareness about EMR and the associated resource problem. Even for this research initiative to bring out the in-out of slow adoption of EMR, it would have been more beneficial if there is an equal proportion of participation from all the level of staff (from top management level to down level). Initiatives to encourage the active participation of the managerial staff can bring out some vital aspects that are the crux in the process of EMR implementation. Future studies can address these issues in detail. Mobilization of resources strategically so as to utilize the available resources in an optimized manner can certainly convince the concerned staff to overcome the lacunae and to upgrade themselves.

Limitations

This study confined to only one group of hospitals because of many constraints. However, as EMR implementation is a general issue in all developing and developed hospitals and hence inclusion of more hospitals for study can reveal a range of opinions, it would be beneficial to do so. Also, consideration of region-specific requirements as well as cultural constraints for implementation of EMR is not done in this study. Organizing the study by keeping these aspects in view can bring out various dimensions that need attention. Considering the EMR services providers apart from the staff of the hospital also can unveil not only the demand side problems of EMR, but also supply-side problems.

Future Research Prospects:

As discussed in the limitations, reviewing the lacunae and developing studies to spread the scope of respondents can help to understand the problem in a better way. Studies involving all the players in the EMR scenario like patients as well as service providers can showcase the grey areas in the EMR implementation process.

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AUTHORS PROFILE



Alarqam Saeed Batarfi Alkendi, is an active researcher and completed his Master of Science (MSc), Information System Management from University of Liverpool, UK. He has served as a senior IT manager for 15 years. His main role is setting up and managing IT infrastructure and applications in diverse roles across the organizational hierarchy. Presently he is associated as a Corporate IT Infrastructure & KSA IT Manager with Magrabi Hospitals & Centers., Jeddah, KSA. He also contributed to analyzing the behavior of software, hardware, and systems with regards to the usage of communications technology and deploying effective solutions and optimizing the performance of Cisco Switches, Routers, Firewall, WAN, internet utilization, bandwidth, and UPS's.

Habib Khan is a contributing faculty of School of Information Systems and Technology at College of Management and Technology in Walden University, USA since 2007. He completed his Ph.D. degree in the area of Information Technology. He is an active researcher in his field and published many papers in his area of research. His research interests are in the area of health care systems and Security. He is an active member of IEEE and other leading bodies of the field.