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Assessing Electronic Medical Record System Implementation at Kilimanjaro Christian Medical Center, Tanzania

Joel S. Mtebe[1], Ronald Nakaka[2],
[1]University of Dar es Salaam, Tanzania
[2]American International Health Alliance, United States of America.

Abstract

Background: Hospitals in sub-Saharan Africa countries have been investing heavily in electronic medical records (EMR) systems aiming at improving patient safety, healthcare quality, and transforming the healthcare industry. Similarly, the Kilimanjaro Christian Medical Centre (KCMC) has been implementing various EMR systems in the past few years. However, the implementations of these systems have not been successful like in many hospitals in sub-Saharan Africa.

Objectives: To help the hospital avoid failure of EMR systems implementation in the future, this study assessed EMR systems implementation through adopting some elements of the technology–organization–environment (TOE) framework.

Methods: The qualitative research method involving 10 focus group discussions with a total of 46 respondents, documents reviews, and observation as data collection instruments.

Results: The study found that poor ICT infrastructure, lack of participatory approach during EMR systems implementation, lack of policies and standards, and lack of ICT Directorate were among factors that contributed to the failure of EMR systems implementation at KCMC.

Conclusion: The findings of this study will help those hospitals planning to implement EMR systems to avoid these challenges during implementation especially in sub-Saharan Africa.

Keywords: Electronic Medical Records (EMR); Hospital information System; Electronic Health Record System (EHR); Barriers to implementation; EMR Tanzania.

1. INTRODUCTION

The healthcare sector worldwide has been investing heavily in electronic medical records (EMR) systems aiming at improving patient safety, healthcare quality, and transforming the healthcare industry [1-4]. The EMR systems store and process various types of clinical, administrative, and financial data about patients [2]. They also coordinate the retrieval of patient records from multiple health facilities thus,

[1]Joel S. Mtebe, University of Dar es Salaam (UDSM), Dar es Salaam, Tanzania. Email: jmtebe@gmail.com; Tel: +255715 383 366

providing vital historical medical information for critical decision-making [1]. Therefore, the adoption and use of these systems will lead to major health care savings, reduce medical errors, and improve the quality of health care [5-7].

Given these benefits, the number of EMR systems adopted in various hospitals worldwide has been increasing substantially. In a study conducted in the USA, it was found that up to 75% of US hospitals adopted at least one EMR system [8]. Countries such as India, Thailand, Japan, Kingdom of Saudi Arabia, and Estonia are amongst the most adopted EMR systems [9,10]. Given the poor state of medical records and increased health expenditure in sub-Saharan Africa, EMR systems have been described to have much larger impacts than in developed countries [11,12]. Naturally, several hospitals in countries such as South Africa, Rwanda, Kenya, Ghana, Nigeria, and Mozambique have been spending thousands of dollars in ICT infrastructure, human resource, and in implementing EMR systems of various kinds [13]. In Tanzania, several hospitals such as Arusha Lutheran Medical Center, Hydom hospital, Makiungu hospital, St. Elisabeth hospital, Muhimbili National Hospital, Bugando Hospital, Benjamini Mkapa hospital, and Kilimanjaro Christian Medical Centre (KCMC) are among hospitals that have adopted and implemented EMR systems [14].

Despite the continued adoption of EMR systems in many hospitals worldwide, the majority of them tend to fail [15,16]. Across the health sector, at least 40% of information systems either are abandoned or fail to meet business requirements, while fewer than 40% of systems meet their goals [17]. EMR systems implementation is much more complex than other healthcare information systems and the chances of failure are high [18,19]. This is because EMR systems implementations involve both medical professionals and non-medical professionals with both having high levels of expertise, power, and autonomy [20, 21]. Moreover, these professionals have multiple objectives, such as curing and caring for patients, and educating new physicians and nurses, and they both need to be involved in the EMR systems implementations [22].

With these challenges in mind, it is not surprising that those few countries where EMR systems have been implemented tend to fail [23, 24]. Evidently, many surveyed hospitals in Tanzania, for instance, were looking to change their EMR systems after having implemented in short period of time [14]. The KCMC, being one of tertiary referral hospital in Tanzania has been implementing various EMR systems in the past few years. The adoption of EMR system can be traced back in 2003 when the hospital adopted the open source system based on Care2x framework. Although the system was implemented successfully in the few departments, it failed to meet the intended objectives. In 2015, the hospital replaced it with the HarmoniMD system. The HarmoniMD system has been implemented in few hospitals in USA, Philippines and it was expected to work well at KCMC [25]. Despite showing great promise at the beginning of the implementation, the hospital management have been left frustrated with the progress of

implementation. By the end of 2017, only two modules were partially completed. Therefore, the hospital was planning to replace it with another system.

To help the hospital to avoid possible failure of EMR system implementation in the future, an assessment of previous efforts was thought to be necessary. Therefore, this study adopted some elements of the technology–organization–environment (TOE) framework [26] were adopted using qualitative research method involving 10 focus group discussions with a total of 46 respondents, documents reviews, and observation were used as data collection instruments. The TOE framework uses three components: technological context, organizational context, and environmental context to explain the factors of adoption of technology in a given organization. Figure 1 shows various elements of TOE framework.

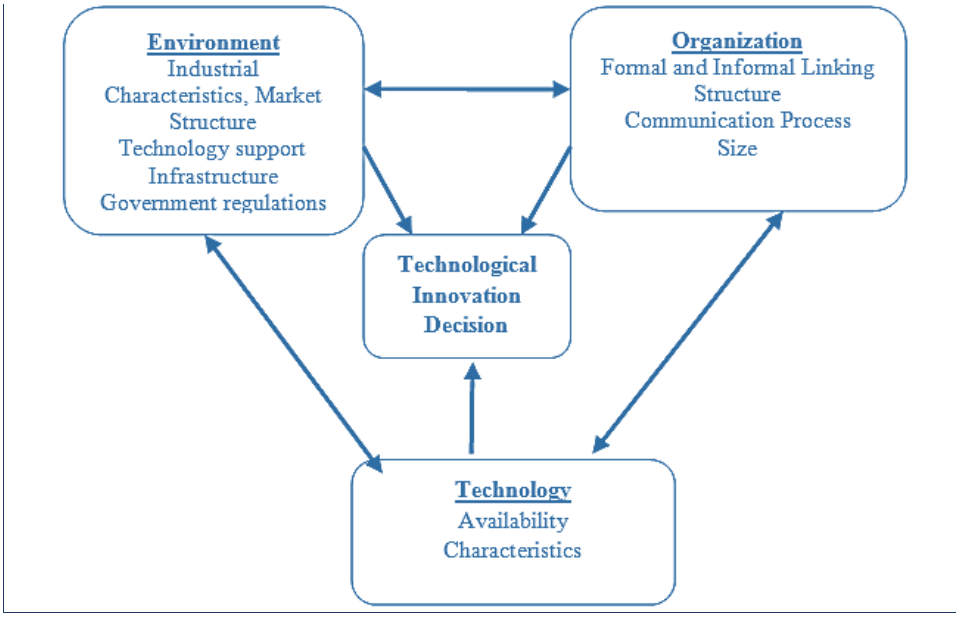

Figure 1: The technology–organization–environment framework [27]

The technology context examines technologies that are relevant to the firm – both technologies that are already in use at the firm as well as those that are available in the marketplace relevant to the organization [27, 28]. The technology context include ICT infrastructure, Internet skills, ICT technical know-how, user time, and developers [29]. The technology context has been described to have an impact on the adoption of various systems at the hospital. This is because, hospitals with greater technological infrastructure can easily invest in EMR systems [30].

Similarly, organizational context can constrain or facilitate the adoption and implementation of a technology in an organization [28]. The organizational context include firm size and scope; the centralization, formalization, and complexity of its managerial structure; top management support; the quality of its human resource; and the amount of slack resources available internally [27, 29]. For instance,

the organization that emphases on horizontal communication are accepting of new ideas from employees, which might create an environment in which EMR systems could be easily installed [30].

Environment context is the arena in which the firm conducts its business – its industry, competitors, access to resources supplied by others, and dealings with the government [26]. It also includes the structure of the industry, the presence or absence of technology service providers, and the regulatory environment [27]. In context of this study, governments and other stakeholders exert pressure on healthcare organizations to improve cost effectiveness and patient care through use of ICT can push hospitals towards increased EMR systems adoption [31].

Research has demonstrated that the TOE model has broad applicability and possesses explanatory power across a number of technological, industrial, and national/ cultural contexts [27]. Therefore, this study adopted some of the elements of TOE to evaluate EMR system implementation at KCMC. The study adopted qualitative approach due to the limited number of respondents at the hospital. The methodology explaining how the study was conducted is explained next.

2. METHODOLOGY

The study adopted qualitative research method specifically in-depth interviews, focus group discussion, documentary review, and observation as data collection instruments. The explanation of each instrument is explained next:

2.1 Focus Group Discussions

The focus group discussions were conducted to get feedback from users who were involved in the implementation of various EMR systems. A total of 10 focus group discussions were conducted organized per department. A total of 46 respondents were involved from all the departments (See Figure 2). Table 2 shows the distribution of respondents from each department.

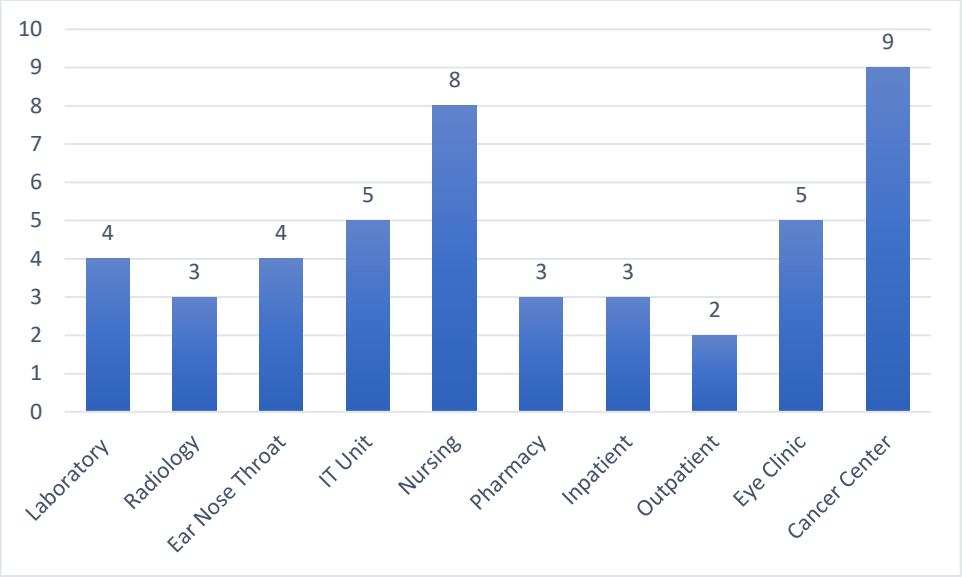

Figure 2: Distribution of number of respondents per department

2.2 Documentary Review

The official documents, and reports on the adoption and implementation of various EMR systems were reviewed. Moreover. operational manuals and organizational documents were also reviewed to understand the linkage between hospital business process and how the IT has been integrated. Some of the reviewed documents include patient access policy, health and safety policy, human resources policies and procedures, and customer service policies and procedures. In addition to these documents, literature review was conducted to understand existing EMR systems implemented in various hospitals in Tanzania. Through the literature review, Arusha Lutheran Medical Center and Bugando hospital were found to have adopted EMR systems since 2014. The researchers visited these two hospitals to learn the success stories as well as challenges faced during the implementation of EMR systems.

2.3 Observation

The researchers observed how users were interacting and using various information systems implemented at the hospital. Moreover, researchers were given access to the HarmoniMD system to assess the implemented modules. Generally, the use of observation supplemented findings obtained from documentary review and focus group discussions.

3. FINDINGS

3.1The Technological Context

3.1.1 ICT Infrastructure

The ICT infrastructure is of critical importance for EMR system implementation and provide a platform on which the EMR system can be implemented [2]. Therefore, ICT infrastructure to support the implementing of EMR system was assessed. It was found that the hospital had Local Area Network (LAN) connected to the fibre optical cable linking all the buildings. However, the LAN was found to be poorly configured with the majority of devices being old. Several ICT firms were given contracts in the past and every firm designed the network without taking into consideration existing networks.

In terms of Internet access, it was found that the hospital receives Internet with a speed of 12mbps from the provider. Despite the high cost the hospital has been paying, the Internet has not been reliable. As a result, the majority of existing systems have been configured to be accessible via the LAN rather than via the Internet. The study also found that the hospital has server room dedicated for hosting various information systems. Nonetheless, few information systems were hosted in the server room with the majority of other systems being hosted in departmental server rooms. For instance, PAC system was hosted in the Radiology department while the QuickBooks was hosted in the pharmacy department. When asked about the backup system, IT staff indicated that they do not have external back system rather they store data into tapes and DVDs.

3.1.2 Existing Information Systems

It was revealed that the hospital has installed several information systems serving various hospital functions. For instance, picture archiving and communication system (PACS) system provides storage and convenient access to the patients' images. Other departments can easily access these images via the LAN. Similarly, the DisaLab system streamlines all activities in the laboratory. Other information systems installed in various departments are shown in Table 1.

Table 1: List of Information systems installed at KCMC

No.	Information system	Department	Purpose
1.	QuickBooks	Pharmacy	Accounting software
2.	EyeSoft	Eye Center	Registration of patents at the unit and it is integrated with billing module
3.	Carestreem system	Radiology	Image processing system
4.	PACS system	Radiology	Storage of radiology images
5.	CanReg5	Cancer care center	Input, store, check and analyze cancer registry data
6.	NHIF system	OPD	Reconciliation of National Health Insurance Fund (NHIF) payments
7.	Disa*Lab	Laboratory	It is laboratory information management system
8.	HarmoniMD system	General	EMR system

3.1.3 Status of EMR System Implementation

The study found that hospital was implementing HarmoniMD system as the main EMR system since 2015. Prior to HarmoniMD system, the hospital tried to implement EMR system based on Care2x framework. The implementation of this system was not successful before being replaced with the HarmoniMD system. Since its acquisition of the HarmoniMD system, only patient registration and appointments modules were implemented. It was noted that there was no a written plan on when other modules will be completed. For instance, one head of unit said

> *"For a year now, we have been asking them a plan to complete the other modules, but we don't get define answers. They are very slow in responding to our emails sometimes you ask something, and they respond with totally a different issue"*

While another IT staff complained

> *"I think they don't have developers dedicated to this project. Every time we sent our request, it takes more than a month for them to respond and without providing a solution"*

We asked the IT team as to why the development of the system has been such in a slow pace. They showed us their communications with developers who were based in the USA. It was found that some requirements which were requested by KCMC were too contextual such that they cannot be replicated in other countries where the system was going to be implemented. Therefore, the developers were reluctant to change the system entirely to meet the context of KCMC since most of the proposed functionalities were unlikely going to be used elsewhere. For instance, KCMC requested the system to be integrated with mobile money payments such as Mpesa, Tigopesa as well as integrating with NHIF system. These features are unique to Tanzania environment and few countries use mobile payments. Moreover, the hospital requested developers to include regions in the patient registration, and the response from developers was:

> *"This will appear in the State/Province field. It should be the same as in your context, there is no need to change"*

Upon discussion with top management, we were informed that the developers were planning to visit KCMC to conduct intensive user requirements and implement the remaining modules. The study also found that existing two modules: patient registration and appointments were not customized for the context of KCMC. Registering patient requires users to enter Zip code, email address, blood group, fax as mandatory fields while the appointment module did not have the ability to send reminders via SMS, emails, etc.

3.1.4 Integration of HarmoniMD System with Other Information Systems

The study found that the HarmoniMD system was not integrated with other existing systems at the hospital limiting its extensive usage. As a result, users had to enter data into HarmoniMD system and still continue using other systems separately. For instance, doctors are required to access images from radiology system while at the same time accessing laboratory results from the Disa*Lab. The situation was caused by lack of functional EMR system which was supposed to link these systems.

3.2 Organizational Context

3.2.1 Management Support

The top management awareness of the role of information systems in supporting hospital activities is crucial if these systems are to be successfully implemented. The management can offer both moral and financial support during the implementation of EMR systems if they are aware of the importance of these systems [31]. In this study, we were interested to find out the awareness of top management on the role of ICT in managing hospital activities through focus group discussions with Directors, and the Head of Units. The study found that there was a strong support from the top management in the implementation of information systems at the hospital. For instance, the Executive Director indicated:

> "*We have no problem to spend money for the EMR system, the most important thing is to ensure we get the system that will be working at an affordable price. We are losing a lot of revenues for conducting our business manually. We need to make use of the technology now. What I need is to know if we have to continue with the current system or replace with another system and at what cost."* (Interview with the Executive Director)

3.2.2 EMR Acquisition Approach

The study found that the majority of information systems including previous EMR systems were acquired in top down approach with few users being involved. The top management were involved in the initiation, negotiation and procurement of the information systems. It was revealed that even IT staff were not fully involved in the acquisition of these systems. One IT staff said:

> *"We were told the hospital has entered agreement with a firm from Arusha to implement an EMR system. One of us was appointed by the Executive Director to facilitate the implementation of the system"* (Staff from IT Unit).

3.2.3 Institutional Arrangements

We also investigated the institutional arrangements of IT resources in the existing management structure. The study found that the hospital management structure did not have IT directorate. Existing IT staff were positioned in the directorate of Human Resource and Administration. Moreover, it was found that the hospital had a shortage of competent IT staff who are capable of implementing and supporting existing and future information systems. The hospital was found to have only four IT staff with few of them having degree or higher in computer science or related field.

3.3 Environment Context

3.3.1 EMR Systems Implemented in Tanzania

Competitive pressure has been widely recognized to have positive impact towards the adoption of information systems in a given organization [28]. One organization can adopt a certain technology simply because a similar organization is using such technology. In this study, existing EMR systems initiatives implemented in various hospitals in Tanzania were reviewed from the literature. The study found that care2X system was the most implemented EMR system in the majority of hospitals. The system has been implemented at Arusha Lutheran Medical Center, Hydom hospital, Makiungu hospital, and St. Elisabeth hospital.

The care2X system is an open source system that can be downloaded via http://www.care2x.org/. Many hospitals have customized it to meet the requirements of their context including adding additional modules. In the surveyed hospitals, users have shown positive experience in using the system [14]. The electronic health management system (EHMS) is another EMR system that was found to be implemented at Bugando and Sanitas hospitals and has been developed using open source tools such as PhP and MySQL. The system was fist pilot at Kairuki hospital before being implemented at Bugando and Sanitas hospitals. It is not clear why the system was not successfully at Kairuki hospital. In addition to hospital business, the system has been integrated with national insurance systems and banking system.

Another EMR system that was found to be implemented in some hospitals in Tanzania is the JEEVA system. The JEEVA system is a closed, commercial system developed by Napier Healthcare Systems firm of India. At the moment, the system is used by Muhimbili National Hospital. Finally, the study found that MEDIPRO system was implemented at Jakaya Kikwete Muhimbili Orthopaedic Institute in Dar es Salaam and at the Benjamini Mkapa hospital in Dodoma. Just like the JEEVA system, is a closed, commercial system developed by an Indian firm.

3.3.2. Relevant Policies and Standards

The study found that there was no policies and standards governing the acquisition, implementation, and usage of information systems at the hospital. The presence of policies and standards are important in guiding how future systems are going to be aligned with existing systems. The absence of polices at the hospital has led to the duplication of data and systems functionalities across various information systems.

3.3.3 EMR Systems Development Approach

The development of the system tends to follow certain development life-cycle procedures that describes phases, tasks and considerations that are necessary for a successful software project [32]. The choice of development methodology has impact on the success or failure of the system to be implemented. In this study, it was revealed that the development of both Care2x system and HarmoniMD system followed traditional development methodologies i.e. the waterfall methodology. The majority of traditional methodologies tend to gather user requirements at the beginning of the project and continue with the development of the system without fully involving users during other stages of the development process. The lack of involvement of users throughout the project had an impact on the success of the EMR systems implemented at KCMC especially in hospital environment where user requirements tend to change rapidly. For instance, the study found that developers of HarmoniMD system realized that the initial requirements had changed, and new ones had emerged when they were delivering the two modules after spending six months developing.

4. DISCUSSION

This study assessed the implementation of EMR systems at KCMC using TOE as a research framework. The study adopted qualitative research method specifically focus group discussion, documentary review, and observation with key stakeholders at the hospital. Although the hospital has made some attempt to implement EMR systems, it clear that none of the systems have been successfully implemented. The study also found that the current HarmoniMD system was not viable solution for the hospital due to a number of challenges reported in the study. One main reason for the failure of previous implemented EMR systems was the adoption of traditional development approach which do not involve users in every stage of the project. Adequate user-involvement is important to foster ownership of the system by the future users, and to allow the implementation of systems that will actually match work processes [33].

Therefore, agile software methods such as Extreme Programming, Crystal methods, Lean Development, Scrum, Adaptive Software Development have been recently proposed [34, 35]. They

concentrate only on the functions needed at first hand, delivering them fast, collecting feedback from users and reacting to received information [36]. By regularly involving users during the development process, agile methods reduces the software process overheads while releasing a working software early and continuously testing with customers [37]. It was recommended that future development of EMR system at KCMC should follow one of the agile development methodologies.

It was also found that commercial EMR systems implemented in several hospitals in Tanzania were costly and beyond to many budgets of hospitals. For instance, it was found that JEEVA firm quoted KCMC US$1,500,000 to implement EMR system excluding yearly maintenance fee. It is clear that the cost of procuring JEEVA is beyond many mid-sized hospitals like KCMC. In fact, the high financial cost of implementing EMR systems is considered a major barrier to adoption of these system in many hospitals in sub-Saharan Africa [2]. It was therefore recommended that KCMC to look for an open source EMR system in order to reduce the cost of acquiring commercial systems. The majority of open source systems have many functionalities that are similar to that of commercial systems [11, 38] and many hospitals in sub-Saharan African countries have been adopting them [13]. For instance, in a study conducted by Akanbi et al. [13] in 15 sub-Saharan African countries found that about 91% hospitals reported to have adopted open source EMR systems.

The study also found that the hospital did not have institutional arrangements that recognizes the role of IT within its organization structure. It was therefore recommended that the hospital to establish the Directorate of ICT/IT staffed with competent individuals who will spearhead the adoption and implementation of EMR system and other information systems. The proposed Directorate of ICT/IT to be headed by a person who is reporting directly to the Executive Director like the existing Directors.

Another challenge that was found to affect the implementation of EMR systems KCMC is the poor ICT infrastructure. The presence of reliable ICT infrastructure is necessary to ensure smooth implementation of EMR systems [20]. It was recommended that the hospital should redesign the network including replacing old devices such as routers and improve the cabling structure. Finally, it was recommended the hospital should formulate policies and standards that will govern the implementation of EMR system and other related systems. Early attention to policies and standards will create an environment for the smooth implementation of the EMR system and planning how future systems should integrated with existing systems. Moreover, policies and standards will help the hospital to address important issues such as data security, privacy, and protection of intellectual property that normally affect the adoption and use of EMR systems. Lack of policies in implementing EMR systems was described to affect the deployment of several systems in studies conducted in Arabic countries [10].

5. CONCLUSION

The potential of EMR systems to transform medical care practice has been recognized over the past decades [6]. In developing countries where the health expenditures has been increasing, the adoption of these systems has been a subject of discussion [12]. Nonetheless, experience of EMR systems implementation in sub-Saharan Africa countries is much more scarce [39] and many countries have been adopting healthcare information systems due to the need to report aggregate statistics for government or funding agencies [19]. As a result, many articles in the literature have been focusing on experiences of implementing the healthcare information systems [40]. It is therefore difficult to obtain failure data in order to learn from them and to plan for successfully implementation of EMR systems. This study assessed EMR systems implementation at KCMC through adopting some elements of the technology–organization–environment (TOE) framework. The study adopted qualitative research method involving 10 focus group discussions with a total of 46 respondents, documents reviews, and observation were used as data collection instruments. The study found out that poor ICT infrastructure, lack of participatory approach during the system development, lack of policies and standards, and lack of IT directorate were amongst factors contributed to the failure of EMR systems implementation at KCMC. As the ICT infrastructure continue to improve in sub-Saharan Africa, the number of EMR systems adopted in many hospitals will continue to increase. Similarly, hospitals will continue to spend thousands of dollars in ICT infrastructure, human resource, and in implementing EMR systems. Given limited resources in sub-Saharan Africa, the costs of any type of EMR system failure is likely going to be high. Therefore, the findings of this study will help hospitals planning to implement EMR systems especially in Sub-Saharan Africa to learn from these challenges and plan for successfully implementation of these systems in the future.

6. Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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