Blockchain-Based Quality of Service for Healthcare System in the Gaza Strip

Abdelkhalek I. Alastal, Raed A. Salha, Maher A. El-Hallaq

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Abstract— Electronic Health Records EHRs are critical, highly sensitive private information in healthcare, and need to be frequently shared among different parties for example patients, physicians and administration. Blockchain provides a shared, immutable and transparent health records of all the transactions to build applications with trust, accountability, and transparency. This provides a unique opportunity to develop a secure and trustable EHR data management and sharing system using blockchain. This study aims to develop the use of health records as well as finding the current status of EHRs by designing a checklist to measure the extent of use of health records in the Gaza Strip hospitals and exploring the possibilities of using blockchain technology to develop the use of the electronic health records to share accurate and complete health data between multiple parties such as patients, doctors, and managers in an effective, transparent and secure manner.

Index Terms— Blockchain Technology, Distributed Ledger Technology, Electronic Health Records, Healthcare, Information Management.

I Introduction

Actually, correct, accurate and timely information is the most important foundation for smart cities. Blockchain, big data and artificial intelligence are the most important technologies used in smart city applications [1-3]. One of the most important applications of smart cities is healthcare. EHR management system aims to provide a full history of a patient, that contains the right information in the right place in the right order, at the right time for the right person at the lowest cost, considering the security of patient data. There are no EHRs designed to manage multi-institutional, lifetime medical records. Many global healthcare systems are in crisis because of prohibitive costs, limited access to care, patient safety and privacy concerns, data breaches, and varying quality of care.

Patient's health record is an important part of information for the process of medical treatment of patients including personal data, personal medical profile, allergies, etc. Several hospitals adopt information communication and technology to manage patient medical records which are called Electronic Health Record System.

The current EHR system in most countries is not very effective, as hospitals have used different programs. The EHR systems in hospitals are private and developed to use within the organization only, where some hospitals have developed their own system, while others have purchased ready-to-use application software. Thus, it is not connected to each other. If a patient transfers for any reason to another hospital, access to the patient's medical profile in the new hospital could not be done. As a result, patients receive limited benefits from the data in the private EHR system. Such problems make hospitals unable to transfer important information between the stakeholders in the system with confidence. As well as, patients are not confident about the security and privacy of their data [4].

As a result, advancement of blockchain technology is necessary to have the potential to accommodate an exchange of existing data safely. The operation of blockchain comprises information confidential, accurate and ready-to-use information [5]. Blockchain offers a potential solution; it enables us to put the patient at the center of the healthcare ecosystem and increases the security, auditability, and privacy of sensitive health data and interoperability of systems that contain such personal information. Therefore, doctors can diagnose symptoms precisely from the past medical treatment, and pharmacists can supply medicines correctly and accurately from the prescriptions through the system [6]. Additionally, it can provide the information accurately and timely for the strategic planning of the healthcare service providers more effectively [7].

Blockchain's success depends on whether all stakeholders are willing not only to adopt its technical infrastructure and its core principles but also to participate in healthcare standards development and ongoing governance of blockchain-based healthcare platforms. The need to increase the efficiency of healthcare delivery and reduce duplication and er-

rors is essential to enable health organizations to meet the increasing demand for services in the future. Many countries experience identifies that adoption of a comprehensive EMR system will assist in achieving these objectives [7].

This study aims to investigate the availability, use and efficiency of the electronic health record in the Gaza Strip hospitals, and explore the possibility of applying blockchain technology to improve health care in it and standing on the obstacles that hinder the use of such technology in the field of EHRs. For this purpose, a checklist is designed and analyzed to achieve the above aim.

II The Study Questions

Unleashing blockchain's potential in healthcare will require organizations to address significant challenges. Since its greatest benefits revolve around streamlining, the coordination among multiple providers, and patients, healthcare organizations will need to measure and study the current situation of EHRs and study how appropriate an EHR is to use and benefit from blockchain technology. This what research tries to address.

It also offers a new vision of smart healthcare, by potential formularization of effective healthcare policies for decision-makers, patients, health care providers with different health care institutions, and other stakeholders. In addition to, it tries to identify the reality of the EHR and its effectiveness in the providing of healthcare in the Gaza Strip, explore the possibility of applying blockchain technology to improve healthcare in its medical centers. Considering the Gaza Strip case study, study importance can be realized from answering the following key research questions.

- What are the capabilities of EHR?
- How medical centers such as hospitals and clinics are ready for using blockchain technology?
- What are the obstacles that obstruct the use of blockchain technology in the field of EHR?
- What are the capabilities of the new blockchain technology in the field of healthcare and EHR?
- What are the benefits of using blockchain technology for patients, medical staff, hospital management, and community?

III Blockchain and EHR Concepts

A longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data, and radiology reports. The EHR automates and streamlines the clinician's workflow. The EHR has the ability to generate a complete record of a clinical patient encounter – as well as supporting other care-related activities directly or indirectly via interface – including evidence-based decision support, quality management, and outcomes reporting [8].

An EMR, Electronic Medical Record, is an application environment composed of the clinical data repository, clinical decision support, controlled medical vocabulary, order entry, computerized provider order entry, pharmacy, and clinical documentation applications. This environment supports the patient's electronic medical record across inpatient and outpatient environments, and is used by healthcare practitioners to document, monitor, and manage healthcare delivery within a Care Delivery Organization (CDO). The data in the EMR is the legal record of what happened to the patient during his or her encounter at the CDO and is owned by the CDO [8].

Conceptually, blockchain can be easily explained as a type of database for recording and confirming transactions. Each transaction is verified, recorded and combined with other transactions to produce a new block in the ledger that is then copied to peer nodes in the participating network, thus creating a distributed ledger of sorts. These transactions can range from moving data to transferring money, and even relating The Electronic Health Record and confidential personal information, etc. Salha et al. [9] discuss in depth the concept of blockchain in terms of definitions from different perspectives related multiple uses of stakeholders by different domains and applications.

Healthcare is one of the most important areas that is suitable to be effectively used in emerging blockchain technology and healthcare initiatives. In less than a decade, blockchain has surged from a technology with narrow applications related to digital currencies, to one with important applications in many domains especially in healthcare, so, drawing attention to policymakers at different levels too. EHRs are never designed to manage multi-institutional, lifetime medical records. Patients leave data scattered across various organizations. Thus they lose easy access to past data, as the provider, not the patient, generally retains primary stewardship on EHR. Patients thus interact with records in a fractured manner that reflects the nature of how these records are managed [10]. Table 1 presents the most important advantages of EHRs and their challenges.

TABLE 1
Advantages and Challenges of EHRs.

Advantages of EHRs [11]	Challenges to EHRs Adoption [12, 13]
• Patient information is accurate, up-to-date, and complete • Quick and convenient information access at the point-of-care • Secure information sharing with patients and other clinicians • Safer and reliable medication prescribing • Legible and complete documentation • Accurate and streamlined billing	• High financial cost. • User resistance to using the system . • Organizational cultural change • Lack of user support. • Lack of computer experience. • Technical limitations – slow system performance. • Lack of quality in patients' information. • Interoperability/no standard protocols for data exchange. • Lack of EHR standards. • Lack of incentives

• Reduce medical errors and provide safer care • Improve provider efficiency and productivity • Reduce costs – ordering and documentation	• Confidentiality concerns. • Difficulty Transition of data • Issues of implementation, maintenance, upgrades, and training. • Privacy and/or security

Blockchain technology can enhance EHRs efficiency that are essential in fields of health care. At its core, blockchain relies on a decentralized, digitalized and distributed ledger model. By its nature, this is more robust and secure than the centralized models which are currently used in the health care ecosystem. Blockchain technology creates a viable, decentralized record of EHRs transactions – the distributed ledger – which allows the substitution of a single master database. It keeps an immutable record of all transactions, back to the originating point of a transaction. This is also known as the provenance, which is essential in health care, allowing health care institutions, stakeholders and patients to review all transaction steps and reduce the risk of fraud, prevents changing and tampering with the data of the electronic health record of the patients. Table 2 shows current issues within the smart healthcare industry.

TABLE 2
Current Issues Within the Smart Healthcare Industry [14].

Issue	Activity
Healthcare Data Interchange	Data must pass between healthcare providers to necessary third parties, insurers, and patients while meeting data protection regulation in the healthcare sector.
Nationwide Interoperability	Having a single standard for patient data exchange allows for ease of passing data between healthcare providers, which legacy systems often do not provide.
Medical Device Tracking	Medical device tracking from supply chain to decommissioning allows for swift retrieval of devices, prevention of unnecessary repurchasing, and fraud analytics.
Drug Tracking	As with medical devices, blockchain offers the capability to track the chain of custody from supply chain to patients, allowing for tracking any transaction and prevention of counterfeit drugs.

IV Related Work

A problem facing healthcare record systems is how to share the medical data with more stakeholders for various purposes without sacrificing data privacy and integrity. Blockchain as a promising technology to manage the transactions has been gaining popularity in the domain of healthcare. It has also the potential of securely, privately, and comprehensively manage patient health records.

Zhang M. and Ji Y. [15] discuss the latest status of blockchain technology and how it could solve the current issues in healthcare systems. They evaluated the blockchain technology from the multiple perspectives around healthcare data, including privacy, security, control, and storage. They reviewed the current projects and researches of blockchain in the domain of healthcare records and provide the insight into the design and construction of next generations of blockchain-based healthcare systems.

Conceic A. et al. [16] discuss how blockchain technology, and smart contracts, could help in some typical scenarios related to data access, data management and data interoperability for the specific healthcare domain. They propose the implementation of a large-scale information architecture to access EHRs based on smart contracts as information mediators. The main contribution for this study is the framing of data privacy and accessibility issues in healthcare and the proposal of an integrated blockchain based architecture.

Park et al. [17] confirm that it is possible to exchange EHR data in a private blockchain network. They concluded that to develop a blockchain-based EHR platform that can be used in practice, many improvements are needed, including reductions in data volume, improved protection of personal information, and reduced operating costs.

Ekblaw et al. [18] propose a novel and decentralized record management system to handle the EHRs, using the blockchain technology. Their system gives patients a comprehensive, immutable log and easy access to their medical information across the providers and treatment sites.

Xiao Yue et al. [19] propose centric access model ensures the patients to control their healthcare data on their own; simple, unified indicator – centric schema makes it possible to organize all kinds of personal healthcare data practically and easily. Their method also indicates the fact that MPC (Multi-Party Computing) is one promising solution to enable an interested third party to conduct computation over patient data without violating privacy. Zhang et al. [20] address the adoption of blockchain in social network domain but not fully explores the benefits of the blockchain.

V EHRs in the Gaza Strip

A The Study Area

Gaza Strip constitutes the south west part of Palestinian coastal plain of Mediterranean Sea and it is confined between the Mediterranean Sea in the west, Sinai of Egypt in the south, Negev desert in the east and green line in the north. The Gaza strip area is about 365 km^2. The length is about 41 km on the western Mediterranean coast and the width varying from 7 to 12 km, Figure 1. It is located on a latitude of 31˚ 16′ to 31˚ 45′ North and 34˚ 20′ to 34˚ 25′ East [21]. The population density of Palestine is generally high at 826 persons/km^2, particularly in the Gaza Strip, where it is 5,453 persons/km^2 compared to a lower population density in the West Bank of 528 persons/km^2 in mid-2019 [22].

B Healthcare in the Gaza Strip

Healthcare sector in the Gaza Strip is composed of; (a) primary healthcare represented in clinics; (b) secondary

healthcare represented in hospitals [23]. Ministry of Health (MOH) is considered the main provider of secondary healthcare in the Gaza Strip. It defines hospital as a place prepared to receive patients for more than one day for diagnosis or treatment [24]. There are 30 hospitals in the Gaza Strip; 13

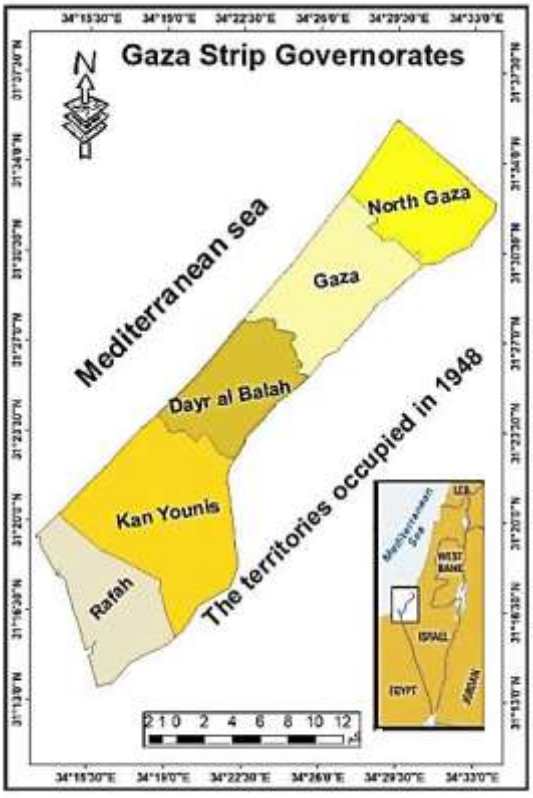


Fig. 1. Geographic Location of the Gaza Strip

hospitals supervised by MOH, 14 hospitals supervised by NGOs, and 3 hospitals supervised by Ministry of Interior (MOI). Private sector and the United Nation Relief and Works Agency for Palestine and Refugees in Near East (UNRWA) do not operate hospitals in the Gaza Strip [25]. The distribution of healthcare facilities according the supervision agency is showed in Table 3.

TABLE 3
The Distribution of Healthcare Facilities According to the Supervision Agency.

Supervision Agency	Number of Primary Healthcare Facilities	Number of Secondary Healthcare Facilities
MOH	53	13
MOI	4	3
NGOs	19	14
UNRWA	21	0
Total	97	30

C Diseases Status

Vaccination coverage levels are one of the best indicators of the health system performance. Therefore, MOH provides all the needed services to ensure that immunizations for each child according to the national immunization schedule are granted. Figure 2 shows number of communicable diseases status in the Gaza strip of the year 2018 [26].

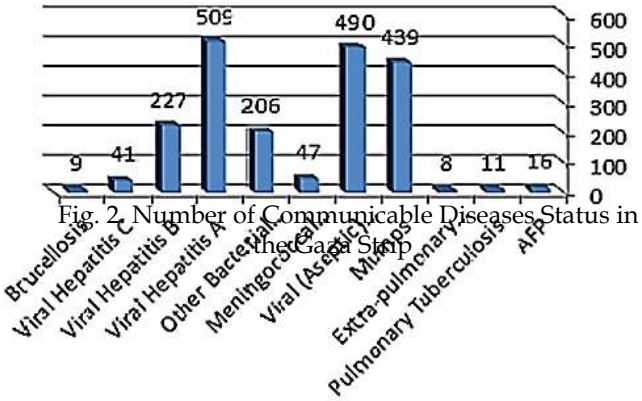


Fig. 2. Number of Communicable Diseases Status in the Gaza Strip

As shown in Table 4, non-communicable diseases NCDs such as ischemic heart disease is ranked the first (40%) from reported chronic diseases in the Gaza Strip in 2010. Whereas, cancer is ranked the second (20%), followed by cerebrovascular disease CVD (13%). Respiratory disease is ranked the fourth (10.4%) among reported chronic diseases in the Gaza Strip population.

TABLE 4
Non Communicable Diseases in the Gaza Strip [27].

Rank	Cause	Total deaths (per 100,000 people) (%)
1	Heart diseases (IHD)	72.8 (40.0)
2	Cancer (lung & breast)	36.6 (20.0)
3	Cerebrovascular disease	23.3 (13.0)
4	Respiratory disease (COPD)	18.9 (10.4)
5	Chronic kidney Disease	11.2 (6.2)
6	Hypertension	10.5 (5.8)
7	Diabetes Mellitus	8.5 (4.6)

D EHRs Challenges

Challenges facing the development of EHRs in the Gaza Strip involve [26]:

- Interoperability
- Lack of adoption of uniform standards and interoperability.
- Privacy and confidentiality.
- Social and organizational barriers.
- Technology limitations.

- Preserving electronic records.
- The legal status of EMR
- Lack of national information standards.
- A lack of funding.
- Concern about physician usage.
- Resistance to EHR systems.
- Patient confidentiality and privacy.
- System maintenance and down time.
- EHR software quality and ease of use.
- Lack of awareness and experience about the usefulness of EHR.

VI Checklist Analysis and Discussion

A checklist is designed to assess the performance of EHR and the potential using of blockchain at governmental and NGOs hospitals in the Gaza Strip. This design is highly accepted to assist to meet the study purposes. The target population of this study is hospital managers and IT managers who are working in governmental and NGOs hospitals in the Gaza strip. The total number of healthcare providers is 84, and thus, the target community in the study consists of 84 samples. The survey is conducted over six weeks. The checklist has been distributed to hospital administrators, and if the IT department is available, the head of the IT department is asked to answer the checklist.

Ethical approval is obtained from the Islamic University of Gaza as well as the official approval from the General Directorate of Human Resource Department in MOH -Gaza. Every participant in the study received a complete explanation of confidentiality and research purposes.

A Checklist Design

The checklist has been prepared on the subject of the study and consists of two sections. Section one includes the demographic data such as personal, general and technical data of the respondent like institution's name, city name, name of governorate, institution level, supervising authority, institution age, etc. On the other hand, section two involves fifth dimensions which are:

- Dimension One: The capabilities of EHR (17 variables).
- Dimension Two: Challenges in using EHR technology (16 variables).
- Dimension Three: The capabilities of the approved EHR technology in terms of coding, user authentication and record access (11 variables)
- Dimension Four: The audit log and the metadata characteristics adopted in the EHR technology (17 variables).
- Dimension Five: The approved EHR features for patients' access to their data (8 variables).

B Checklist Validity and Reliability

Content validity refers to the extent to which the paragraphs in the checklist, or the measuring tool, represent the content that has been chosen for inclusion in the test, by presenting the checklist to the arbitrators for their opinions. The checklist is presented to a number of experts as shown in Table 5. The arbitrators' opinions are taken into consideration and the amendment is made in light of the submitted proposals, thus the checklist is finalized.

TABLE 5
Arbitrators Names and Positions.

Name	Position
Dr. Medhat Abbas	Director-General of Primary Health Care - Ministry of Health – Palestine
Dr. Rami Hader Alabadla	Infection Control Consultant - Ministry of Health – Gaza - Palestine
Dr. Ayman Yassin Al Astal	Director of the emergency department, Nasser Medical Complex, Ministry of Health, Gaza, Palestine
Dr. Ibrahim Hamed Al Astal	Dean Faculty of Education, Islamic University, Gaza, Palestine
Dr. Faisal Abdelfattah	Department of Psychology, College of Education, Imam Abdulrahman Bin Faisal University (formerly known: University of Dammam), KSA.

Internal consistency is a check to ensure all of the test items are measuring the concept they are supposed to be measuring. Table 6 shows the internal consistency performed using Cronbach's Alpha to verify the reliability of each dimension. Cronbach's Alpha test for all checklist variables is 0.964.

TABLE 6
Alpha Cronbach Test Results for Each Dimension.

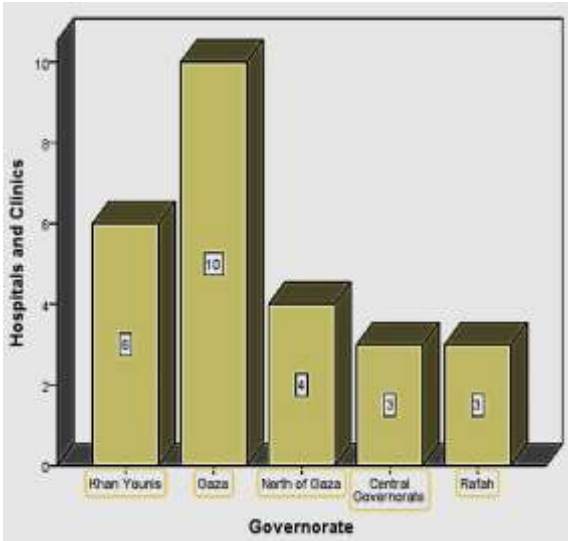
Checklist Dimension	Number of paragraphs	Cronbach's Alpha	Self-Validity*
Dimension One: The capabilities of HER	17	.843	0.918
Dimension Two: Challenges in using EHR technology	8	.710	0.842
Dimension Three: The capabilities of the approved EHR technology in terms of coding, user authentication and record access	35	.953	0.976
Dimension Four: The audit log and the metadata characteristics adopted in the EHR technology	58	.968	0.983
Dimension Five: The approved EHR features for patients' access to their data	23	.767	0.875
All dimensions		0.848	0.920

*Self-validity = positive square root of the Alpha-Cronbach factor

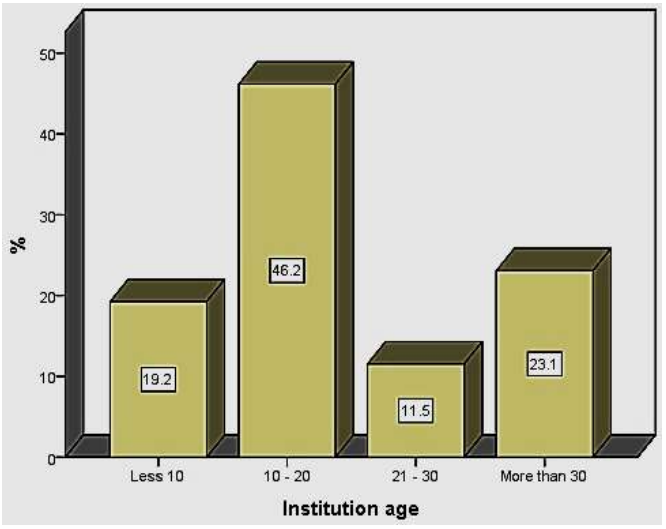
C Demographic Data Analysis

Figure 3 summarizes the demographic data analysis of the checklist. Figure 3-a shows, that Gaza Governorate comes first in terms of number of hospitals and clinics in the governorates of the Gaza Strip. This is due to its high population as well as the presence of governmental, educational, economic

and other institutions. Figure 3-b indicates that 46% of health institutions age is between 10-20 years and 23.1% are over 30 years old. These results mean that health institutions in the Gaza Strip possess medical and technical expertise, experiment, and cadres that can improve the quality of healthcare.



(a)



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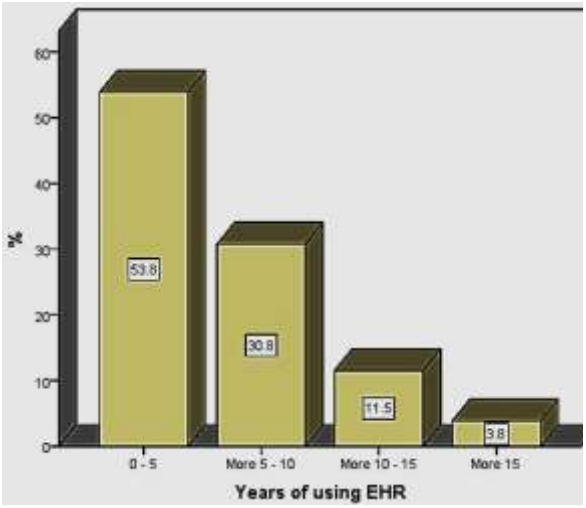
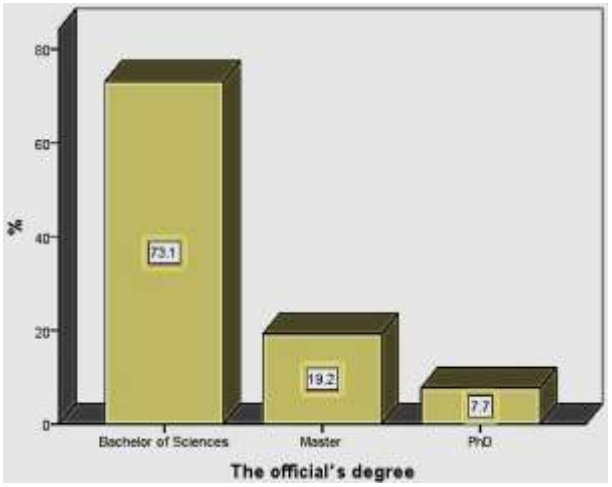
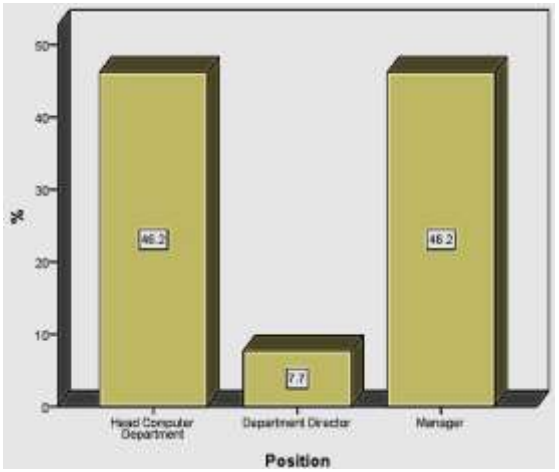


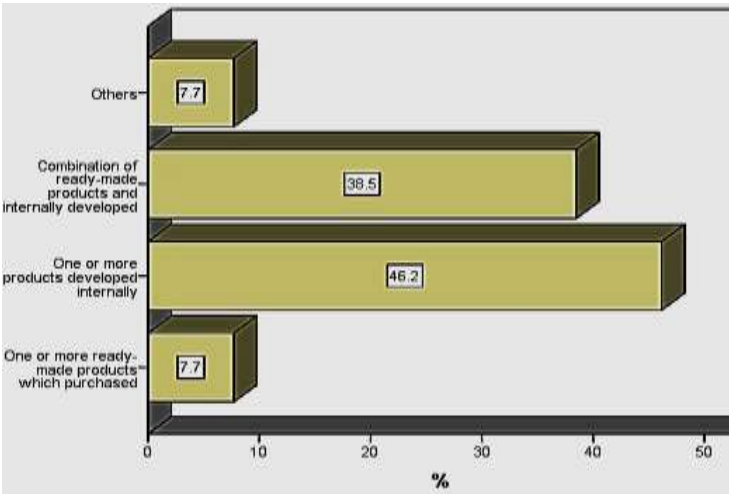
(c)



(d)



(e)



(f)

Figure 3. The Demographic Data Analysis of Respondents According to: (a) Number of hospitals in each governorate, (b) Institution experience, (c) Years of using HER, (d) The official's degree, (e) Title position of respondent, and (f) Kind of EHR used in the institution.

Figure 3-c shows that 53.8% of the sample use EHR in the past 0-5 years. This indicates that the use of EHR is relatively recent and it may not meet all the needs of patients in the health sector. It also appeared from the study that there are a number of health institutions that do not have EHR.

Figure 3-d clearly shows that 73.3% of the sample who responded to the study hold a bachelor's degree in computer science, 19.2% a master's degree and 7.7% a doctoral degree. These results confirm once again that the health sector has the scientific and technical personnel ability to develop the EHR and improve healthcare.

It can be observed as in Figure 3-e that 46.2% of the respondents are heads of computer departments in health institutions, as well as the same percentage 46.2% of respondents are managers of health institutions, and this matches the importance and accuracy of the information that can be obtained about EHR for this study.

Figure 3-f indicates that 46.2% of EHR technology used is one or more products developed internally, and 38.5% is a combination of ready-made products and internally developed. That means that there are different groups of health systems technology. Consequently, there may be incompatibilities between these different systems, as well as non- interoperability between these systems.

D Analysis of Checklist Paragraphs

The cross-tabulation is used to analyze the paragraphs of the checklist's dimensions, where cross tables are appropriate to the analysis of this kind of data, which consists of dichotomies.

Dimension One: The capabilities of the current EHR

Table 7 summarizes the analysis result of the first dimension. It indicates, for example, the sum of those agreeing to paragraph No. (2) "It is possible to order medical checks and follow up laboratory results through EHR" is 91.7%. This means that radiology, medical and laboratory examinations are conducted and followed widely on most health institutions, through the EHR. This occurs in most health facilities separately, and not between them through an international, regional, or even local network. This answers the first question of this research, about the capabilities of the electronic health record for hospitals and clinics in the Gaza Strip.

The same result is obtained where the total of those who agree with the paragraph (7) is 12.5% that says "Patient allowed to access his health record electronically or share it with other specialists in the patient's case". Therefore, this indicates that the patient cannot share or view his EHR through the Internet. Here, blockchain technology can greatly help to connect health institutions and stakeholders, especially patients, so patients can view their data on the health record.

Respondents to paragraph No. (8) report that 12.5% agree with this paragraph which says that "There is an alarm system in EHR when results for a medical analysis appear to need an urgent intervention". This indicates that the EHR in the health institutions has not an alarm system. Hence, there is an urgent need to use Blockchain technology to develop the use of the EHR, to provide true, accurate and up-to-date information anytime and anywhere for the patient through the EHR. Thus, the second and third questions in this study are answered about the capabilities of the electronic health record, and the capabilities and benefits of blockchain technology in the healthcare field, especially in the Gaza Strip.

TABLE 7
Results of Dimension One.

Paragraph	Governorate					Total
	Khan Younis	Gaza	North Gaza	Middle	Rafah	
(1) The EHR technology available operateerate according to a network in all hospitals and clinics.	8.3%	16.7 %	8.3%	8.3%	12.5 %	54.2 %
(2) It is possible to order medical checks and follow up laboratory results through EHR.	16.7 %	41.7 %	12.5 %	8.3%	12.5 %	91.7 %
(3) The EHR be used in the field of scientific research by extracting accurate statistics about diseases, their symptoms, and geographical distribution.	12.5 %	29.2 %	12.5 %	4.2%	8.3%	66.7 %
(4) It is possible to view (by specialists inside or outside the institution) the previous laboratory tests of the patient through HER.	20.8 %	41.7 %	12.5 %	8.3%	12.5 %	95.8 %
(5) Request radiology examinations and track results through the HER.	16.7%	41.7%	12.5%	8.3%	4.2%	83.3%
(6) Doctor allowed to monitor the patient's health record from his home or private clinic.	4.2%	8.3 %	8.3%	0.0%	4.2%	25.0 %
(7) Patient allowed to monitor his health record electronically or share it with other specialists in the patient's case.	0.0%	0.0 %	4.2%	4.2%	4.2%	12.5 %
(8) There is an alarm system in EHR when results for a medical analysis appear to need an urgent intervention.	4.2%	4.2 %	.0%	4.2%	0.0%	12.5 %
(9) The EHR have a warning system for communicable diseases in which the patient may have infected.	4.2%	4.2 %	.0%	8.3%	0.0%	16.7 %
Total	20.8 %	41.7 %	16.7 %	8.3%	12.5 %	100 %
Percentages and totals are based on respondents. Dichotomy group tabulated at value 1.						

Dimension Two: Challenges facing the use of EHR

Table 8 illustrates that phrase No. (1) which says "The current EHR technology meets the necessary requirements for entering all data", where, 45.8% of the respondents agreed to this phrase, as well as 29.2% of the previous percentage is for government supervision bodies and 16.7% for the private sector. This means that it must be ensured that the EHR has the capacity and competence to meet the basic needs in order to enter data correctly and accurately.

Phrase No. (5), which is "Is there a mobile application that allows monitoring of electronic health records (by the doctor, patient or family of the patient) or requesting medical examinations?", 29.2% agree on this phrase, all respondents are from government health institutions, and the percentage of respondents from private health institutions is 0%. There may be lack of clarity among respondents, as there is a special program for the Ministry of Health, but this program does not include functions for the EHR that can be viewed by the patient or doctor via the Internet.

Thus, it can be said that the healthcare system needs to develop a mobile program to enable patient stakeholders and doctors to view the patient's health record details according to the health law as well as the validity and privileges of each user. Here, the answer to the second and third question from the study is confirmed in terms of the capabilities of the EHR. The urgent need to use blockchain technology to link all governmental and private health institutions is also evident.

TABLE 8
Results of Dimension Two.

Paragraph	Supervision side		Total
	Governmental	Private	
(1) The current EHR technology meets the necessary requirements for entering all data	7	4	11
	29.2%	16.7%	45.8%
(2) The current EHR technology allows all patient necessary information to be recorded?	10	3	13
	41.7%	12.5%	54.2%
(3) Are there enough computers capable of achieving the required tasks?	8	7	15
	33.3%	29.2%	62.5%
(4) Are iPads available to follow- up the patient's case in the morning follow-up tour?	5	1	6
	20.8%	4.2%	25.0%
(5) Is there a mobile app that allows EHR to be monitored (by the doctor, patient, or patient's family) or to order medical tests?	7	0	7
	29.2%	.0%	29.2%
(6) Is a medical secretarial available for data entry?	11	8	19
	45.8%	33.3%	79.2%
(7) Are the necessary technical and medical cadres available to achieve, operate, monitor and maintain EHR?	11	8	19
	45.8%	33.3%	79.2%
(8) Do technical and medical cadres receive the necessary training to achieve, operate, monitor and maintain EHR?	10	7	17
	41.7%	29.2%	70.8%
Total	15	9	24
	62.5%	37.5%	100.0%

Dichotomy group tabulated at value 1.

Dimension Three: Adopting EHR technology on coding, user authentication, and EHR access.

Table 9 shows the important factors in the Dimension Three. Regarding Phrase No. (1) "Hospital has plans to adopt computer-assisted coding", total responses are 94.4% agreeing with the phrase, as hospitals responded by 50%, and the medical community 27.8%. This result is positive as it becomes clear that there is an awareness among the health institutions of the importance of developing performance by adopting the development of coding, user authentication, and EHR access. The rest of the phrase on this axis has very weak approval, and this indicates weakness or lack of access by external entities to the EHR. Thus, private hospitals, insurance companies, and patients are not able to access the health record. We have answered here the fourth and fifth questions of the study, in terms of the capabilities and benefits of blockchain technology that can link health institutions to each other, address the lack and problems that exist in the EHR, and allow patients, doctors, and stakeholders to access the patient's health record, Thus, making the patient at the center of attention of all health operations.

TABLE 9
Results of Dimension Three.

Paragraph	Institution level			Total
	Medical complex	Hospital	Clinic	
(1) Hospital have plans to adopt computer-assisted coding.	5	9	3	17
	27.8%	50.0%	16.7%	94.4%
(2) Hospital allow any outside entity (Such as private hospitals - insurance companies - patients) access to the HER technology.	0	2	0	2
	0.0%	11.1%	0.0%	11.1%
(3) Hospital establish unique user IDs to track outside entities' activity.	0	1	0	1
	0%	5.6%	0.0%	5.6%
(4) Hospital limit outside entities' access.	0	3	0	3
	0.0%	16.7%	0.0%	16.7%
(5) Are outside entities allowed access to patient's audit logs and metadata.	0	1	0	1
	.0%	5.6%	.0%	5.6%
Total	5	10	3	18
	27.8%	55.6%	16.7%	100.0%

Percentages and totals are based on respondents.
Dichotomy group tabulated at value 1.

Dimension Four: Audit log and metadata properties approved in the EHR.

Dimension Four scene is summarized in Table 10 to Table 12, where the most important paragraphs are presented in Table 10 and details of phrases No. (2) and (3) are illustrated in Table 11 and Table 12 respectively. For example, paragraph No. (3), which says that "Audit log include the following data" reveals that 50% of all respondents who agree to this paragraph are head computer departments. This clearly indicates the presence of highly qualified medical and technical cadres to deal with the EHR project.

Pargraph No. (4) "Internet Protocol (IP)/ Media Access Control (MAC) address" in Table 12 is one of the most important phrases. The approval rate of the computer department heads is 35.7%. Likewise, they are high in the rest of the paragraphs. This indicates the importance of the fourth-dimension data in terms of documenting the movement of access to EHR data. The same idea applies to paragraph (2) of Table 12. Paragraph No. (6) in Table 10 "Can the audit record be deleted?",

the total of those approving it is 14.3%. This percentage indicates that there is an important basis in maintaining the audit record from deletion or change, and this saves the patient's EHR from alteration and manipulation and thus protect the patient's rights. Thus, blockchain technology is needed to enhance the documentation of movement to access the EHR, where the patient's health information is provided through the EHR for both the patient, the doctor, stakeholders and society. This is the answer of the fifth question of this study.

TABLE 10
Results of Dimension Four.

Paragraph	Position			Total
	Head Computer Dept.	Dept. Director	Manager	
(1) Is there an audit record in the institution?	7	2	5	14
	50.0%	14.3%	35.7%	100%
(2) Audit log record the following event data *	7	2	5	14
	50.0%	14.3%	35.7%	100%
(3) Audit log include the following data **	7	2	5	14
	50.0%	14.3%	35.7%	100%
(4) Is the audit log operational whenever the EHR technology is available for updates or viewing?	5	1	4	10
	35.7%	7.1%	28.6%	71.4%
(5) Can the audit log be disabled?	2	2	1	5
	14.3%	14.3%	7.1%	35.7%
(6) Can the audit log be deleted?	1	0	1	2
	7.1%	.0%	7.1%	14.3%
(7) Can the audit log be edited?	4	2	3	9
	28.6%	14.3%	21.4%	64.3%
(8) Does the EHR technology allow the destruction of EHR audit log data or any other data according to the hospital's data retention policies?	0	2	2	4
	0.0%	14.3%	14.3%	28.6%
(9) Can the EHR technology produce a user friendly version of the audit log (i.e., a summary of audit data in a readable format or embedded in an electronic form) for transmitting, printing, or exporting?	5	2	4	11
	35.7%	14.3%	28.6%	78.6%
(10) Does any qualified or certified person in the hospital analyze the audit log data?	3	2	4	9
	21.4%	14.3%	28.6%	64.3%
Total	7	2	5	14
	50%	14.3%	35.7%	100%

Dichotomy group tabulated at value 1.
* Details are in Table 11
** Details are in Table 12

Dimension Five: Approved EHR technology features for patients' access to their data.

The important paragraphs in Dimension Five are shown in Table 13. Regarding the barriers, paragraph (4) "Concerns about the patient's security and privacy" indicates that 64.7% agree with this paragraph and consider it one of the most important obstacles in preventing patients from accessing their data through the EHR. of these, 17.6% are to the medical complex, 29.4% to the hospital and 17.6% to the clinic. This means that the issue of maintaining the privacy and security of patient information is a very important component, and must be addressed at the level of health laws, policies, and procedures before addressed on electronic health records. Also, paragraph (8) "Concerns with EHR system performance", 29.4% of respondents agree to this paragraph, out of this percentage 11.8% for medical complex, 17.6% for the hospital, and 0% for the clinic.

TABLE 11
Audit log record the following event data and position cross-tabulation

Paragraph Variable	Position			Total
	Head Computer Dept.	Dept. Director	Manager	
Each entry or access to the EHR.	6	2	5	13
	42.9%	14.3%	35.7%	92.9%
Signature event (the proactive or auto default completion of a patient encounter).	4	2	4	10
	28.6%	14.3%	28.6%	71.4%
Export of EHR document (printed, electronically exported, emailed).	4	2	4	10
	28.6%	14.3%	28.6%	71.4%
Corrections or modifications of data.	6	2	3	11
	42.9%	14.3%	21.4%	78.6%
Import of data.	6	2	4	12
	42.9%	14.3%	28.6%	85.7%
Disabling of audit log.	2	2	3	7
	14.3%	14.3%	21.4%	50.0%
Release of encounter for billing.	4	2	5	11
	28.6%	14.3%	35.7%	78.6%
Access by an authorized outside entity.	3	2	2	7
	21.4%	14.3%	14.3%	50.0%
Total	7	2	5	14
	50.0%	14.3%	35.7%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

TABLE 12
Audit log include the following data and position cross-tabulation

Paragraph Variables	Position			Total
	Head Computer Dept.	Dept. Director	Manager	
(1) Patient National Number (ID number)	7	1	5	13
	50.0%	7.1%	35.7%	92.9%
(2) Date/Time/User stamps.	7	2	5	14
	50.0%	14.3%	35.7%	100%
(3) Access type (creating, editing, viewing, printing, etc.).	5	0	5	10
	35.7%	0.0%	35.7%	71.4%
(4) Internet Protocol (IP)/ Media Access Control (MAC) address.	5	1	2	8
	35.7%	7.1%	14.3%	57.1%
(5) Network Time Protocol (NTP)/ Simple Network Time Protocol (SNTP) synchronized time.	5	1	1	7
	35.7%	7.1%	7.1%	50%
(6) Method of data entry (direct entry, speech recognition, automated, copy/import, copy forward, dictation).	3	2	3	8
	21.4%	14.3%	21.4%	57.1%
(7) Date/Time/User stamp of original author when data are copied.	5	2	3	10
	35.7%	14.3%	21.4%	71.4%
(8) Date/Time/User stamp of original author if data are entered on behalf of another (e.g., an assistant enters. clinical information for a physician).	3	2	2	7
	21.4%	14.3%	14.3%	50%
Total	7	2	5	14
	50.0%	14.3%	35.7%	100%

Dichotomy group tabulated at value 1.

This means 70.6% of the respondents do not agree with this paragraph, and they consider the performance of the EHR

system is good, but it may need improvement, and this is considered a strong point in the electronic health system.

As for the second part of Table 13, which talks about procedures to check a patient's EHR data, paragraph (2) "Verifying identity based on information an individual can verify (e.g., address, date of birth)", reveals that 91.7% of the respondents agreed to it. The distribution of this percentage is 29.2% medical complex, 50.0% hospital and 12.5% clinic. On the other hand, paragraph (3) "biometric identification", the percentage of approval of respondents is 12.5%. This means that the procedures used to verify the patient's EHR are the same as those in the old system, and these procedures and tools need to be developed to fit into the electronic health system.

This axis addresses the obstacles facing the EHR, which are the same obstacles that face the implementation of blockchain technology, which can be resolved by enacting laws and legislation and implementing measures that maintain the privacy and security of health information, also developing procedures for identifying the personality of the patient who is trying to access its own EHR and other procedures that enhance confidence in the EHR. Here, the answer to the third question of the study is emphasized.

TABLE 13
Dimension Five results

Barriers to patients accessing their EHR and Institution level Cross tabulation				
Paragraph	Institution level			Total
	Medical complex	Hospital	Clinic	
(1) EHR technology does not support access to their information.	4 23.5%	4 23.5%	0 .0%	8 47.1%
(2) Hardware does not support access to their information.	1 5.9%	3 17.6%	1 5.9%	5 29.4%
(3) Resistance by physicians to have patients access to their information.	0 0.0%	3 17.6%	2 11.8%	5 29.4%
(4) Concerns with patient security and privacy.	3 17.6%	5 29.4%	3 17.6%	11 64.7%
(5) Funding restrictions/additional costs to implement.	2 11.8%	3 17.6%	2 11.8%	7 41.2%
(6) Insufficient training on EHR technology.	2 11.8%	4 23.5%	2 11.8%	8 47.1%
(7) Inability to integrate with existing systems.	2 11.8%	3 17.6%	2 11.8%	7 41.2%
(8) Concerns with EHR system performance.	2 11.8%	3 17.6%	0 .0%	5 29.4%
(9) Hospital policy prevents such access.	1 5.9%	2 11.8%	1 5.9%	4 23.5%
Total	5 29.4%	8 47.1%	4 23.5%	17 100%
Procedures to check a patient's EHR data and Institution level Cross tabulation				
	Institution level			Total
	Medical complex	Hospital	Clinic	
(1) Photo identification.	1 4.2%	5 20.8%	0 .0%	6 25.0%
(2) Verifying identity based on information an individual can verify (e.g., address, date of birth).	7 29.2%	12 50.0%	3 12.5%	22 91.7%
(3) Biometric identification.	0 0.0%	3 12.5%	0 .0%	3 12.5%
Total	7 29.2%	14 58.3%	3 12.5%	24 100%
Dichotomy group tabulated at value 1.				

VII DISCUSSION

Based on the checklist results, there are some strengths at the current EHR in the Gaza Strip, which involves qualified medical and technical cadres, experience in the field of EHR that extends for many years, as well as the infrastructure of health systems from using computer technology and networks.

EHRs systems need to develop legislation, laws, and procedures in line with modern technology. Developing tools to improve the quality of health services through the use of blockchain technology to improve the use of the EHR by linking government and private health institutions to a unified network so that the patient can finally have permanent access to his medical data through the electronic health record anytime and anywhere.

Setting a roadmap to improve the performance of EHR using blockchain in the health sector in the Gaza Strip should include:

- Digitization of all health institutions, where it is found that there are some health institutions still operating on the basis of the paper system.
- Unifying medical terms by setting clear and specific

standards to achieve high efficiency in the performance of the EHR.

- Developing laws, legislations, and health procedures to suit modern technology and improve the performance of the EHR through blockchain technology.
- Ensuring that the current EHR meets all the requirements for entering the patient's medical and demographic data and health institutions. where there are no EHRs were designed to manage multi-institutional, lifetime medical records.
- Addressing issues related to patient information privacy and security.
- Connecting all health facilities to a unified network through blockchain technology to enable the patient, doctor and stakeholders to access the electronic health record anytime and anywhere.
- Improving the performance of EHR programs to deal with a large amount of health data, which is significantly enlarged.
- Developing and enhancing procedures to verify the identity of the patient who is trying to access his medical data through the EHR. In addition, enhancing public confidence in the electronic health record.
- Developing model to improve performance of the current EHR Gaza strip using blockchain.
- Developing software for mobile that allows the patient, doctor, and stakeholders to access the EHR anytime and anywhere.
- Setting a road map to awareness the public society and medical society the importance of EHR for the patient and all stakeholders. In addition, enhancing confidence in the information of EHR.

VIII CONCLUSION

This study shows that the use of EHR in the Gaza Strip is relatively recent, with 50% of respondents using the electronic health record 0-5 years ago. And it may not meet all the needs of patients in the health sector. It also reveals that there are number of health institutions that do not have EHR. The study also shows that 70.6% of respondents believe that the performance of the EHR system is good, but it may need improvement, and this is considered a strong point in the electronic health system. The procedures used to verify the patient's access to EHR are the same as those in the old paper system, and these procedures and tools need to be developed to fit into the EHR. The study indicates that the issue of maintaining the privacy and security of patient information is a very important component, and must be addressed at the level of health laws, policies, and procedures before addressed on electronic health records. It also illustrates that conducting radiology report, medical examinations and laboratory data follow-up on a large scale in most health institutions, through the EHR. This occurs in most health facilities separately, not between them through an international, regional, or even local network. This confirms the presence of important patient-specific medical data distributed among different and independent health institutions, as the patient does not benefit from it through the EHR that was designed on the basis of the paper-based medical system, and not on the basis of computer use. The study concludes that the patient cannot share or view the EHR online. Here, blockchain technology can greatly help connect health institutions and stakeholders, especially patients, so that patients can display their data in the health record. In addition to, there are different software for the EHR, which differ from one health institution to another, some of these software are ready-made, some are internally developed, and some are a mixture internally developed and ready-made, and thus, the problem of incompatibility between these programs, and the inability to interoperate between it. Therefore, the urgent need to use blockchain technology to solve these problems. EHR in health institutions do not have an alarm system when results for medical analysis appear to need urgent intervention. Consequently, there is an urgent need to use blockchain technology to develop EHR use, to provide true, accurate, and up-to-date information anytime, anywhere to the patient through EHR. The study shows that the health care system needs to develop a mobile program to enable stakeholders and doctors to view patient health record details in accordance with the health law as well as the validity and privileges of each user. Finally, it is concluded that there is a strong need for blockchain technology to link public and private health institutions to one another, address the deficiencies and problems present in EHR, and allow the patient, physician, and stakeholders to access the patient health record.

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Abdelkhalek I. Alastal was born in khan Younis City, Palestine, on the 10th of April 1964. He obtained a BA of Geography from Tanta University in the A.R.E in the year 1986. He obtained a MA of Geography and Information Systems from Islamic University in Gaza 2019. He worked as an IT spcialist, programer, IT coordinator and IT administrator in Faculty of Humanities and Social Sciences in U.A.E University since 1994 to 2012. He participated in the teaching of many courses such as; Hardware and Software Maintenance, Operating Systems (Mac & Windows), and Applications such as; SPSS and MS Office for faculty members, students and staff. In addition, he has many publications in refereed specialized journals. He also published a book entitled "Big Data in Smart Cities: Exploring Possibilities in Terms of Opportunities and Challenges" Published in "LAMBERT Academic Publishing" at 28 May 2020. Now he works in a research entitled "Big data for sustainable efficiency in advanced healthcare".

Raed A. Salaha had his Bc. Degree in Geography from King Suad University-Suadi Arabia Kingdom. He also obtaind his Master and PhD in Geography and Urban Planning from Research Instuitute-Egypet. Nowadays, Dr. Salha is associate professor of Geography and Urban Planning at Department of Geography and Information Systems, The Islamic University of Gaza as well as being the Dean of Faculty of Arts.

Maher A. El-Hallaq was born in Gaza City, Palestine, on the 29th of December 1967. He obtained a PhD of Surveying and Geodesy Engineering from Cairo University in the Arab Republic of Egypt in 2010. Currently, he works as an associate professor of Geomatics Engineering in the Department of Civil Engineering at the Islamic University of Gaza since 2010. He participates in the teaching of many courses such as; Surveying I, Surveying II, Geomatics, Engineering Mechanics: Statics and Dynamics, Global Navigation Satellite Systems, Geodesy, Remote Sensing Principles and Applications, Cartography, GIS/DSS of Infrastructure. In addition, he has many publications in refereed specialized journals and international scientific conference proceedings. He also published a book entitled "Map Comparison Using Template Image Matching Techniques". Dr. El-Hallaq is a consultant of many local municipalities and private agencies in the Gaza Strip. Nowadays, he is a member of "Geodesy" Committee of Geo-MOLG project, Ministry of Local Government. He is also a reviewer for ASCI-Surveying, JERT, IUG and other many Journals as well as being an editorial member of American Journal of Remote Sensing (AJRS).