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"Impact of Health Information System Downtime on the Delivery of Healthcare Services to Emergency Patients in Public Hospitals in the North of the West Bank"

By

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Declaration

The work provided in this thesis, otherwise referenced, is the researcher's work and has not been submitted elsewhere for any other degree or qualification.

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Dedication

To Allah, Lord of the worlds, my family, and everyone who helped me and believed in my abilities to achieve this degree.

Acknowledgement

In the beginning I thank Allah and praise Him in a manner that befits the (infinite) number of His creation, and as it pleases Him, for supporting me in the completion of this work.

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Abstract

Introduction

Most health institutions, especially governmental ones in Palestine, have recently adopted electronic health records (EHR), or what is known as the health information system (HIS). HIS regulates all medical and administrative procedures in hospitals, from patient registration, diagnostics, x-ray requests, laboratory tests, medicines, to meals, pricing, and more. Despite the great importance of shifting from a paper-based system to an electronic system, this system is subject to many challenges, especially as it depends on the computer network and the Internet. Avoiding HIS downtime is a primary concern of the hospitals.

Purpose of the Study

The purpose of this study is to evaluate "the impact of Health Information System downtime on the delivery of healthcare services to emergency patients in public hospitals in the north of the west bank".

Methods of the Study

The study was a cross-sectional study. The study included 4 governmental hospitals in the northern West Bank in Palestine. The study population consisted of124 employees, including 40 doctors and 76 nurses, in the emergency departments and 8 employees from the IT department of the four hospitals. Due to the small population size, the study sample consisted of all doctors, nurses and IT staff working in the targeted hospitals. In this study, a mixed approach (quantitative and qualitative) was used by designing two questionnaires, one directed to information technology employees and the other directed to doctors and nurses in the emergency departments. Data were analyzed using the IBM Statistical Package for Social Sciences (SPSS) version 25.

Results

One hundred and six out of 116 questionnaires were completed and returned to the researcher (response rate 91.38%). The results of descriptive statistics revealed that the downtime of the health information system affecting the workflow (mean=4.4490), increase crowding in the emergency department (mean=4.3367), causing a delay in requesting lab tests (mean=4.2551), causing delay in requesting the x-rays (mean=4.1633) and increase the length of a patient's stay in the emergency department (mean=4.0510). ANOVA test showed that there are statistically significant differences at the level ($p \leq 0.05$) in the average responses of the respondents about the extent of the impact of the HIS downtime on the health services provided to emergency patients due to the gender variable ($p=0.039$) and job title variable ($p=0.0303$).

Conclusion

The study found that the HIS downtime significantly affects the workflow and the provision of health services to patients. It emphasized the urgent need to adopt official plans and policies to deal with downtime and to train medical staff on that and sheds light on some of the reasons that increase the likelihood of downtime for HIS. Moreover, the study provided some recommendations to decision makers to help reduce the downtime of the HIS such as training the medical staff on how to deal with the downtime of the HIS, adopting the official downtime policy by the Ministry of Health and adopting a daily checklist for IT staff to ensure that the devices and various programs are working properly. More research is needed on the causes and effects of the downtime on data integrity and patient safety.

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List of Abbreviations

AAUP: Arab American University of Palestine

ADS: Automated Dispensing System

ADT: Acceptance, Discharge, and Transfer

ANOVA: Analysis of Variance

CIS: Clinical Information System

CPOE: Computerized Provider Order Entry

CRIS: Clinical Research Information System

CRT: Clinician Read Time

EDIS: Emergency Department Information System

EHR: Electronic Health Record

eMAR: electronic Medication Administration Record

EMR: Electronic Medical Record

HIS: Health Information System

IT: Information Technology

LOS: Length of Stay

LTAT: Laboratory Turnaround Time

MOH: Ministry of Health

NIH CC: National Institutes of Health Clinical Center

SAFER: Safety Assurance Factors for EHR Resilience

SPSS: Statistical Package of Social Science

UPS: Uninterruptible Power Supply

USAID: United States Agency for International Development

VPN: Virtual Private Network

Chapter 1: Introduction

Whether it is paper or electronic, the health record is vital to document all the medical services the patient receives from the first moment of his birth. Based on the information in the health record, the doctor makes essential clinical decisions. Through the health record, the quality and effectiveness of health care services provided by health institutions are evaluated. This data is also used in research and education, for example, to find out which diseases are most common in a particular country.

Previously, the medical record consisted of a set of papers inside a file used when the patient visits the clinic or when research is needed. These files are usually stored on the lower floors of the institutions. One of the significant drawbacks of paper records is that they are limited in terms of accessibility, and one doctor can read them simultaneously. Also, paper records suffer from a lack of security as unauthorized persons can access them, and the data that was viewed cannot be known (“Pros and cons,” 2019).

Most health institutions have switched from using the paper health record to Electronic Health Records (EHR), regardless of storing data in local servers or the cloud. The EHR provides access to a patient's health record by many healthcare providers from anywhere and anytime. Most EHR systems also support what is known as a Patient portal where everyone can view their medical data (Kent, 2019).

Although the health record is in the database of a specific medical institution, it ultimately belongs to the patient. A health record "is not just a collection of data that you guard - it is life". Therefore, health institutions must pay great attention to protecting patient privacy and preventing their data from being destroyed.

EHRs rely on the Internet to store and transmit data between the public hospitals, which may be subject to problems facing the Internet, that may lead to the stoppage of the computerized health system.

A health information system (HIS) or EHR regulates the procedures in hospitals and supports all hospital functions and activities such as patient registration, admission, accounting, inventory and administration. HIS designed to manage healthcare data. This includes sub-systems that collect, store and manage a patient's medical record. Because health information systems commonly access, process and maintain large volumes of health data, avoiding downtime is a primary concern ("What is a health information system," 2020).

The HIS implemented in 2010 in Rafidia hospital, which was the first public hospital, was transformed from a paper-based system into an electronic system. The digital system allows health workers to input, access, and track patient information more efficiently than the previous, paper-based system, resulting in improved quality of care for clients and greater accuracy, efficiency, and accountability for health workers.

The biggest problem in the health information system and electronic patient records is that computer systems and programs may not be available at all times. It depends on the computer networks' infrastructure and the computer itself; therefore, any failure in electrical power, operating systems, and network devices such as routers and switches and application and database servers may lead the system to stop working. Downtimes can also be planned when regular maintenance and updates to the HIS are performed (Fahrenholz et al., 2009).

Downtime events, particularly unplanned ones, can potentially impact patients' safety risks because the patient medical history that includes critical information such as

radiology and laboratory orders, which are very important and needed by doctors, is not available (Bowman, 2013). Many issues happen during partial or complete system downtime, such as delay in reporting the laboratory test results, failure to transmit x-ray images to the patient medical record, and duplication of medication orders (Wang et al., 2016).

“Downtime preparedness is essential to ensure patient safety and continuity of care when health information systems are impaired or completely unavailable.” (Kashiwagi et al., 2017).

The purpose of this study is to explore the effects of health information system downtime on health care services in emergency departments in public hospitals in the northern West Bank during partial or complete system downtime.

This study is based on a questionnaire filled out by the doctors and nurses who work in the emergency department. They are in direct interaction with patients and can assess the extent of the impact of the downtime on health services provided to emergency patients. A second questionnaire will be filled by the IT department's employees to examine the most important reasons that lead to downtime.

There is a lack of research conducted to evaluate the implementation of the health information system in Palestine and to identify the disadvantages of its disruption. The researcher decided to carry out this research to determine the impact of the health system’s downtime in emergency departments. Through this thesis, we will obtain scientific results about the causes of downtime and its impact on health care services which will encourage decision-makers to take appropriate procedures.

1.1 Statement of the Problem

The health information system constitutes a qualitative leap in inpatient care, as it worked to unify all medical procedures and achieve the greater goal of "one patient one record." However, the absolute dependence on the computerized system and the lack of alternative plans in the event of any problem, the system stops, may lead to delays in providing treatment to patients and following up on their health status.

The computerized health system network consists of a computer or laptop and its requirements from the user's side, servers that carry various applications, network switches, and routers in addition to internet and electricity lines. Therefore, any problem in one of them leads to a breakdown or slowdown in the HIS.

In the case of the emergency department, the HIS downtime and the inability of doctors to read the patient's medical records, in addition to other potential effects such as delayed arrival of the results of laboratory and x-ray examinations, delay in admitting patients to the hospital departments will have more significant risks for patients who need medical intervention and quick decisions.

1.2 Study Objectives

The main objective:

The purpose of this thesis is to explore the effects of Health Information System downtime on health care services in emergency departments in Public Hospitals in the Northern West Bank from the viewpoint of doctors and nurses by focusing on the problems that may occur during partial or complete system downtime and from the viewpoint of IT staff by determining the main causes of HIS downtime.

Secondary objectives:

1. Determine the availability of a hospital downtime plan, and whether the staff following this plan.
2. Examine the effect of socio-demographic characteristics on the extent to which the provided services are affected by HIS's downtime.

1.3 Research Questions

1. To what extent does the HIS's downtime affect the workflow, various health services such as x-rays, laboratory tests, medicines, and patient admission?
2. Is there a clear policy, procedures and plan to deal with HIS downtime, and are their implementation monitored and their terms updated?
3. Are medical staff trained in how to deal with patients during HIS downtime?
4. To what extent is the medical staff affected in providing health services in the event of the system downtime, according to socio-demographic characteristics?
5. To what extent do the technical measures in place affect the prevention of HIS downtime?

1.4 Research Expected Outcomes

At the end of this study, the researcher will be able to determine whether the system outages have a significant impact on healthcare services in emergency departments and what are the main reasons for the HIS downtime and how we can overcome these reasons. My recommendations will be technical and managerial.

1.5 Significance of the Study

After more than ten years of implementing HIS (Avicenna) at the level of governmental a hospital in Palestine, there is still a dearth of scientific research conducted to evaluate this system, highlight its advantages, and warn of defects that must be addressed. One of

these defects is system downtime, which frequently occurs from time to time, mainly due to problems with power outages, old computers and servers

Accordingly, the researcher decided to conduct this study to determine the impact of the disruption of the health information system on health services in emergency departments, to reach accurate results on this reality from the point of view of health service providers and to make recommendations to decision-makers in the Ministry of Health.

In Palestine, this is the first study that will examine the effects of health information system downtime on health care services in emergency departments in public hospitals in the northern West Bank.

1.6 Outline Structure of the Thesis

The arrangement of the thesis appears as the following:

-Chapter one includes a general introduction about the study, a problem statement, study objectives, research questions, research expected outcomes and significance of the study.

-Chapter two includes a literature review about HIS in Palestine, HIS advantages at emergency departments and HIS downtime worldwide. The researcher described the most relevant and significant publications regarding the topic, summarized their main points, discussed the gaps in researches, and evaluated the publication's contribution to the issue.

-Chapter three where the research methodology is presented, including study design, study setting, study population and sample size, study instrument, pilot study, reliability of the questionnaire, data collection, data analysis, scale correction, ethical considerations and study limitations.

-Chapter four in which the results are presented. This chapter includes respondents' characteristics and tables of percentages relating to questionnaire data, and offers studies that support the study's results.

-Chapter five in which discussion, the conclusion, recommendations, strength of the study and future work, are presented.

Chapter 2: Literature review

2.1 Introduction

Technological advancement has brought an evolution in every sector, making the management process speedy and seamless, serving more people worldwide. The healthcare sector is no exception. The arena of healthcare informatics, combined with healthcare data, information technology, and business, has gained a huge boost from technology. Health Information System (HIS) is such a technological boon for the health industry, helping the management of healthcare data with utter efficiency. The implementation of this system helps in improving the quality of patient care, reducing operational costs, making administration data error-free and shaping the entire internal management process more organized ("What Is Health Information System & Its Importance," 2020).

In this chapter of the study, health information system in Palestine and HIS advantages at the emergency department will include. This chapter also shows the literature concerned with the impact of the health information systems downtime on healthcare services in health facilities worldwide.

2.2 Health Information System in Palestine

The traditional paper health record is being replaced by the electronic health record in many hospitals worldwide. EHR is a digital record for an individual that includes all patient information such as health problems, diagnoses, vital signs, medications, previous medical and surgical history, demographic information, billing information, radiology reports, laboratory data, etc.

In September 2011, an EHR application known as Avicenna Hospital Information Management Platform was implemented with USAID funding at Rafedia Hospital

(Salameh et al., 2019). After being approved in this hospital, it has been implemented in more than 13 Palestinian government hospitals. The application field has also expanded to include several health directorates and clinics. This system worked to standardize medical procedures, diagnostics and create a single electronic file for each patient. It also organized the work of all administrative, financial, and medical hospital departments. This system is considered one of the most successful in the Palestinian health sector due to the significant advantages it added to hospitals mainly. However, the most critical point is that this system depends on a technological infrastructure of computers, network devices, and servers, and this all requires continuous development. This development, in turn, requires the allocation of large sums of money for this purpose to avoid the downtime problems that have increased in recent times, especially after the cessation of financial support by USAID.

Figure 2.1 below demonstrate the Avicenna HIS network structure for the four hospitals and datacenter.

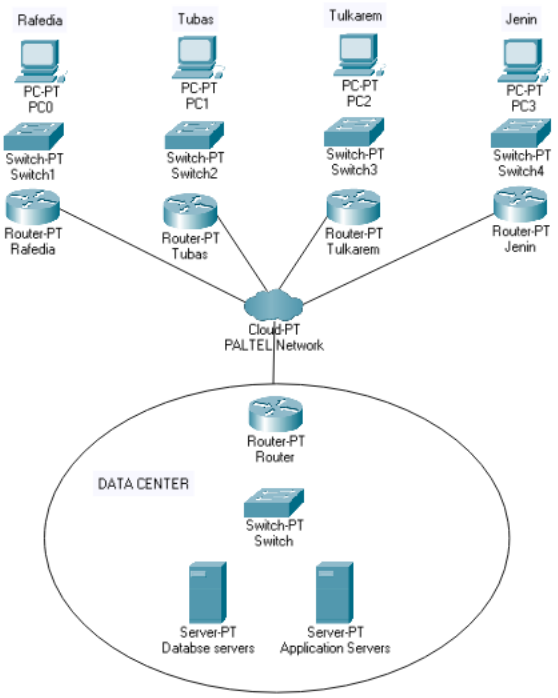

Figure 2. 1, Avicenna HIS network structure

2.3 HIS Advantages at Emergency Departments

The use of medical information from the health information system has been associated with improving health care in general and in the emergency department. The use of essential medical information such as medical history, laboratory tests, and x-rays has had a strong relationship with making decisions regarding admission to hospital departments or discharges from emergency.

The results of one study show that the ability to access patients' medical history via an electronic health record, including information about diagnoses, medications, laboratory tests, and x-rays, is critical to forming an appropriate care plan and ultimately making more accurate decisions (Ben-Assuli et al., 2014).

“Electronic health records (EHR) enable the electronic transmission of health-related information between points of care” (Fontaine et al., 2010). The emergency department is the main gateway to patient care, where physicians need information about patients' past medical treatment as well as information about current immediate symptoms.

Research has shown that medical care is more efficient in many ways when implementing an EHR system. These include reducing antibiotic use, increasing diagnostic accuracy and reducing patient mortality (Faisal et al., 2013).

2.4 HIS Downtime Previous Studies

In recent years, health institutions' dependence on information technology has increased. Despite the many advantages of information technology and computerized health systems in organizing medical procedures and standardizing patient medical records, making patient care safer and more efficient, the interruption of these systems may threaten patient safety (Menon et al., 2014). Regardless of the health institutions' reliance on technological systems, these institutions need to ensure patient care

continuity. Availability and familiarity with an IT outage plan across organizations are vital to maintaining business continuity and patient care services (Kashiwagi et al., 2017).

Kashiwagi et al. (2017) described the usage of an IT outage toolkit for a health institution, which guides the process of developing a downtime plan and designing, implementing, and evaluating downtime drills in the organization's various departments. This study was carried out at a large academic institution in the Midwestern United States, where a specialized committee was formed to unify preparedness and response in computerized health systems downtime to ensure continuity of care and patient safety during the outage of any clinical system. The approach was to build on current processes and resources, support the emergence of actionable IT outage plans and establish a plan for tracking outage drills while ensuring compliance with The Joint Commission and the Health Insurance Portability and Accountability Act (Kashiwagi et al., 2017).

As a result of the committee's efforts, a clear policy was approved to prepare healthcare personnel to support patient care in the absence of electronic health records, including requirements for exercises to test the effectiveness of the downtime plan. A toolkit has been developed to provide the leadership with the resources to develop an outage plan and implement and evaluate outage drills in their work area. Once the downtime toolkit was available, work area assessments of both actual IT downtimes and downtime drills were reviewed. The most frequently reported areas for improvement by self-report are located key system downtime forms. The staff knew who was responsible for restocking system downtime forms or equipment and, by the audit, locating IT Outage Plan and locating key system downtime forms. The importance of self-report and external audits

of downtime exercises helped identify performance gaps and gaps in downtime plans (Kashiwagi et al., 2017).

Chen et al. (2017) examined the downtime events that were recorded by the hospital's IT department from February 2010 to October 2012. The purpose of the study was to find out the causes and patterns of IT system downtime in a hospital. This study was conducted in a teaching hospital that has an electronic medical record in Australia. A total of 129 events related to the downtime of the electronic medical record were analyzed. The analysis included a descriptive analysis in determining the patterns of downtime events such as the distribution of downtime by day, day of the week, and affected areas. Also, the causes of downtime were examined by identifying keywords in the event descriptions such as router, virus, electricity. Accordingly, the reasons were grouped into four main categories network issues, power outage, software, and others (Chen et al., 2017).

As a result of the downtime events, the IT systems did not function optimally or were not available to physicians for a total of 5.1 days over 33 months. On average, the hospital experienced 49 hours of downtime per year. Regarding the causes, computer network issues were the most common ones, e.g., inability to access servers, database networks, and virtualization services. Then, power outages problems such as major supplier power cuts, failure of backup power supplies, and human errors. Power outages affect the computer and network devices, which need to be restarted, reprogrammed, or replaced. Finally, software problems, most of the problems are security reasons, such as firewall malfunctions, program bugs, and computer viruses. Examples of other downtime events are card system failure and air conditioning failure (Chen et al., 2017).

It is worth noting that several areas were affected due to power failure and network problems, which indicates the importance of re-evaluating and designing the network. Events are detected either by users who notice performance problems while using the electronic medical record system or by IT staff using monitoring systems. However, these systems have limited capabilities to discover complex problems arising between components of information technology systems. Therefore, more robust methods are needed to promptly detect and respond to downtime before it disrupts care delivery and harms patients (Chen et al., 2017).

After a series of downtime events at the medical center in the early 2000s, it resulted in an inability to access patient records, laboratory reports, prescriptions, etc., for nearly three days. Accordingly, this study was carried out based on a survey to assess the impact of downtime on employees in the center, assess their familiarity with downtime procedures, and determine the current plan's adequacy. The survey results were used to reinforce the nursing downtime plan and identify areas for improvement for other departments (Nelson, 2007).

The survey results were used to create a clearly defined downtime plan. The Downtime survey indicated that the nursing department needs specific guidance on data that requires "back-charting" into a computer after a downtime. Downtime documentation guidelines have been developed to provide specific details about which data must be entered into the computer, who is responsible for entering the data, and which data can remain in the downtime flow sheet. The pharmacy's respiratory therapy and downtime policies have also been updated, and the policy format used by nursing staff is followed. Finally, the study confirmed that the downtime plan alone is not sufficient. "Downtime drills," such as evacuation drills during fires, must be implemented to include all

departments and employees. This proactive approach better prepares employees for downtime, both planned and unplanned (Nelson, 2007).

In the mid-Atlantic region of the United States, Larsen et al. (2018) examined the effect of downtime on the care process. The study aimed to determine the types of clinical processes such as ordering drugs and x-rays affected by the interruption of the electronic medical record by analyzing the reports of patient safety events. 76 Safety event reports directly related to the computerized health system's disruption were documented, analyzed, classified, and coded into categories related to clinical processes: medication, imaging, laboratory, etc. (Larsen et al., 2018).

The largest category of downtime is related to delays in the laboratory department. There were issues with labeling and tracking samples and a lack of continuity of patient identification from where the samples were collected to their laboratory delivery. These issues resulted in redrawing samples from patients and delays in reporting results. Medication problems were the second most common category. Medication problems included wrong doses and wrong medication. Also, incomplete information on order forms and difficulties in calculating the dose to be requested (Larsen et al., 2018).

Concerning radiography, there were difficulties in transferring the images to the electronic health record and delays in reporting the results to the physician in charge. Also, the downtime affects the patient's registration and thus all the services he should receive. Finally, doctors were unable to examine patients' medical history in the emergency department and were unable to verify whether patients had received the same drugs beforehand (Larsen et al., 2018).

An important finding of the analysis of patient safety event reports showed that work downtime procedures were either not followed or were not in place. Thus, there is a

need to develop downtime procedures and monitor their implementation by all hospital staff. Without implementing the downtime measures and without the evaluation and development of the procedures, these events will continue. Hospitals must take into account some things when developing a plan of procedures for downtime. Among them, hospitals must realize the importance of this plan and the excellence in its implementation regardless of the rarity of the downtime. The paper forms to be used during the downtime period must be tailored based on each department's needs and not just a hard copy of electronic records. They also have to overcome the challenge of a large number of x-rays and laboratory tests, as the downtime leads to a significant slowdown in its processing. The necessary mechanisms must be specified to transfer requests and results across hospital departments. Emphasis must also be placed on patient identification during all the procedures he needs in the hospital in all departments (Larsen et al., 2018).

The electronic health record consists of many integrated devices and programs from the main data center to the user in hospitals, and therefore any problem in any of these components will affect the entire process. One article reviewed the downtime of the electronic health record, called the Clinical Research Information System (CRIS) at the National Institutes of Health Medical Center (NIH / CC) in terms of describing the event, lessons learned, necessary improvements, and procedures and policies that should be followed if the downtime occurs in the future (Coffey et al., 2016).

On May 13, 2010, a sudden stop of the electronic health record resulted from a failure in one of the network devices, which caused damage to the primary databases and backups, which means that doctors will not have access to clinical information for all patients. However, the computer network environment is equipped with the latest

devices -a primary and secondary data center equipped with an excess of electricity, cooling systems, and high-bandwidth fiber communications- and the existence of a continuity plan. However, the plan did not consider the primary and backup database's failure, and there was no actual failover test for the remote storage area network. Finally, this article recommended the necessity of reviewing, developing, and circulating downtime policies and plans and conducting experiments to ensure that all staff is familiar with them. It also creates a downtime toolkit, a plastic storage box with volumes grouped by category (for example, orders, vital signs, and nursing notes) with appropriate forms for each category listed in the volumes. Besides, maintaining a robust infrastructure, ensuring high devices and systems availability, monitoring tools, and reviewing and testing procedures from time to time are keys to minimizing the probability of downtime (Coffey et al., 2016).

Hoot, et al. (2003) studied the various components of the health information system that contributed to the downtime of the information system in the emergency department and the frequency and length of the downtime during a study period of four months. A distinction is made between planned and unplanned downtime and complete and partial downtime. Overall system availability reached 97.0%. There were 54 complete system outages and 23 crashes. The maximum interruption period for an event was about 16 hours. Two reasons led to the most extended downtime: a worm attack worldwide and a power outage in the local electrical service. Also, the emergency department information system had some technical problems that caused 17 outages. The rest of the system failures are due to the Acceptance, Discharge, and Transfer (ADT) system, which feeds EDIS with patient registration information (Hoot et al., 2003).

There was no clear downtime plan to be followed by the emergency department staff, which led to their dispersion between downtime procedures and appropriate health service provision. In addition to the costs involved in downtime, such as the need for additional staff to re-entering medical notes into the electronic record, frequent system disruptions lead to decreased patient and employee satisfaction. Reducing the frequency and severity of system failure is a step towards the ultimate goal of improving patient care (Hoot et al., 2003).

The emergency department receives the most significant number of patients who need urgent care. It is also considered the main gateway to admission to other inpatient departments, leading to crowding. In general, crowding in the emergency department is associated with decreased medical care quality and possibly increased mortality. In southern Sweden, Wretborn, et al. (2019) assessed the effect of the electronic health record's downtime on the patient's length of Stay (LOS), occupancy rate, admission, and staff workload in emergency departments in 3 hospitals system failure extended to 96 hours (Wretborn et al., 2019).

The number of patients attending emergency departments did not change before, during, and after the electronic health records were disrupted, but the level of workload and congestion as measured by patient LOS and occupancy increased significantly. The author presented a set of recommendations, including the need for more employees when the system breaks down. Alternative systems that do not depend on electricity, such as a whiteboard, track patients and paper records based on a continuity plan. Also, institutions must rely on backup systems, and the network with all their devices must be designed to support redundancy. Finally, institutions must test any new updates to their

electronic systems in a virtual environment that does not affect the existing system (Wretborn et al., 2019).

In the mid-Atlantic, Larsen et al. (2019) assessed downtime effects in two hospitals, especially on the laboratory section. The total downtime resulted from the ransomware attack lasting for approximately 48 hours, followed by 48 hours of partial downtime. This study was characterized by being a hybrid of quality and quantity. Paper records of the downtime events were analyzed and compared to normal operations. Data on the arrival of samples to the laboratory, time to start testing, completion of the test, and time to report the result was reviewed, especially for samples from the emergency department due to the importance of completing them as quickly as possible. Interviews were also conducted with 17 hospital employees, who had experience with several downtime events (Larsen et al., 2019).

Larsen et al. (2019) found that downtime is detrimental to patient care in general. The time taken to reach the laboratory result increased by 20 minutes compared to regular operation and the delay in delivering the results manually to the doctor who requested the tests. The interviewees reported that during the downtime, the departments continued to request laboratory tests with the same momentum and were not aware of laboratory work's nature during the downtime, which indicates the existence of communication problems between the different departments. The nurses who were interviewed reported that they had not had any formal training on how to handle downtime and that they had relied on the nursing staff working before applying the electronic medical record. The interviewees made a set of suggestions to improve the downtime management, including the existence of a mechanism to notify the departments when an outage occurs in one or more departments, train and drill all the

staff on work procedures during the suspension period. Also, to reduce the workload of services that depend entirely on the health record and providing support staff to assist in non-clinical essential work, such as delivering paper lab results. Many of these suggestions fit with the general themes of SAFER guides (Larsen et al., 2019).

To understand the weaknesses in health information technology, prevention methods and increase the speed of response Lei et al. (2003) analyzed health information technology outages by studying articles and accident reports that are available to the public on the Internet in China. To reduce the risks of information technology outages, the importance of risk identification and risk assessments, and the necessity of having transparent and standardized contingency plans for all health institutions (Lei et al., 2013).

Most of the interruptions in the information technology systems occurred in the morning period. A final explanation has not yet been reached, but some signs indicate that work pressure on these systems increases in the morning period. Also, all upgrade and security patches take place after midnight, and thus the result of these updates appears the following day. Most of the health information technology interruptions were due to overload, whether on the computer network or the servers, due to the large volume of simultaneous connection and a large amount of stored and exchanged data. This indicates the need to re-evaluate the infrastructure and take into account future needs when designing (Lei et al., 2013).

The computerized health system is linked to many other systems, such as the municipality level's health insurance system. Therefore, the disruption of this system led to the disruption of many jobs in the accounting department. Therefore, there is a need for a continuation plan at the district level. Preparing specialized medical teams to work

during crises, training employees periodically to use paper-based systems, and developing post-crisis treatment mechanisms are part of the contingency plans that must be adopted to mitigate downtime's adverse effects. The results indicated that there is an urgent need to establish a systematic mechanism for health care institutions to document and report unplanned health information technology disruption events in order to enhance transparency and accountability and to provide unified mechanisms regarding the most effective prevention and emergency response practices (Lei et al., 2013).

Lee et al. (2009) examined the level of readiness of health information departments and other departments in Victorian public and private hospitals in the event of a system failure, to verify whether they had contingency plans to deal with internal disasters, identifying potential risks, availability of recovery plans and backup systems, and how to restore health information services after system recovery. Study data for this research project were obtained through a self-administered survey tool (Lee et al., 2009).

The majority of internal disasters were software failures, followed by fires, floods, and severe power outages. These disasters affected the operations of their health information systems. Approximately 65% of health information services in state hospitals have contingency plans for internal and external disasters, and another 16% have disaster plans. Backup systems represent an essential solution to preparing for possible internal disasters in large hospitals, especially backup for patient master index and medical records. The lack of standardized statewide preparedness procedures may cause particular concern in small hospitals in terms of disaster contingency planning, recovery plans, and resource allocation (Lee et al., 2009).

Wang et al. (2016) conducted a study in a 350-bed metropolitan teaching hospital in Australia to measure the effects of a computer system failure on clinical processes

associated with pathology testing and reporting results. The focus on pathology tests is that laboratories provide up to 80% of clinicians' information to make critical medical decisions, and IT use directly influences patient safety in this process. An identical condition control design was used to examine the effects of five downtime events over 11 months, ranging from 5 to 300 minutes. The four tests representing different laboratory workflows - potassium, hemoglobin, troponin, and activated fractional thromboplastin time exposed to downtime - were matched with tests during unaffected control periods by test type, time of day, and day of the week to measure delays and errors. Measures included clinician read time (CRT), laboratory turnaround time (LTAT), missed read rates, fruitless searches, duplicate orders, and missed test results (Wang et al., 2016).

Pathology tests and results for all admissions were extracted from the EMR between February 2011 and January 2012. For each test order, timestamps were available when a test was performed by the laboratory when results were posted and available, and reviewed by a clinician. If a clinician attempted to review a result before it was available, this was also recorded by the system and counted as a futile search (Wang et al., 2016).

The most prominent results reached were that the effects of downtime on clinician follow-up varied according to the type of IT problem. Lack of access to results reporting delayed clinician review of standard pathology tests, including potassium and hemoglobin. Compared to control periods, the time taken to review tests was up to six times longer. Finally, the study has demonstrated that a matched case-control design is feasible to measure downtime effects on delays and errors in clinical processes. The methodology has the potential to be applied to examine the effects of downtime in other

clinical processes where tasks are pre-defined and time stamped the EMR routinely captures clinical data. Clinician follow-up of test results was significantly delayed by downtime (Wang et al., 2016).

In the United States, Hanuscak et al. (2009) used a questionnaire consisting of three main sections, including demographics, the availability of different types of CIS in the hospital, and the potential effects of a CIS breakdown on drug safety. The study sample consisted of one participant from each of 78 hospitals in Ohio who were directly responsible for supporting and maintaining information-based technologies. The objectives of this study were to describe the causes of downtime for several types of ITs and to examine and categorize medication errors that were reported during downtime with respect to various hospital-based clinical information systems (CISs) and automated dispensing systems (ADSs), in which system malfunction and discontinuity at any point in the process of care delivery can place patients at risk or expose them to harm (Hanuscak et al., 2009).

The downtime was attributed to many factors, especially interface loss and malfunctions, software and hardware malfunctions, and upgrades. User error and inexperience were concerns with electronic medication administration records (eMARs) and others. The most severe medication error occurred when downtime events influenced eMARs because of eMARs inpatient care's significant role. Downtime events linked with eMARs often result in delayed access to patient records, which can ultimately compromise patient outcomes to varying degrees depending on patient acuity, omitted doses, duplicate therapy, and delayed therapy (Hanuscak et al., 2009). The researcher emphasized the occurrence of medication errors during CIS and ADS downtime despite the availability of backup systems and standard protocols to deal with

system downtime. The researcher also emphasized that efforts should be directed to reduce the frequency and length of downtime in order to reduce medication errors during this downtime (Hanuscak et al., 2009).

Because disruption of information systems is a global challenge facing healthcare organizations, regardless of whether downtime is planned or unplanned, patients' lack of essential health information requires alternative solutions. Bamdeg, J. & Schmidt, T. (2020) conducted a scoping review of how hospitals deal with unexpected downtime in hospitals. The study included 13 papers in the final analysis, and it was concluded that dealing methods could be grouped into three strategies. 1) Increasing communication, 2) Analog backup, and 3) Redundant systems. Since most coping mechanisms are associated with increased communication and analog backup, the results indicated the importance of customizing coping mechanisms for individual healthcare institutions (Bamdeg & Schmidt, 2020).

Analog backup is the most prevalent coping mechanism. Some of the included work contains practical recommendations and reflections on the interplay between backup paper and EHRs. The study revealed that one of the reasons for the downtime is the increasing interconnectedness and complexity of information technology and the threat of cyber-attacks, which we have witnessed many of them in the past few years. Thus, health organizations should strive to enhance awareness of their employees' threats and behavior and have straightforward procedures and guidelines in place given the collapse of IT systems. The study concluded that there is a continued need for having backup systems to handle the lack of access to the IT systems and design IT systems that empower their end-users to deal with the lack of these same systems (Bamdeg & Schmidt, 2020).

Harrison et al. (2019) evaluated the impact of EHR downtime exposure on important patient-centered outcomes that lasting more than 60 minutes over a 6-year study period. The study included patients age 18 years or older who underwent surgical procedures at least 60 minutes in duration with an inpatient stay exceeding 24 hours within the study period at the Mayo Clinic in Rochester, MN. The integrated clinical information viewer, picture archiving and communication, and CPOE systems were the 3 most commonly affected applications. Multivariable regression analysis and trend analysis for the effect of duration of downtime on outcomes were performed. Downtime-exposed patients had operating room duration 1.1 times longer and postoperative length of stay 1.04 times longer than unexposed patients. The 30-day mortality rates were similar between these groups. That is means EHR downtime had no impact on 30-day mortality. Potential associations for the increased postoperative length of stay and duration of time spent in the operating room were observed among downtime-exposed patients. There was no association between duration of downtime in trend analysis concerning evaluated outcomes, postoperative length of stay, and 30-day mortality (Harrison et al., 2019).

The findings of Harrison et al.'s study can be attributed to several reasons. It is possible that these systems' unavailability, such as anesthesia information management system, could cause incomplete transfer of critical information between the operating room, post-anesthesia care unit, and hospital floors, leading to a delay in the appropriate diagnosis/or treatment (Harrison et al., 2019). Moreover, the Inability to access the imaging system could result in a prolonged surgical approach and/or inadvertent complication, such as bleeding from transecting an anatomically aberrant blood vessel, which could otherwise have been known and avoided. EHR applications contain an abundance of vital clinical information necessary for both the intraoperative and

postoperative surgical patients' care. It is possible that the unavailability of these systems could have adverse consequences. The findings of the study support the need to maintain updated contingency plans in the event of a downtime, as advocated at national levels—such as the SAFER Guides (Safety Assurance Factors for Electronic Health Record Resilience)—and institutional levels, where work-area–specific downtime preparedness plans must be implemented (Harrison et al., 2019).

Jenkis et al. (2020) conducted a study in the largest educational center and the largest tertiary care center (Hamad General Hospital) in the State of Qatar. The study aimed to investigate the implementation of EMR in the emergency department and to determine the frequency, duration and prediction of EMR downtimes. During the study period, 12 downtimes occurred, for a total of 58 hours. The incidence of EMR downtime was not associated with on-duty physician coverage levels, month, or clinical shift (morning, evening, or night shift). However, the occurrence of EMR downtime was statistically significantly associated with days of the week (Jenkis et al., 2020).

Larsen et al. (2021) study aimed to define design criteria (needs, obstacles and context considerations) for continuing safe and effective patient care activities during downtime. Interviewees were recruited in the emergency department and clinical laboratory of two hospitals who had recently experienced an unplanned downtime event requiring all computer systems to be shut down for several consecutive days. Interview transcripts from medical personnel with experience of downtime incidents were examined using a phenomenological approach. The results of the study indicated that the distribution of workload and communication is one of the important issues in patient care during the downtime period. There may not be an equal distribution of work, which leads to increased workload for some employees during the downtime. Some downtime

criteria have been identified as potential guidelines for developing better contingency plans for downtime (Larsen et al., 2021).

2.5 Summary of Previous Studies

Regarding the causes of downtime, and based on previous studies, computer network problems were the most common that led to the inability to access servers, database networks and virtualization services. Secondly, the problems of power outages, whether from the main supplier, generators or UPS, which affected servers, network devices, and computers that need to be restarted, reprogrammed or replaced. Thirdly, software problems, due to firewall malfunctions, program bugs, and computer viruses. Finally, it is worth noting that several areas have been affected due to power outages and network problems, indicating the importance of re-evaluating and designing the network.

The downtime of the health information system affects the care process in different hospital departments. The downtime in the laboratory section causes many problems, including problems in marking and tracking samples and delays in reporting results. Medication problems included wrong dose, wrong medication, and difficulties calculating the required dose. With regard to radiography, there were difficulties in transferring the images to the electronic health record and a delay in reporting the results to the doctor in charge. Also, during the downtime, doctors will not be able to access the patients' medical records, which affects treatment decisions.

There was a dearth of studies targeting emergency departments. These studies emphasized that the number of patients attending the emergency departments did not change before, during and after the disruption of electronic health records, but the level of workload and crowding as measured by the patient's length of stay (LOS) and the occupancy rate increased significantly. In general, crowding in the emergency

department is associated with decreased quality of medical care and possibly increased mortality. Downtime increases the length of stay after surgery and the length of time spent in the operating room among patients subjected to downtime.

Literature reviews emphasized the need to unify preparedness and response in the event of computerized health systems failure in all hospitals to ensure continuity of care and patient safety during any clinical system interruption. Availability and familiarity with an IT outage plan across organizations are vital to maintain business continuity and patient care services. Also, it is imperative to conduct a planned downtime test to see how far ahead and ready the crew is to deal in the event of unexpected downtime. Many studies recommended to develop downtime documentation guidelines to determine the data that must be entered into the computer, who is responsible for entering the data, and which data can remain in the downtime flow sheet. The paper forms that may be used during the downtime period must be tailored based on the needs of each department and not just a hard copy of electronic records.

Based on the findings of the previous literature, it is clear that the downtime period affects the health services provided to patients and may seriously affect patients' health. Therefore, the importance of this study highlights the necessity of assessing the causes and effects of downtime in government hospitals in the northern West Bank, especially in emergency departments.

Most internationally published research has discussed the effect of downtime on different hospital departments. However, it did not focus on the emergency departments and their specifics because of the severity of the cases and their need for rapid medical procedures. Also, there are no previous studies on this subject in the Arab world in general and in Palestine in particular.

2.6 Conceptual Framework of the Study

The conceptual framework created begins with the characteristics of the individual and the job (gender, age, job title, place of work, years of experience, and years of work in the hospital), as these characteristics affect how the health services provided by an individual will be affected by the time of the system downtime as shown in Figure 2.2 below. The workflow is affected, the congestion increases, and the various services in the emergency department are affected, as the results of laboratory tests and X-rays are delayed due to the downtime of the HIS.

The study has the following variables:

The independent variables were:

1. HIS downtime policies and procedures.
2. Training
3. Socio-demographic characteristics: gender, age, job-title, workplace, years of experience, years of work in hospital.

The dependent variable was:

Delivery of healthcare services to emergency patients.

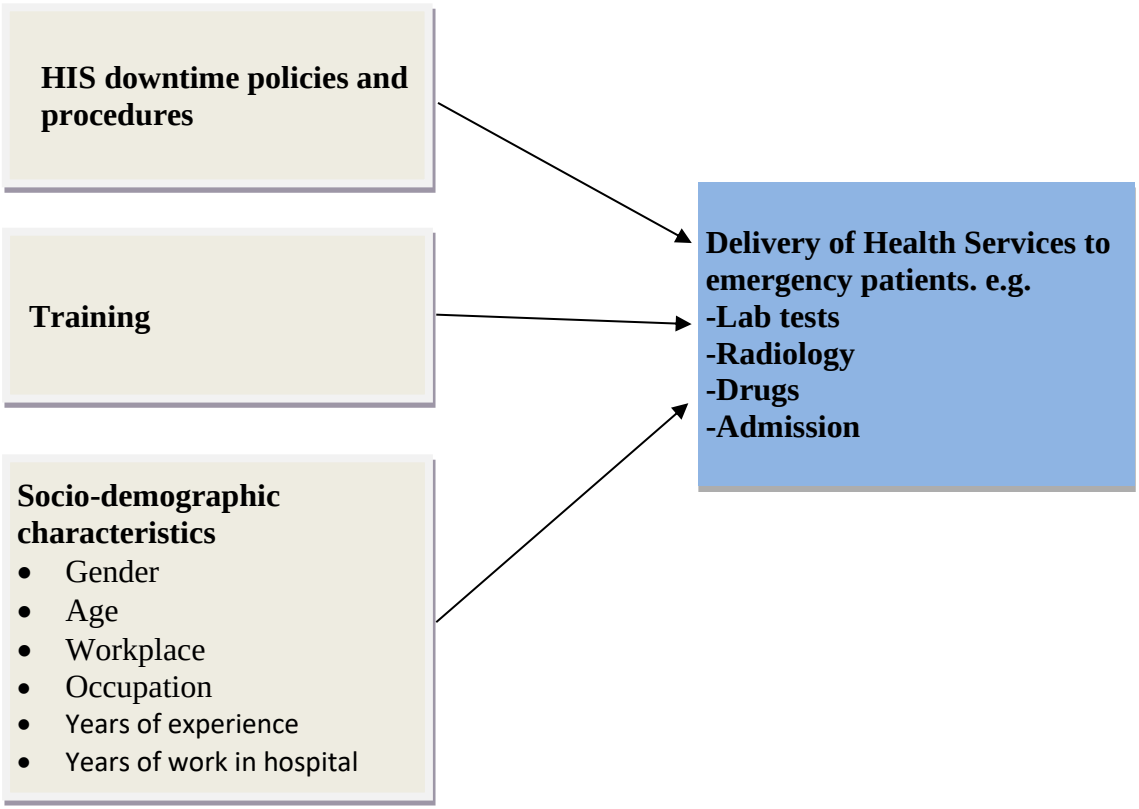

Figure 2. 2, Conceptual framework

2.7 Summary

This chapter included the HIS in Palestine and HIS advantages at the emergency department. It showed the research papers and studies related to the impact of the health information systems downtime on healthcare services in health facilities worldwide.

Chapter 3: Methodology

3.1 Introduction

In this chapter, the researcher presents study design, study setting, population and sample size, instrument, pilot study, data collection, data analysis method, scale correction, ethical considerations and study limitations.

3.2 Study Design

The researcher used a cross-sectional design by collecting data from several places simultaneously for conducting this study. The researcher used it because the cross-sectional studies capture a specific moment in time and take less time than other research types.

Also, the research approach was quantitative to gathering information focuses on describing a phenomenon across a larger number of participants, thereby providing the possibility of summarizing characteristics across groups or relationships.

Finally, the researcher also used a descriptive qualitative approach for this study.

3.3 Study Setting

The study included four governmental hospitals in the Northern West Bank, Rafidia Hospital, Tulkarm Hospital, Jenin Hospital, and Tubas hospital.

Rafidia Hospital & Jenin Hospital of the hospitals in which HIS has been applied for more than 5 years and Tulkarm Hospital and Tubas hospital of the hospitals in which HIS has been applied recently.

3.4 Study Population and Sample Size

The study population consisted of doctors, nurses and IT staff who work in the four government hospitals. Participation criteria include doctors and nurses working in emergency departments in the targeted hospitals and IT staff. The exclusion criteria

included doctors and nurses working in departments other than an emergency. Due to the small population size, the study sample consisted of all doctors and nurses working in the emergency departments of the targeted hospitals and IT staff working in the targeted hospitals.

The study targeted 116 employees, including 40 doctors and 76 nurses, in the emergency departments of the four hospitals. Also, 8 form IT staff who work in the 4 hospitals to explore the main downtime causes.

3.5 Study Instrument

In this study, a mixed approach (quantitative and qualitative) was used by designing two questionnaires: information technology employees and the other directed to doctors and nurses in the emergency departments. The questionnaire for IT employees mainly focuses on the downtime, the mechanism for designing the network, evaluation of the technologies used, and how to deal when the downtime occurs. The second questionnaire was distributed to doctors and nurses in the emergency departments. The main goal is to extract opinions about the possible effects of HIS downtime on the health services provided in the emergency departments, deal with the situation when the downtime occurs, are there written plans to be followed, and so on.

The first part of the questionnaire is concerned with collecting the demographic information -Gender, Age, Workplace, Education level, Occupation, Years of Experience and Years of work in the hospital- of the person completing the questionnaire without the presence of any item that might lead to the identification of the person's name. As for the second section, the questionnaire questions were in the form of a Likert scale from 1 to 5, where the number 1 represented a strong disagree and

the number 5 represented a strong agreement with the sentence as shown in Appendix A and Appendix B.

The second part of the questionnaire for doctors and nursing was divided into six sections: downtime policies and procedures, emergency relationship with laboratory, emergency relationship with radiology, drug request, patient admission, and training as shown in Appendix A. The second part of the questionnaire for IT employees was divided into IT procedures, training, downtime policies, and procedures as shown in Appendix B.

The third part was general questions that allow a person to write his own opinion and suggestions for evaluation and improvement, frankly and objectively.

The items in the second and third sections were chosen based on many literature reviews focusing on the most important axes, which are the reasons for the occurrence of downtime, the effect of downtime on health services, procedures during downtime, downtime plan and training plans for employees in addition to safer guidelines related to sound procedures to reduce the likelihood of downtime occurring or reducing the consequence if downtime occurs.

The questionnaire questions were prepared based on the literature reviews carried out by the researcher. It was prepared in the English language and then translated into Arabic by a subject-matter expert who has a high level of English and his mother tongue is Arabic.

Then, all questions were discussed with the supervisors. After that, the questionnaire was distributed to a number of experts to validate it, and based on their observations, the researcher modified some of the questions.

Due to the small sample size the questionnaire was distributed on paper to all IT employees, doctors and nurses working in the emergency departments of the four hospitals under study. Persons were asked to fill out the questionnaire within a week and deliver the questionnaires to the head of the Emergency Nursing Department.

3.6 Pilot Study

The researcher conducted a pilot study by distributing the questionnaire to a group of people from the IT staff and the medical staff (doctors and nurses), and the results were analyzed to ensure their suitability for the statistical significance of Cronbach alpha. The reliability of the final version obtained after the translation process was further checked on 30 participants by Cronbach's alpha through the pilot study. Cronbach's alpha coefficient were 0.91, which is highly reliable, and the questionnaire was approved to be used in the study.

The piloting was carried out on 25.8 % of the sample size directly after got the ethical approval from the MOH and before the data collection phase. Therefore, 30 employees who met inclusion criteria were randomly selected to check the study questionnaire. The purpose of the pilot study was to assess the feasibility, clarity and ease of reading of the questionnaire items, and to know the average time required to complete the questionnaires. Participants in the pilot study indicated that they had no problem understanding or interpreting the questionnaire items. The pilot study found the average time to complete a questionnaire was 8 minutes. The results also showed that the analysis approach was practical, and did not interfere with the steps.

3.7 Reliability of the Questionnaires

The researcher calculated the reliability using the internal consistency method and calculated the Cronbach Alpha reliability equation, as shown in Table 3.1 below.

Table 3. 1, Reliability Statistics for Questionnaires

Type of questionnaire	**Cronbach's Alpha**
doctors and nurses' questionnaire	0.873
IT staff	0.927

The data presented in Table 3.1 indicate that the value of the reliability of the questionnaire for doctors and nurses at the total score reached (87.3%) and the reliability of the questionnaire for IT employees at the total score reached (92.7%), and thus the questionnaires have a high degree of reliability and is subject to dependence to achieve the study objectives.

3.8 Data Collection

After completing the pilot study and obtaining the necessary approvals to start collecting data, the researcher contacted Personnel Affairs to take a list of doctors and nurses working in emergencies. The researcher also contacted the heads of nurses in the emergency departments and explained the purpose of the study and the importance of answering the questionnaire objectively and transparently. The researcher distributed the questionnaire manually to the nurses and doctors, stressing that the nurse or doctor has the right to refuse to participate. The researcher started with Rafidia Hospital since it is the largest hospital, then Jenin Hospital, Tulkarm Hospital, and Tubas Hospital. The researcher was present in all shifts in order to be able to reach all the target groups, as some nurses only attend the night shift. The answers to the questionnaires were kept in a private place, and none of their managers knew the employees' answers. The researcher did not grant permission to anyone to access the completed questionnaires after entering them in SPSS.

3.9 Data Analysis

Data were analyzed using the IBM Statistical Package for Social Sciences (SPSS) version 25. Descriptive analysis of all the questionnaire variables was performed where the frequencies, percentages, means, and standard deviations were calculated. The Pearson's correlation coefficient was measured to find any significant relationship between the health information system's disruption and patients' health services in the emergency department. Analysis of variance (ANOVA) and Independent - Samples T-Test were also performed to verify whether there was a difference in the impact of the computerized health system downtime on health services in the emergency department - from the viewpoint of those who filled the questionnaire - due to the difference in socio-demographic characteristics.

3.10 Scale Correction

The five-point Likert scale was used, which is a method for measuring behaviors and is used in questionnaires, especially in statistics. The scale is based on responses indicating the degree of approval or objection. Then the average is calculated to determine the degree of the impact of the computerized health system stopping the health services provided to patients in the emergency department from the viewpoint of doctors and nurses. The following levels have been adopted:

Very low, Low, Moderate, High and very high as shown in Table below 3.1

Table 3. 2, The levels of respondents' answers to the questionnaire questions based on the mean.

Level	Mean
Very low	1.00 – 1.80
Low	1.81 – 2.60
Moderate	2.61 – 3.40
High	3.41 – 4.20
Very high	4.21 – 5.00

3.11 Ethical Considerations

The researcher obtained permission from the Ministry of Health to distribute the questionnaire to workers in government hospitals affiliated with the Ministry of Health as shown in Appendix D, as this was indicated in the consent form on the first page of the questionnaire. It was indicated in the consent form that the study aimed to measure the impact of the health information system (HIS) downtime on health services provided to emergency patients in government hospitals in the northern West Bank in order to complete a master's thesis in health informatics at the Arab American University. The researcher emphasized that participation in the study is optional, and the participant has the right not to answer any question he does not want to answer. It has also been emphasized that the researcher will not use this data except for scientific research purposes. It was clarified that the responses to the questions requested in the questionnaire will be dealt with complete and absolute confidentiality, and the responses will not be known to anyone outside the research team, and they will not be disclosed to anyone within the Ministry of Health, and no information in the questionnaire that identifies the person will be requested.

3.12 Study Limitations

- The main limitation of our study is the lack of adequate time to collect more data and analysis due to the Covid-19 pandemic. The sample size was all population's size, which required a large amount of time to collect the data.
- Due to limited sample size, our study was not representative of the entire Palestinian hospitals. Thus, we cannot generalize our results to all hospitals in Palestine.

3.13 Summary

This chapter presented the methodology of the study that is implemented to conduct the study by describing the different ways and tools used to accomplish this study. It included study design, study settings, Study population and sample size, study instrument, pilot study, data collection, data analysis method, scale correction, ethical considerations and study limitations.

Chapter 4: Results

4.1 Introduction

This chapter deals with analyzing the data collected through questionnaires. Statistical methods allow the researcher to analyze, interpret and conclude after converting the digital data into useful information that can be used to provide answers to the study questions. The data analysis methods depend on the type of study, the data collection methods, and the research questions to be answered. In this chapter, the researcher analyzes, schedules and interprets the data collected to get results.

The following sections will be presented: Response rate, Participation's characteristics, Descriptive statistics of the second part of the questionnaire, Relationship between HIS downtime and socio-demographic characteristics and Results of general questions (PART3)

4.2 Response Rate

4.2.1 Questionnaire for Doctors and Nurses

The study sample consists of all doctors and nurses working in the emergency departments of 4 governmental hospitals in the northern West Bank in Palestine. 98 out of 116 questionnaires were completed (response rate 84.48%).

4.2.2 Questionnaire for IT Staff

The study sample consists of all IT staff working in the 4 governmental hospitals in the northern West Bank in Palestine. 8 out of 8 questionnaires were completed (response rate 100%).

Based on previous researches, response rates must be higher than 60% so that the response rate in this study was very good, and therefore the results will be reflected on the study population (Fincham, 2008).

4.3 Participants' Characteristics

4.3.1 Questionnaire for Doctors and Nurses

The results as shown in Table 4.1 and Figure 4.1 below showed, with regard to gender, that most of the study participants were males, numbering 68 people, who accounted for 69.4% of the total participants. As for age, the majority of the participants were from the age group less than 30 years (45.9%), followed by the age group between 30-40 years (38.8%), and the lowest percentage was for the age group greater than 50 years (5.1%). Moreover, 42 of the study participants were working in Rafidia Hospital (42.9%), 26 were working in Jenin Hospital (26.5%), 22 in Tulkarm Hospital (22.4%), and finally 8 at Tubas Hospital (8.2%).

The majority of the participants were nurses (64.3%) and doctors (35.7%). With regard to the level of education, the study showed that the largest percentage of the participants hold a bachelor's degree (77.6%), followed by holders of a diploma (15.3%) and finally those with a doctorate (3.1%). As for years of experience, the majority of study participants had less than 5 years of experience (50%), followed by those with 6 to 10 years of experience (18.4%) and finally those with more than 15 years of experience (16.3%). As for the years of work in the hospital, the majority of the study participants worked for less than 5 years (50%), then came the participants who worked in the hospital between 6 to 10 years (18.4%) and finally those who worked for more than 15 years (16.3%).

Table 4. 1, Socio-demographic characteristics of nurses and physicians.

Characteristics		Frequency	Percentage (%)
Gender	Male	68	69.4
	Female	30	30.6
Age	<30	45	45.9
	30-40	38	38.8
	41-50	10	10.2
	>50	5	5.1
Education level	Diploma	15	15.3
	Bachelor	76	77.6
	Master	4	4.1
	Doctorate	3	3.1
Workplace	Rafidia Hospital	42	42.9
	Jenin Hospital	26	26.5
	Tulkarm Hospital	22	22.4
	Tubas Hospital	8	8.2
Occupation	Doctor	35	35.7
	Nurse	63	64.3
Years of Experience	1- 5	49	50.0
	6-10	18	18.4
	11-15	15	15.3
	> 15	16	16.3
Years of work in the current hospital	1- 5	58	59.2
	6-10	18	18.4
	11-15	12	12.2
	> 15	10	10.2

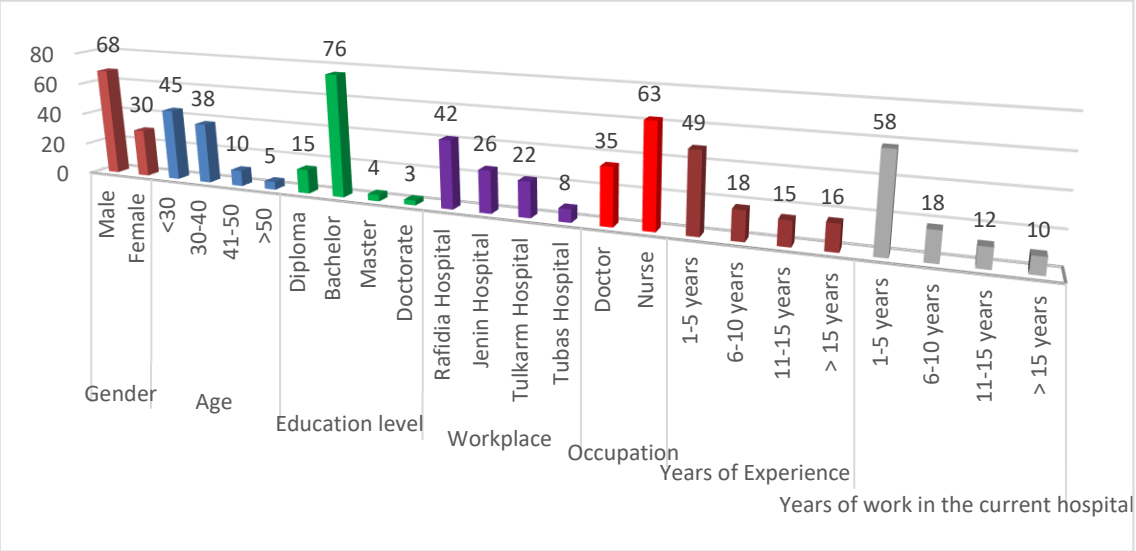

Figure 4. 1, Distribution of respondents (Doctors and Nurses)

4.3.2 Questionnaire for IT staff

The results as shown in Table 4.2 and Figure 4.2 below showed, with regard to gender, that most of the study participants were males, numbering 6 people, who accounted for 75% of the total participants. As for age, the majority of the participants were from the age group between 30-40 years (75%), followed by the age group between 41-50 years (25%). Moreover, 4 of the study participants were working in Rafidia Hospital (50%), 2 were working in Tulkarm Hospital (25%), 1 in Jenin Hospital (12.5%), and finally 1 at Tubas Hospital (12.5%).

The majority of the participants were programmers (62.5%) and engineers (37.5%). With regard to the level of education, the study showed that the largest percentage of the participants hold a bachelor's degree (62.5%), followed by holders of a diploma (37.5%). As for years of experience, the majority of study participants had experienced between 6 and 15 years (75%), followed by those more than 15 years of experience (25%). As for the years of work in the hospital, the majority of the study participants

worked for less than 5 years (50%), then came the participants who worked in the hospital between 6 to 10 years (25%) and finally those who worked for more than 11 years (25%).

Table 4. 2, Socio-demographic characteristics of IT employees.

Characteristics		**Frequency**	**Percentage (%)**
Gender	Male	6	75
	Female	2	25
Age	<30	0	0
	30-40	6	75
	41-50	2	25
	>50	0	0
Education level	Diploma	0	0
	Bachelor	5	62.5
	Master	3	37.5
	Doctorate	0	0
Workplace	Rafidia Hospital	4	50
	Jenin Hospital	1	12.5
	Tulkarm Hospital	2	25
	Tubas Hospital	1	12.5
Occupation	Engineer	3	37.5
	Programmer	5	62.5
Years of Experience	1- 5	0	0
	6-10	3	37.5
	11-15	3	37.5
	> 15	2	25
Years of work in the current hospital	1- 5	4	50
	6-10	2	25
	11-15	1	12.5
	> 15	1	12.5

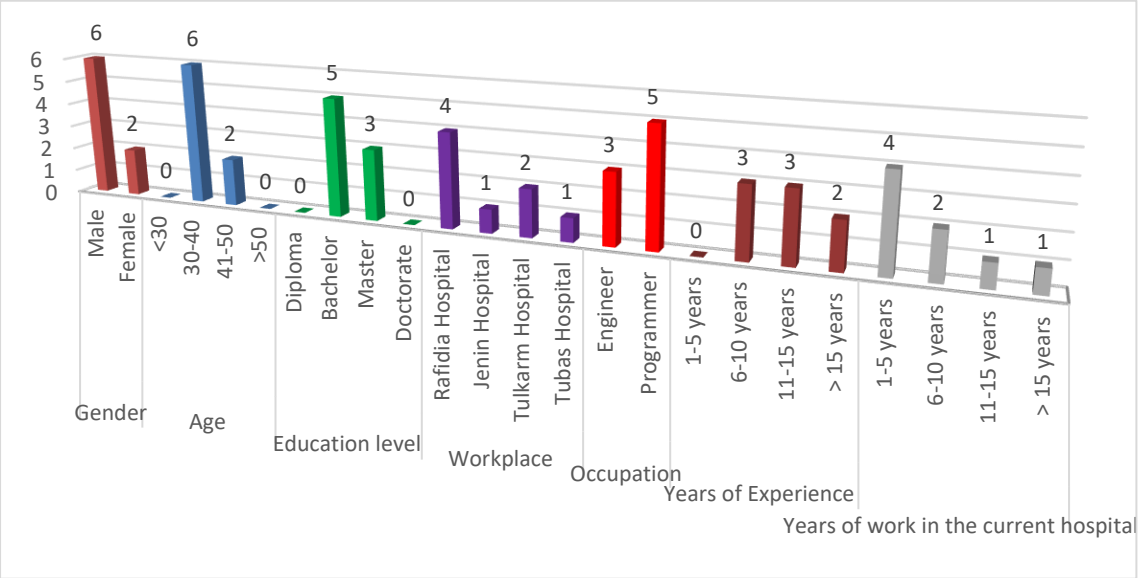

Figure 4. 2, Distribution of respondents (IT staff)

4.4 Descriptive Statistics of the Second Part of the Questionnaire

4.4.1 Questionnaire for Doctors and Nurses

The second part of the questionnaire for doctors and nursing was divided into 6 sections which are downtime policies and procedures, relationship emergency with laboratory, relationship emergency with radiology, drug request, patient admission and training.

The overall median score for all sections as shown in Table 4.3 below was (3.355) with a mean score (3.356) and standard deviation (0.415).

The descriptive statistics of the section as shown in Table 4.3 below, each section separately, are as follows: The median score for downtime policies and procedures section was (3.225) with a mean score (3.1806) and standard deviation (0.47356). The median score for the relationship between emergency department with laboratory section was (3.428571) with a mean score (3.446064) and standard deviation (0.546690). The median score for the relationship emergency with radiology section was (3.5) with a mean score (3.589286) and standard deviation (0.606292). The median

score for the drug request section was (3.5) with a mean score (3.538265) and standard deviation (0.790856). The median score for the patient admission section was (4.0) with a mean score (3.806122) and a standard deviation (0.768694). The median score for the training section was (2.625) with a mean score (2.579082) and standard deviation (0.872398).

Table 4. 3, Median, Mean and Standard deviation for sections

Section	**Median**	**Mean**	**Standard deviation**
Downtime policies and procedures	3.225	3.1806	0.47356
Relationship emergency with laboratory	3.428571	3.446064	0.546690
Relationship emergency with radiology	3.5	3.589286	0.606292
Drug request	3.5	3.538265	0.790856
Patient admission	4.0	3.806122	0.768694
Training	2.625	2.579082	0.872398
Overall sections	3.355	3.356	0.415

Table 4.4 below showed descriptive statistics for every item in the questionnaire sections of part 2.

Table 4. 4, Descriptive statistics for every item in the questionnaire sections of part 2.

Descriptive Statistics (Policies and Procedures)			
	N	Mean	Std. Deviation
The downtime of the health information system affects the workflow	98	4.4490	.93194
The HIS downtime increases crowding in the emergency department	98	4.3367	.94098
The HIS downtime increases the length of a patient's stay in the emergency department	98	4.0510	1.15207
Ensure that patients' vital signs are entered after returning the health information system	98	3.6735	1.04315
Make sure to enter doctor notes after returning the health information system	98	3.6122	1.02175
The downtime of the health information system affects	98	3.6020	1.20771

patient safety			
Medical data is recorded on paper during the downtime	98	3.5918	1.16510
Power outages are among the main reasons for the disruption of the health information system	98	3.4388	1.31656
There are obstacles in communicating with other departments during the downtime	98	3.2041	1.22650
TOTa	98	3.1806	.47356
There is a clear procedure for re-entering medical data into the health information system when it returns to work	98	3.0816	1.08098
The lack or errors of medical data are investigated, and the causes reviewed	98	2.9286	1.01788
Unplanned downtime and preparedness are treated like any other emergency	98	2.7959	1.06451
There is a communication and communication strategy between departments when downtime occurs	98	2.7551	1.14028
Lessons are learned after the hiatus has occurred to identify issues that need to be addressed in future training or policy adjustments	98	2.7245	1.11947
Medical staff are notified of planned system downtime	98	2.7041	1.24527
The missing medical data during the downtime of the health information system is reported to the Quality Manager and appropriately documented as per the system	98	2.6735	1.03322
The downtime handling policy is reviewed and updated at least every two years	98	2.6224	.97933
The hospital has a written and approved policy and procedures to deal with the downtime of the health information system	98	2.4796	1.08627
There is a certain mechanism in place to notify the medical staff when the system returns to work	98	2.4694	1.14157
There is a quick notification system in place to notify medical staff of unplanned system outages and alert staff to affected systems	98	2.4184	1.11155
Valid N (listwise)	98		

ToTa: The arithmetic mean of the respondents' answers to the first section questions

Descriptive Statistics (relationship emergency with laboratory)			
	N	Mean	Std. Deviation
There is a delay in requesting lab tests during the HIS downtime	98	4.2551	.88878
There is a delay in obtaining the results of laboratory tests during the HIS downtime	98	3.8469	1.02898
TOTb	98	3.4461	.54669
The doctor will only request necessary laboratory tests during the HIS downtime	98	3.3163	1.07067
The physician will continue to order all necessary and precautionary checks during the downtime of the HIS	98	3.3061	1.02954
The laboratory technician will provide the doctor with the results over the phone during the downtime	98	3.2857	1.00514
There is an agreed mechanism for requesting laboratory tests and obtaining results during the HIS downtime	98	3.1531	1.18715
The laboratory technician provides the clinician with the results by sending paper documents through specialized personnel during the HIS downtime	98	2.9592	1.21772
Valid N (listwise)	98		

ToTb: The arithmetic mean of the respondents' answers to the second section questions

Descriptive Statistics (relationship emergency with radiology)			
	N	Mean	Std. Deviation
There is a delay in requesting the x-rays during the downtime of the HIS	98	4.1633	.82104
There is a delay in obtaining X-ray results during the downtime of the Health Information System	98	4.1224	.88824
TOTc	98	3.5893	.60629
The various x-rays are printed on a CD and sent with a specialist staff member or accompanying patient to the emergency department during the downtime.	98	3.0918	1.18484
There is an agreed mechanism for requesting x-rays and viewing x-rays during the downtime of the health information system	98	2.9796	1.12130
Valid N (listwise)	98		

ToTc: The arithmetic mean of the respondents' answers to the third section questions

Descriptive Statistics (drug request)			
	N	Mean	Std. Deviation
There is a delay in ordering medication for the patient during the HIS downtime	98	3.9388	1.01348
Confirmation of entering the drug dose that was given to the patient after returning the health information system	98	3.6633	1.05463
Confirm the entry of IV Fluid information that was given to the patient after the HIS returns	98	3.5918	1.05358
TOTd	98	3.5383	.79086
A patient's medical record can be consulted during the HIS shutdown to find out what medicines the patient has taken recently	98	2.9592	1.20067
Valid N (listwise)	98		

ToTd: The arithmetic mean of the respondents' answers to the fourth section questions

Descriptive Statistics (patient admission)			
	N	Mean	Std. Deviation
The admission of patients from emergency to the departments is delayed due to the downtime of the health information system	98	3.8776	1.10543
TOTe	98	3.8061	.76869
A patient who was not registered on the health information system due to system failure is admitted and the necessary treatment is provided	98	3.7347	1.01078
Valid N (listwise)	98		

ToTe: The arithmetic mean of the respondents' answers to the fifth section questions

Descriptive Statistics (training)			
	N	Mean	Std. Deviation
Paper forms or alternative systems and protocols are available to replace basic electronic medical record functionality during downtime.	98	3.0204	1.10276
Staff are trained to use paper forms or alternative systems	98	2.8571	1.16654
Training covers all employees on all shifts, as needed, including evenings and weekends	98	2.6837	1.15408
TOTf	98	2.5791	.87240
Staff receive training and education regarding the policies, protocols, and procedures for when the health	98	2.5408	1.15917

information system is down			
Staff are trained on what to do during planned and unplanned downtime of the Health Information System	98	2.4796	1.25369
Simulated downtime is used as ways to prepare for the probability of an actual HIS shutdown	98	2.4388	1.05583
Certain tools are used to gauge the hospital's preparedness for unplanned system downtime.	98	2.3571	1.04783
An unannounced annual training is conducted that simulates the downtime of HIS	98	2.2551	.99805
Valid N (listwise)	98		

ToTf: The arithmetic mean of the respondents' answers to the sixth section questions

The descriptive statistics of some of the items in each section were as follows. For downtime policies and procedures section as shown in Table 4.4 above, the item (The downtime of the health information system affects the workflow) has the highest degree of approval where the mean was (4.4490) and standard deviation (.93194) followed by the item (The HIS downtime increases crowding in the emergency department) with the mean (4.3367) and standard deviation (.94098) then (The HIS downtime increases the length of a patient's stay in the emergency department) with the mean (4.0510) and standard deviation (1.15207), while the item (There is a quick notification system in place to notify medical staff of unplanned system outages and alert staff to affected systems) has the lowest degree of approval where the mean was (2.4184) and standard deviation (1.11155) followed by the item (There is a certain mechanism in place to notify the medical staff when the system returns to work) with the mean (2.4694) and standard deviation (1.14157) then (The hospital has a written and approved policy and procedures to deal with the downtime of the health information system) with the mean (2.4796) and standard deviation (1.08627).

For the relationship between emergency department with laboratory section as shown in Table 4.4 above, the item (There is a delay in requesting lab tests during the HIS

downtime) has the highest degree of approval where the mean was (4.2551) and standard deviation (.88878) followed by the item (There is a delay in obtaining the results of laboratory tests during the HIS downtime) with the mean (3.8469) and standard deviation (1.02898), while the item (The laboratory technician provides the clinician with the results by sending paper documents through specialized personnel during the HIS downtime) has the lowest degree of approval where the mean was (2.9592) and standard deviation (1.21772) followed by the item (There is an agreed mechanism for requesting laboratory tests and obtaining results during the HIS downtime) with the mean (3.1531) and standard deviation (1.18715).

For the relationship between emergency department with radiology section as shown in Table 4.4 above, the item (There is a delay in requesting the x-rays during the downtime of the HIS) has the highest degree of approval where the mean was (4.1633) and standard deviation (.82104) followed by the item (There is a delay in obtaining X-ray results during the downtime of the Health Information System) with the mean (4.1224) and standard deviation (.88824), while the item (There is an agreed mechanism for requesting x-rays and viewing x-rays during the downtime of the health information system) has the lowest degree of approval where the mean was (2.9796) and standard deviation (1.12130).

For the drug request section as shown in Table 4.4 above, the item (There is a delay in ordering medication for the patient during the HIS shutdown) has the highest degree of approval where the mean was (3.9388) and standard deviation (1.01348) followed by the item (Confirmation of entering the drug dose that was given to the patient after returning the health information system) with the mean (3.6633) and standard deviation (1.05463), while the item (A patient's medical record can be consulted during the HIS

shutdown to find out what medicines the patient has taken recently) has the lowest degree of approval where the mean was (2.9592) and standard deviation (1.20067).

For patient admission as shown in Table 4.4 above, the item (The admission of patients from emergency to the departments is delayed due to the suspension of the health information system) has a high degree of approval where the mean was (3.8776) and standard deviation (1.10543) and the item (A patient who was not registered on the health information system due to system failure is received and the necessary treatment is provided) has also a high degree of approval where the mean was (3.7347) and standard deviation (1.01078).

For the training section as shown in Table 4.4 above, the item (Paper forms or alternative systems and protocols are available to replace basic electronic medical record functionality during downtime) has the highest degree of approval where the mean was (3.0204) and standard deviation (1.10276) followed by the item (Staff is trained to use paper forms or alternative systems) with the mean (2.8571) and standard deviation (1.16654), while the item (An unannounced annual training is conducted that simulates the downtime of HIS) has the lowest degree of approval where the mean was (2.2551) and standard deviation (0.99805).

4.4.2 Questionnaire for IT Staff

The second part of the questionnaire for IT was divided into 3 sections which are IT policies and procedures, training, and downtime policies and procedures.

The overall median score for all sections as shown in Table 4.5 below was (2.810) with a mean score (2.795) and standard deviation (0.831).

The descriptive statistics of the sections, each section separately as shown in Table 4.5 below, are as follows: The median score for the IT policies and procedures section was

(3.116) with a mean score (2.950) and standard deviation (0.489). The median score for the training section was (2.875) with a mean score (3.062) and a standard deviation (1.307). The median score for the downtime policies and procedures section was (2.444) with a mean score (2.375) and a standard deviation (0.858).

Table 4. 5, Median, Mean and Standard deviation for IT questionnaire's sections

Section	**Median**	**Mean**	**Standard deviation**
IT policies and procedures	3.116	2.950	0.489
Training	2.875	3.062	1.307
downtime policies and procedures	2.444	2.375	0.858
Overall sections	2.810	2.795	0.831

Table 4.6 below provides descriptive statistics for every item in the IT questionnaire sections of part 2.

Table 4. 6, Descriptive statistics for every item in the questionnaire sections of part 2.

Descriptive Statistics (IT policies and procedures)			
	N	Mean	Std. Deviation
Contact the engineer in charge in the Engineering and Computer Unit in the event of unable to identify or solve a specific problem.	8	4.2500	1.03510
Malfunctions in operating systems and databases are considered one of the main reasons for HIS downtime in the hospital.	8	4.2500	1.03510
The HIS team is available around the clock even outside the official working hours, seven days a week to solve any problem.	8	4.2500	1.03510
Power failure is one of the main reasons for HIS downtime in the hospital.	8	4.1250	.83452
The occurrence of a problem in the computer network is one of the main reasons for HIS downtime in the hospital.	8	3.7500	1.48805
Hospitals have a central UPS for their main servers	8	3.7500	1.38873
There is more than one application server to distribute the load and reduce the possibility of system slowdowns or downtime.	8	3.5000	1.06904
The power source is automatically transferred to the	8	3.5000	1.19523

generator when the electricity is cut off.			
IT personnel are trained to solve all problems related to the HIS.	8	3.5000	1.30931
Hospitals have UPS for network switches in the emergency department	8	3.5000	1.06904
Relevant local companies are contacted to solve advanced problems related to the HIS and its infrastructure.	8	3.3750	1.06066
An anti-virus program is available and licenses are renewed annually.	8	3.2500	1.16496
A generator and sufficient fuel are available to support the HIS during a power outage.	8	3.2500	1.28174
The HIS system has a reliable and equipped Warm Site Backup in the event of problems in the main data center.	8	3.0000	.75593
TOTa	8	2.9500	.48990
System failure is identified and acted upon (for example, the system or computer's slow response time is unacceptable).	8	2.8750	1.12599
IT personnel test the UPS at least once a month.	8	2.8750	1.12599
The HIS has a read-only backup at the hospital level.	8	2.7500	1.16496
Patient file backup data is updated at least every 24 hours.	8	2.6250	1.18773
Patient data and configuration files are backed up for programs important to hospital operations.	8	2.6250	1.18773
Network devices are connected to the main server room by more than one cable through different paths.	8	2.5000	1.60357
The Engineering and Maintenance Department employees check the operation of the main generator at least once a month.	8	2.5000	1.06904
There is a maintenance contract with the implementing company that is renewed annually to avoid any emergency that may affect the system's complete shutdown.	8	2.2500	1.28174
An electronic system is in place to notify IT staff of a HIS outage in the emergency department.	8	2.2500	1.58114
A Warm Site Backup can be prepared in less than 8 hours to replace the main data center.	8	2.2500	1.03510
Hospitals have a backup generator dedicated to the HIS and its infrastructure.	8	2.2500	1.03510
The read-only system backup is tested at least once a	8	2.1250	1.12599

month.			
There are additional network devices and servers (stand by) in the servers' room so that if a device malfunctions, the system does not stop	8	2.0000	1.19523
The guarantees for servers, switches and routers are constantly renewed once the previous warranty has expired.	8	2.0000	1.06904
Replacement devices are available in the event of any malfunction of the computers and their attachments or network devices in the emergency department.	8	1.8750	.99103
There is an electronic system in place to notify the medical staff and the hospital administration of a HIS downtime in the emergency department	8	1.5000	.75593
Valid N (listwise)	8		

ToTa: The arithmetic mean of the respondents' answers to the first section questions

Descriptive Statistics (Training)			
	N	Mean	Std. Deviation
Paper forms or alternative systems and protocols are available to replace basic electronic medical record functionality during downtime	8	3.5000	1.41421
Hospital staff are trained in what to do during both planned and unplanned downtime of the HIS	8	3.1250	1.35620
TOTb	8	3.0625	1.30760
Employees are trained by IT staff to use paper forms or alternative systems such as excel datasheet	8	2.8750	1.64208
Hospital personnel receive training and education regarding the policies, protocols, and procedures for HIS downtime	8	2.7500	1.38873
Valid N (listwise)	8		

ToTb: The arithmetic mean of the respondents' answers to the second section questions

Descriptive Statistics (Downtime policies and procedures)			
	N	Mean	Std. Deviation
There is a communication strategy and communication between departments, including the IT department, when the downtime occurs.	8	3.5000	1.30931
The hospital has written and approved policies and procedures for dealing in the event of HIS downtime	8	2.8750	1.12599
There is a certain mechanism in place to inform	8	2.7500	1.16496

employees when the system is back in			
The communication strategy of either planned or unplanned HIS downtime occurs via email	8	2.5000	1.41421
Lessons are learned after a system downtime to identify problems that must be addressed in future training or policy adjustments	8	2.5000	1.30931
TOTc	8	2.3750	.85848
The downtime handling policy is reviewed and updated at least every two years	8	2.0000	1.06904
Certain tools are used to gauge the hospital's preparedness for unplanned system downtime	8	1.7500	.70711
Simulation of downtime is used as methods to prepare for the probability of an actual HIS downtime	8	1.7500	.70711
An annual, unannounced trial is conducted that simulates the HIS downtime	8	1.7500	1.03510
Valid N (listwise)	8		

ToTc: The arithmetic mean of the respondents' answers to the third section questions

The descriptive statistics of some of the items in each section were as follows. For IT policies and procedures section as shown in Table 4.6 above, the items (Contact the engineer in charge in the Engineering and Computer Unit in the event of unable to identify or solve a specific problem) , (Malfunctions in operating systems and databases are considered one of the main reasons for HIS downtime in the hospital) and (The HIS team is available around the clock even outside the official working hours, seven days a week to solve any problem) have the highest degree of approval where the mean was (4.250) and standard deviation (1.035) followed by the item (Power failure is one of the main reasons for HIS downtime in the hospital) with the mean (4.125) and standard deviation (.83452) then (The occurrence of a problem in the computer network is one of the main reasons for HIS downtime in the hospital) with the mean (3.750) and standard deviation (1.488), while the item (There is an electronic system in place to notify the medical staff and the hospital administration of a HIS downtime in the emergency

department) has the lowest degree of approval where the mean was (1.500) and standard deviation (.755) followed by the item (Replacement devices are available in the event of any malfunction of the computers and their attachments or network devices in the emergency department) with the mean (1.875) and standard deviation (.991) then the items (The guarantees for servers, switches and routers are constantly renewed once the previous warranty has expired) and (There are additional network devices and servers (stand by) in the servers' room so that if a device malfunctions, the system does not stop) with the mean (2.000) and standard deviation (1.195).

For the training section as shown in Table 4.6 above, the item (Paper forms or alternative systems and protocols are available to replace basic electronic medical record functionality during downtime) has the highest degree of approval where the mean was (3.500) and standard deviation (1.414) followed by the item (Hospital staff is trained in what to do during both planned and unplanned downtime of the HIS) with the mean (3.125) and standard deviation (1.356), while the item (Hospital personnel receives training and education regarding the policies, protocols, and procedures for HIS downtime) has the lowest degree of approval where the mean was (2.750) and standard deviation (1.388).

For the downtime policies and procedures section as shown in Table 4.6 above, the item (There is a communication strategy and communication between departments, including the IT department, when the downtime occurs) has the highest degree of approval where the mean was (3.500) and standard deviation (1.309) followed by the item (The hospital has written and approved policies and procedures for dealing in the event of HIS downtime) with the mean (2.875) and standard deviation (1.126), while the items (An annual, unannounced trial is conducted that simulates the HIS downtime) and

(Simulation of downtime is used as methods to prepare for the probability of an actual HIS downtime) have the lowest degree of approval where the mean was (1.750) and standard deviation (1.035), (.70711) respectively.

4.5 Relationship Between HIS Downtime and Socio-Demographic Characteristics

4.5.1 Questionnaire for Doctors and Nurses

Analysis of variance (ANOVA) and Independent - Samples T-Test were performed to verify whether there was a difference in the impact of the computerized health system downtime on health services in the emergency department - from the viewpoint of those who filled the questionnaire - due to the difference in socio-demographic characteristics.

4.5.1.1 According to the gender variable

Table 4.7 below shows that the P-value (Sig.) 0.039 is lower than the significance level α=0.05. This result indicates there are significant differences between the respondents in their opinions about the impact of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to gender. The respondents' answers for male were of a moderate degree, the mean was (3.306) and standard deviation (0.449) while the respondents' answers for female were of a high degree, the mean was (3.469) and standard deviation (0.299) as shown in Table 4.8 below.

Table 4. 7, Independent - Samples T-Test for HIS downtime with gender

Independent Samples Test					
	t-test for Equality of Means				
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	-1.807-	96	.074	-.16238-	.08988
Equal variances not assumed	-2.102-	80.652	.039	-.16238-	.07726

Table 4. 8, Mean for respondents' answers according to gender variable

Gender	N	Mean	Std. Deviation	Std. Error Mean
Male	68	3.3069	.44943	.05450
Female	30	3.4692	.29994	.05476

4.5.1.2 According to the job title variable

Table 4.9 below shows that the P-value (Sig.) 0.0303 is lower than the significance level α=0.05. This result indicates there are significant differences between the respondents in their opinions about the impact of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to job title. The respondents' answers for doctors were of a moderate degree, the mean was (3.242) and standard deviation (0.351) while the respondents' answers for nurses were of a high degree, the mean was (3.420) and standard deviation (0.436) as shown in Table 4.10 below.

Table 4. 9, Independent - Samples T-Test for HIS downtime with the job title

Independent Samples Test					
	t-test for Equality of Means				
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	-2.071-	96	.041	-.17813-	.08600
Equal variances not assumed	-2.203-	83.584	.030	-.17813-	.08086

Table 4. 10, Mean for respondents' answers according to the job title variable

Job title	N	Mean	Std. Deviation	Std. Error Mean
Doctor	35	3.2421	.35105	.05934
Nurse	63	3.4202	.43602	.05493

4.5.1.3 According to workplace variable

Table 4.11 below shows that the P-value (Sig.) 0.065 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in their opinions about the impact of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to workplace variable. The respondents' answers from Rafidia hospital and Jenin hospital were of a moderate degree, the mean was respectively (3.306) and (3.254) and standard deviation was respectively (0.350) and (0.404), while the respondents' answers from Tulkarm hospital and Tubas hospital were of a high degree, the mean was respectively (3.549) and (3.418) and standard deviation was respectively (0.496) and (0.410) as shown in Table 4.12 below.

Table 4. 11, ANOVA test for HIS downtime with workplace variable.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.228	3	.409	2.488	.065
Within Groups	15.463	94	.165		
Total	16.691	97			

Table 4. 12, Mean for respondents' answers according to workplace variable

	N	Mean	Std. Deviation	Std. Error
Rafedia	42	3.3066	.35008	.05402
Jenin	26	3.2547	.40443	.07931
Tulkarm	22	3.5499	.49603	.10575
Tubas	8	3.4185	.41098	.14530
Total	98	3.3566	.41481	.04190

4.5.1.4 According to the age variable

Table 4.13 below shows that the P-value (Sig.) 0.605 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in their opinions about the impact of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to the age variable. The respondents' answers with ages 30 to less than 40 and 40 to less than 50 and more than 50 were of a moderate degree, the mean was respectively (3.327), (3.276) and (3.227) and standard deviation was respectively (0.384), (0.482) and (0.366), while the respondents' answers with age less than 30 was of a high degree, the mean was (3.412) and standard deviation (0.433) as shown in Table 4.14 below.

Table 4. 13, ANOVA test for HIS downtime with the age variable.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.323	3	.108	.618	.605
Within Groups	16.368	94	.174		
Total	16.691	97			

Table 4. 14, Mean for respondents' answers according to the age variable

	N	Mean	Std. Deviation	Std. Error
Less than 30	45	3.4130	.43377	.06466
30 to less than 40	38	3.3280	.38417	.06232
40 to less than 50	10	3.2761	.48219	.15248
More than 50	5	3.2273	.36614	.16374
Total	98	3.3566	.41481	.04190

4.5.1.5 According to education level variable

Table 4.15 below shows that the P-value (Sig.) 0.871 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in their opinions about the impact of HIS downtime on healthcare services in emergency

departments based on respondents' perceptions in governmental hospitals due to education level. The respondents' answers with bachelor, master and doctorate degree were of a moderate degree, the mean was respectively (3.348), (3.337) and (3.238) and standard deviation was (0.429), (0.042) and (0.149), while the respondents' answers with diploma degree was of a high degree, the mean was (3.427) and standard deviation (0.435) as shown in Table 4.16 below.

Table 4. 15, ANOVA test for HIS downtime with education level variable

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.125	3	.042	.236	.871
Within Groups	16.566	94	.176		
Total	16.691	97			

Table 4. 16, Mean for respondents' answers according to education level variable

	N	Mean	Std. Deviation	Std. Error
Diploma	15	3.4277	3.42770	.11256
Bachelor	76	3.3482	.42981	.04930
Master	4	3.3375	.04261	.02130
Doctorate	3	3.2381	.14964	.08639
Total	98	3.3566	.41481	.04190

4.5.1.6 According to years of experience variable

Table 4.17 below shows that the P-value (Sig.) 0.739 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in their opinions about the impact of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to years of experience variable. The respondents' answers with years of experience less than 5, from 11 to less than 15 and more than 15 were of a moderate degree, the mean was respectively (3.345), (3.338) and (3.301) and standard deviation was respectively

(0.414), (0.373) and (0.446), while the respondents' answers with years of experience from 6 to less than 10 was of a high degree, the mean was (3.451) and standard deviation (0.438) as shown in Table 4.18 below.

Table 4. 17, ANOVA test for HIS downtime with years of experience variable

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.221	3	.074	.420	.739
Within Groups	16.470	94	.175		
Total	16.691	97			

Table 4. 18, Mean for respondents' answers according to years of experience variable

	N	Mean	Std. Deviation	Std. Error
Less than 5	49	3.3455	.41497	.05928
6-10 years	18	3.4511	.43867	.10339
11-15 years	15	3.3384	.37308	.09633
More than 15	16	3.3012	.44606	.11152
Total	98	3.3566	.41481	.04190

4.5.1.7 According to years of work in the hospital variable

Table 4.19 below shows that the P-value (Sig.) 0.838 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in their opinions about the impact of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to experience variable. The respondents' answers with years of work in the hospital less than 5, from 6 to 10 years and from 11 to 15 years were of a moderate degree, the mean was respectively (3.370), (3.302) and (3.308) and standard deviation was respectively (0.422), (0.398) and (0.461), while the respondents' answers with years of work in the

hospital more than 15 was of a high degree, the mean was (3.432) and standard deviation (0.386) as shown in Table 4.20 below.

Table 4. 19, ANOVA test for HIS downtime with years of work in the hospital variable

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.149	3	.050	.282	.838
Within Groups	16.542	94	.176		
Total	16.691	97			

Table 4. 20, Mean for respondents' answers according to years of work in the hospital variable

	N	Mean	Std. Deviation	Std. Error
Less than 5	58	3.3704	.42214	.05543
6-10 years	18	3.3023	.39882	.09400
11-15 years	12	3.3082	.46106	.13310
More than 15	10	3.4320	.38614	.12211
Total	98	3.3566	.41481	.04190

4.5.2 Questionnaire for IT Staff

Analysis of variance (ANOVA) and Independent - Samples T-Test were performed to verify whether there was a difference in the causes of the HIS downtime on health services in the emergency department - from the viewpoint of those who filled the questionnaire - due to the difference in socio-demographic characteristics.

4.5.2.1 According to the gender variable

Table 4.21 below shows that the P-value (Sig.) 0.899 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in their opinions about the causes and impacts of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to gender variable. The respondents' answers for male were of a moderate degree,

the mean was (2.827) and standard deviation (0.848) while the respondents' answers for female were of a moderate degree, the mean was (2.700) and standard deviation (1.099) as shown in Table 4.22 below.

Table 4. 21, Independent - Samples T Test for HIS downtime with the gender variable

Independent Samples Test					
	t-test for Equality of Means				
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	.175	6	.867	.12778	.73110
Equal variances not assumed	.150	1.425	.899	.12778	.85145

Table 4. 22, Mean for respondents' answers according to the gender variable

	N	Mean	Std. Deviation	Std. Error Mean
Male	6	2.8278	.84862	.34645
Female	2	2.7000	1.09994	.77778

4.5.2.2 According to the job title variable

Table 4.23 below shows that the P-value (Sig.) 0.765 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in their opinions about the causes and impacts of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to job title variable. The respondents' answers for programmers were of a moderate degree, the mean was (2.883) and standard deviation (0.759) while the respondents' answers for engineers were of a moderate degree, the mean was (2.649) and standard deviation (1.101) as shown in Table 4.24 below.

Table 4. 23, Independent - Samples T Test for HIS downtime with the job title variable

Independent Samples Test					
	t-test for Equality of Means				
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	.361	6	.730	.23432	.64857
Equal variances not assumed	.325	3.174	.765	.23432	.72090

Table 4. 24, Mean for respondents' answers according to the job title variable

	N	Mean	Std. Deviation	Std. Error Mean
Programmer	5	2.8837	.75922	.33953
Engineer	3	2.6494	1.10148	.63594

4.5.2.3 According to workplace variable

Table 4.25 below shows that the P-value (Sig.) 0.764 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in their opinions about the causes and impacts of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to workplace variable. The respondents' answers from Tubas hospital, Rafidia hospital and Tulkarm were of a moderate degree, the mean was respectively (3.368), (2.845) and (2.846), while the respondents' answers from Jenin hospital was of a low degree, the mean was (1.922) as shown in Table 4.26 below.

Table 4. 25, ANOVA test for HIS downtime with workplace variable

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.106	3	.369	.396	.764
Within Groups	3.729	4	.932		
Total	4.835	7			

Table 4. 26, Mean for respondents' answers according to workplace variable

	N	Mean	Std. Deviation	Std. Error
Rafedia	4	2.8458	1.00368	.50184
Jenin	1	1.9222	.	.
Tulkarm	2	2.8463	.84067	.59444
Tubas	1	3.3685	.	.
Total	8	2.7958	.83110	.29384

4.5.2.4 According to the age variable

Table 4.27 below shows that the P-value (Sig.) 0.930 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in their opinions about the causes and impacts of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to age variable. The respondents' answers with ages 30 to less than 40 & 40 to less than 50 were of a moderate degree, the mean was respectively (2.779) and (2.846) and standard deviation was respectively (0.907) and (0.840) as shown in Table 4.28 below.

Table 4. 27, ANOVA test for HIS downtime with the age variable.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.007	1	.007	.008	.930
Within Groups	4.828	6	.805		
Total	4.835	7			

Table 4. 28, Mean for respondents' answers according to the age variable

	N	Mean	Std. Deviation	Std. Error
30-40	6	2.7790	.90792	.37066
40-50	2	2.8463	.84067	.59444
Total	8	2.7958	.83110	.29384

4.5.2.5 According to education level variable

Table 4.29 below shows that the P-value (Sig.) 0.366 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in

their opinions about the causes and impacts of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to education level variable. The respondents' answers with master degree were of a moderate degree, the mean was (3.167) and standard deviation (0.942), while the respondents' answers with bachelor degree was of a low degree, the mean was (2.572) and standard deviation (0.773) as shown in Table 4.30 below.

Table 4. 29, ANOVA test for HIS downtime with education level variable

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.664	1	.664	.956	.366
Within Groups	4.171	6	.695		
Total	4.835	7			

Table 4. 30, Mean for respondents' answers according to education level variable

	N	Mean	Std. Deviation	Std. Error
Bachelor	5	2.5726	.77350	.34592
Master	3	3.1679	.94271	.54427
Total	8	2.7958	.83110	.29384

4.5.2.6 According to years of experience variable

Table 4.31 below shows that the P-value (Sig.) 0.015 is lower than the significance level α=0.05. This result indicates there is significant differences between the respondents in their opinions about the causes and impacts of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to years of experience variable. The respondents' answers with years of experience from 11 to 15 years were of a high degree, the mean was (3.587) and standard deviation (0.290), while the respondents' answers with years of experience more than 15 years was of a moderate degree, the mean was (2.846) and standard deviation (0.840) and

finally the respondents' answers with years of experience from 6 to 10 years was of a low degree, the mean was (1.970) and standard deviation (0.122) as shown in Table 4.32 below.

Table 4. 31, ANOVA test for HIS downtime with years of experience variable.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.930	2	1.965	10.858	.015
Within Groups	.905	5	.181		
Total	4.835	7			

Table 4. 32, Mean for respondents' answers according to years of experience variable

	N	Mean	Std. Deviation	Std. Error
6-10 years	3	1.9704	.12215	.07052
11-15 years	3	3.5877	.29012	.16750
More than 15 years	2	2.8463	.84067	.59444
Total	8	2.7958	.83110	.29384

4.5.2.7 According to years of work in the hospital variable

Table 4.33 below shows that the P-value (Sig.) 0.841 is greater than the significance level α=0.05. This result indicates no significant differences between the respondents in their opinions about the causes and impacts of HIS downtime on healthcare services in emergency departments based on respondents' perceptions in governmental hospitals due to years of work in the hospital variable. The respondents' answers with years of work in the hospital from 11 to 15 years was of a high degree, the mean was (3.477), while the respondents' answers with years of work in the hospital from 1 to 5 years and from 6 to 10 years were of a moderate degree, the mean was respectively (2.699) and (2.919) and finally the respondents' answers with years of work in the hospital more than 15 years was of a low degree, the mean was (2.251) as shown in Table 4.34 below.

Table 4. 33, ANOVA test for HIS downtime with years of work in the hospital variable.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.829	3	.276	.276	.841
Within Groups	4.006	4	1.002		
Total	4.835	7			

Table 4. 34, Mean for respondents' answers according to years of work in the hospital variable

	N	Mean	Std. Deviation	Std. Error
1-5 years	4	2.6995	.82008	.41004
6-10 years	2	2.9194	1.41029	.99722
11-15 years	1	3.4778	.	.
More than 15 years	1	2.2519	.	.
Total	8	2.7958	.83110	.29384

4.6 Results of General Questions (PART3)

In the third part of the two questionnaires, 4 general questions were asked, to which the respondent would answer as he deems appropriate from his point of view.

The questions are:

1-How would you rate the HIS program in terms of optimal business continuity in terms of "downtime, program slowdown"?

2-What are the suggestions to improve the system's work and reduce downtime?

3-Do you think that the HIS slowdown and freeze problems are technical, administrative, or financial problems, and why?

4-How can any negative effects of HIS downtime be avoided?

4.6.1 Questionnaire for Doctors and Nurses

Regarding the first question, almost 13 out of 98 respondents (13.26%) think that the program is more than good and that stoppage and slowness are rare and do not hinder

work, while the majority (56.74%) assert that interruptions occur continuously and that the system suffers from slowness, especially in the morning periods, which leads to confusion in work and overcrowding of patients and delaying their treatment and directing them to different departments, while 30% did not answer this question.

With regard to suggestions to improve the system's work and reduce downtime, the majority (25%) emphasized the necessity of purchasing new computers, improving the quality of current computer equipment in hospitals, and doing regular maintenance for them, while the suggestions varied greatly, including increasing the number of employees in the emergency department, and for IT team to work in all shifts, conducting periodic checks of generators, providing generators and UPS devices to avoid system shutdown when power outages, increasing the number of servers, increasing internet speed, and training staff to deal with downtime.

Concerning the third question, the percentages were as follows: 28.57% believe that the problems of HIS downtime are purely technical problems, while 13.26% believe that the problem is technical, administrative and financial combined, 9.18% believe that the problem is technical and administrative, and the same percentage think that the problem is technical and financial, 4.06% believe that downtime problems are administrative and financial problems, and the same percentage think they are financial problems only, 0% think they are only administrative problems. Finally, 31.60% did not answer this question.

Regarding how to avoid any negative effects of HIS downtime, most emphasized the necessity of making clear and alternative plans and training the medical staff on how to work with this plan, conducting special periodic training courses for new employees and reminding the medical staff to work with the alternative plan, and the existence of an

alternative program that works separately from Avicenna program that contains patient's data.

4.6.2 Questionnaire for IT Staff

Regarding first question, the minority (3 out of 8) considered the program good and that the downtime or slowdown is few compared to the continuity of the program throughout the year without interruption. While, the majority (5 out of 8) considered the program to be slow and sometimes very slow, especially during peak hours and when dealing with patient files that contain a lot of medical information, which causes a hindrance to work.

With regard to the second question, respondents offered a set of ideas to reduce downtime, including continuous monitoring and updating of databases and servers, having a server in every hospital to store data locally and then transferring it to the main server every 12 hours, for example, raising the internet speed of the VPN line designated for hospital network main data center and increase the number of application servers. However, one of the respondents indicated the need to change all the infrastructure dedicated to HIS.

As for the third question, most agreed, with a rate of 75%, that the reason for downtime is due to the presence of technical, administrative and financial problems, as there are no continuous updates to the program and the senior management in the Ministry of Health does not understand the importance of the computerized system in the ministry, and therefore the financial support necessary for its development is not allocated. While 25% of the respondents asserted that the main reason is the lack of sufficient funds to develop the program.

Concerning the fourth question (How can any negative effects of the HIS system be avoided), the majority (62.5%) emphasized the need for written and clear protocols to

deal with the disruption of HIS, such as the availability of a paper system or other alternative systems, with an emphasis on the need to enter medical data after the system’s return. Others emphasized the necessity of having alternative servers and providing generators for the HIS infrastructure, making annual maintenance contracts with the company implementing the system and annual licenses for operating systems and firewall and antivirus programs.

4.7 Summary

This chapter presented a description of the research result, including respondents' characteristics and descriptive statistics of the questionnaire's data and the results of the relationship between HIS downtime and socio-demographic characteristics of respondents by use of inferential statistics. Moreover, this chapter presented the results of the general questions in the last part of the questionnaires.

Chapter 5: Discussion & Conclusion

5.1 Introduction

The present study aimed to assess "the impact of the health information system downtime on health services provided to emergency patients in government hospitals in the northern West Bank." This section discusses the results of the study in terms of causes and the proximity of these results to previous international studies. Also, this chapter will present conclusion, recommendations, strength of the study and future studies.

5.2 HIS Downtime Affects the Workflow and Various Health Services in Emergency Departments

The first research question refers to "to what extent does the downtime of the health information system affect the functioning and various health services such as x-rays, laboratory tests, medications, and patient admission?" The results revealed that downtime significantly affects workflow, crowding, and patient safety by impacting various health services, such as laboratory tests, medications, x-rays, and others.

With regard to overcrowding in the emergency department, the downtime of the HIS leads to a complete obstruction of work, which reduces the frequency of work and thus leads to the accumulation of patients who are looking at the completion of treatment as this depends on the arrival of the results of laboratory and x-ray examinations to take the appropriate medical decision. This is in line with the study by Wretborn et al. (2019) which confirmed that the emergency is the main gate for the patient, and therefore there are large numbers of patients flocking daily to the emergency, as the HIS downtime leads to congestion that is associated with diminishing quality Health services, which in turn may affect patient safety.

Study results confirm that downtime significantly affects patient safety. The downtime means that the medical staff will not be able to access the patient's electronic medical record, which includes important information about previous treatments, laboratory tests, x-rays, and medications that he has taken previously, thus helping a lot in treatment plans. This is in line with Kashiwagi et al. (2017) assert that computerized health systems make patient care safer and more efficient, and that interruptions to these systems may threaten patient safety.

The downtime leads to a significant delay in the arrival of the laboratory test requests. The requests are sent either through the patient's facilities or through contact with the laboratory. The working mechanism in the laboratory is also transformed into the traditional manual method, which also leads to a delay in the issuance of the test results and delivering the results to the emergency department. This result is consistent with Larsen et al. (2018) that found that the downtime is detrimental to patient care in general, as the time taken to reach the laboratory result increased by 20 minutes compared to regular operation, in addition to the delay in delivering the results manually to the doctor who requested the tests. The same situation occurs when ordering x-rays. This is in line with Larsen et al. study that confirmed difficulties in transferring the images to the electronic health record and delays in reporting the results to the physician in charge. There is a delay in ordering drugs from the pharmacy and balancing them in the custody of the emergency department. Still, the positive thing is that the drug doses and IV fluid are given to patients are entered into the medical file of each patient after the system's return.

Among the other findings of the study is that as a result of the downtime, the length of the patient's stay in the emergency department increases as well as the delay in

admitting patients from emergency to departments where the matter is done just through the HIS system and thus may lead to a risk to the patient's safety. This in line with the study by Wrestborn et al. (2019) which found that patient LOS and occupancy increased significantly.

5.3 Health Information System Downtime Plan

The results showed that most respondents answered that the hospital does not have a written and approved policy and procedures to deal with HIS downtime. Still, there may be internal mechanisms that do not rise to the level of policies in every hospital department about how to deal in the event of system downtime. This is consistent with the study by Larsen et al. (2019) which indicated that downtime procedures were either not followed or were not in place. Thus, there is a need to develop downtime procedures and monitor their implementation by all hospital staff and implementing the downtime measures, and without the evaluation and development of the procedures, downtime events will continue. Kashiwagi et al. (2017) emphasized the need for a clear policy to prepare healthcare workers to support patient care in the absence of electronic health records. Hoot et al. (2003) found there was no clear downtime plan to be followed by the emergency department staff, which led to their dispersion between downtime procedures and appropriate health service provision.

Consequently, another result of the downtime plan is that there is no notification system to inform the medical staff in the event of the downtime, as this causes a confusing situation, for example the doctor or nurse will restart the computer and the program more than once, as they expect that the problem is only in their computers. This leads to a loss of time, and thus there is a need for a practical and rapid system to inform the medical staff in case the downtime is general and how long is the expected period for

the system to return. Also, one of the results is that the medical staff is not informed when the system returns and leaving the matter to repeated attempts by medical staff to try to operate the system, and thus also leads to loss of time and may increase the patient's stay time in the emergency and may affect the safety of patients.

One of the essential findings in this study is that the medical data is recorded on paper during downtime. Although there is no clear procedure for re-entering medical data into the HIS when the system returns, the medical staff makes sure that the patients' vital signs are entered. The doctor's notes are also entered after the HIS is restored. This matter is fundamental so that the patient's medical file is complete and devoid of any deficiencies that may cause future medical errors. Thin is consistent with the study by Bamdeg, J., & Schmidt, T. (2020) which concluded that there is a continued need for having backup systems such as paper-based systems to handle lack of access to the IT systems.

Regarding communication between departments, the results confirmed that there are communication problems, whether between the different departments, as the downtime causes a delay in obtaining the results of laboratory tests and x-rays, for example, as some confirmed that communication takes place through the phone. In contrast, others confirmed that the communication takes place While sending a paper's results with the patient's companion. Also, there are problems with the administration's communication with the departments. There is no immediate decision on the procedures that must be followed during the halt, especially if there is a pause at peak times. There is a reluctance between waiting and switching to paperwork. This reason may also be attributed to the administration's lack of knowledge about the truth of reasons for the downtime and how long the system is expected to return.

5.4 Training

The third research question states “Are medical staff trained in how to deal with patients during HIS downtime?”, the results showed that the majority of respondents agreed that there is a real problem with regard to training on the procedures that must be followed when the health information system is stopped. Despite the wide variation in opinions about the existence or non-existence of paper forms or alternative systems and protocols that are supposed to replace the basic functions of electronic medical records during the work break, there is almost a consensus that employees are not trained on how to use these forms either during the downtime or re-entering this data after the system returns.

The results confirmed that the medical staff does not receive training and education regarding policies, protocols, and procedures when the health information system is disrupted. Failure to train the medical staff on what to do during the planned and unplanned downtime increases the pressure during the downtime and leads to a failure to standardize procedures among the members of the medical staff themselves in dealing with the situation, as well as failure to standardize procedures between different government hospitals. This requires setting up a training program to be adopted in all hospitals and holding it periodically to avoid any confusion and standardization of procedures.

Finally, the results show that simulated downtime is not used to prepare for the potential for actual HIS downtime, and no annual unannounced training simulating a HIS downtime is conducted. This training method helps assess the extent to which the staff is familiar with the appropriate procedures to deal with the downtime situation. Thus, avoiding any adverse effects that may occur due to the medical staff not getting acquainted with the proper way to deal with the downtime. This is in line with the study

by Nelson N. C. (2007) that confirmed that a stopover plan alone is not sufficient. "Downtime drills," must be implemented to include all departments and employees. This proactive approach better prepares employees for downtime, whether planned or unplanned.

5.5 Demographic Characteristics and HIS Downtime

The fourth research question states, “To what extent is the medical staff affected in the provision of health services in the event of the system downtime, according to socio-demographic characteristics?”. The results revealed no difference between age, years of experience, years of work in the hospital, education level, workplace, and health services provided during the time of HIS downtime as these factors were not statistically significant. On the other hand, the results showed that there is a difference between the job and gender, and the provision of health services during the time of HIS downtime, as these factors had a statistical significance.

Regarding the job title, the results showed that nurses believe that the effect of HIS downtime on providing health services is more significant from the doctors' point of view. This may be because nurses are placed on a heavy burden in dealing with the patient and entering vital signs, and following up all requests with other departments, such as laboratory orders and x-rays. At the same time, the doctor only gives clinical decisions after obtaining the results of the requests. Regarding gender, the results show that females believe that the effect of interruption of HIS on providing health services is more significant from males' point of view. This may be due to males' greater boldness in finding solutions to field problems and diligence to do what they see appropriate. Simultaneously, females tend to adhere to agreed protocols and fear of diligence that

may lead to issues that may harm patients. Previous studies did not address the relationship between demographic characteristics and HIS downtime.

5.6 HIS Downtime Causes

The fifth research question states, "To what extent do the technical measures in place affect the prevention of HIS downtime?". Based on the study results, operating systems and databases' problems are considered the main reason for the downtime. We can attribute the reason to the expansion in the system's application in a large number of government hospitals. Still, at the same time, there was no increase and development in the number of application servers and databases in proportion to that. It leads, according to the respondents, to the rise in the periods of downtime. Secondly, the power outage is the second factor causing the downtime, especially the downtime at the level of a hospital or one department. Finally, computer network problems are the third cause of downtime. For example, a possible failure in the switches or a break in the VPN line on the part of the telecommunications company is considered the reason for the downtime. This does not correspond to a study by Chen et al. (2017) that confirmed that the main reason for the HIS downtime is computer network problems, followed by power outages and finally software problems. Hoot et al. (2003) found that two reasons led to the most extended downtime: a worm attack worldwide and a power outage in the local electrical service. Lei et al. (2013) found that most of the health information technology interruptions were due to overload, whether on the computer network or the servers, due to the large volume of simultaneous connection and a large amount of stored and exchanged data.

Although the power outage is one of the main reasons for the downtime, the study results confirmed that the hospitals own electrical generators and these generators have

sufficient fuel are available to support the HIS during a power outage. Also, the power source is automatically transferred to the generator when the electricity is cut off. Moreover, there is a central UPS in the server room and UPSs for the switches located in the emergency department, which protects the network from interruption during the short period between the power failure and the transition to work on the electrical generator.

The study revealed the presence of more than one application server to distribute the load and reduce the possibility of system slowdowns or downtime. Also, the HIS system has a reliable and equipped backup in the warm site backup site in the event of problems in the primary data center. Also, an anti-virus program is available, and licenses are renewed annually. This, in turn, contributes to reducing downtime resulting from problems in the operating system due to the entry of viruses into computers and servers.

About the IT employees, the results of the study showed that IT personnel are trained to solve all problems related to the health information system. Also, the HIS team is available around the clock, even outside the official working hours, seven days a week to solve any problem. If the employee cannot solve, it is contacted with the responsible engineer in the Engineering and Computer Unit. Moreover, in case of significant issues, the relevant local companies are contacted to solve advanced problems related to the health information system and its infrastructure.

Among the other results that have been reached, network devices do not connect to the main server room with more than one cable. Thus, there is no redundancy in the event of a break in one of the cables, and there are no alternative devices in the event of failure of the current devices, which threatens to increase the downtime. Although a backup copy of the HIS system is taken periodically, the backup copy is not tested at

least once a month to ensure its work. Regarding the warm backup site's presence, the dilemma was that it was impossible to prepare a backup copy of the warm site in less than 8 hours to replace the main center data. Moreover, there is no dedicated electric generator for the health information system and its infrastructure.

These are the most prominent results related to the causes, whether direct or indirect, which may lead to a downtime.

5.7 Conclusion

This study emphasized the tremendous negative impact of the HIS downtime on providing health services and the necessary follow-up for patients in emergency departments, especially from doctor's and nurses' viewpoints. It also highlighted the need for a well-thought-out. It approved a downtime plan to standardize protocols in dealing with the situation when the HIS stops, especially about communication between the relevant departments and the notification system from the IT department to notify the medical staff when the downtime occurs and the need for advanced training courses in this context.

For each result, there are causes. The study found many reasons, whether direct or indirect, that lead to downtimes, such as operating systems, databases, power outages, and various other administrative and technical problems.

The foregoing leads us to realize that downtime has risks to patient safety and therefore the results of this study are very important for decision-makers, especially in the Ministry of Health, to address all causes that may lead to the HIS downtime by adopting the continuity plan and allocating a large budget to support HIS, whether at the hardware level or at the level of maintenance contracts and licenses necessary for the various programs.

Perhaps this is the first study in Palestine that highlights the dangers of HIS downtime, but we hope that the study will find listening ears and thoughtful minds to sound the alarm and work to overcome difficulties and remove obstacles towards a comprehensive development of the HIS and its infrastructure.

5.8 Recommendations

Based on the results of the current study, the researcher recommends the following:

- Paying attention to training the medical staff, especially the newly hired, on how to deal with the downtime of the health information system.
- The necessity of adopting an official policy by the ministry of health to regulate the protocols and mechanisms that must be followed in the event of HIS downtime.
- Replace old computers and their accessories and old servers with other modern devices.
- The necessity of adopting a daily checklist for IT staff, each according to the nature of his work, to ensure that network devices, servers and various programs are working properly.
- The necessity of usage of open source HIS in case the downtimes of the main HIS and must be integrated with the main HIS database.
- Increasing the number of IT employees in hospitals to be able to provide technical support 24/7.
- Further researches on the causes and effects of downtime on data integrity and patient safety are needed.

5.9 Strength of the Study

The strength of this study stems from the fact that it is the first study in Palestine to highlight the negative effects of HIS interruption on health services provided to

emergency patients. The study highlighted the direct and indirect reasons that contribute now and may contribute in the future to increasing the downtime events. The important results obtained open the horizon for the researcher or other researchers to continue doing relevant research. The study gives decision-makers very important results about the causes and risks of downtime occurrence, and thus making the necessary practical decisions to prevent downtime events.

5.10 Future Work

The researcher recommends conducting a study on the impact of the disruption of the health information system on health care services in emergency departments on a large scale in West Bank hospitals to give more accurate and comprehensive results. Also, explore the impact of HIS downtime on other departments in MOH hospitals.

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Appendixes

Appendix A: 1-Questionnaire for Doctors and Nurses (باللغة العربية)

استبيان حول تأثير توقف نظام المعلومات الصحية (HIS) على الخدمات الصحية المقدمة لمرضى الطوارئ في المستشفيات الحكومية في شمال الضفة الغربية

عزيزي /تي الموظف /ـة:

يقوم الباحث بإجراء دراسة حول تأثير توقف نظام المعلومات الصحية (HIS) على الخدمات الصحية المقدمة لمرضى الطوارئ في المستشفيات الحكومية في شمال الضفة الغربية وذلك لإكمال رسالة الماجستير في المعلوماتية الصحية في الجامعة العربية الأمريكية.

لقد حصل الباحث على إذن من وزارة الصحة لتوزيع الاستبيان على العاملين في مرافق الوزارة.

سيكون الباحث ممتنا لك /ي إذا أجبت على أسئلة هذا الاستبيان، مع الاحتفاظ بحقك في عدم الإجابة على أي سؤال لا تريد الإجابة عليه، علما انه لا يجوز للباحث استخدام هذه البيانات إلا لأغراض البحث العلمي.

يرجى قراءة التعليمات المرتبطة بكل قسم وكل سؤال بعناية، سيتم التعامل مع ردودك على الأسئلة المطلوبة في هذا الاستبيان بسرية تامة ومطلقة، ولن تكون ردودك معروفة لأي شخص خارج فريق البحث، ولن يتم الكشف عنها لأي شخص داخل مؤسستك الصحية، ولن يتم طلب أي معلومة في الاستبيان تحدد هويتك.

إذا كان لديك أي استفسار آخر حول الاستبيان يرجى التواصل مع الطالب حسب المعلومات أدناه:

الطالب: معاذ لهلبت

جوال:0598900377

وطنية:0562401342

بريد الكتروني: muath.lahlabat@gmail.com

المشرفون: د. يوسف الميمي، د. رامي حدرب.

الجزء الأول: المعلومات الديموغرافية

الجنس: ذكر ☐ انثى ☐

العمر: أقل من 30 ☐ 30-40 ☐ 40-50 ☐ أكبر من 50 ☐

مكان العمل: مستشفى رفيديا ☐ مستشفى جنين ☐ مستشفى طولكرم ☐ مستشفى طوباس ☐

مستوى التعليم: دبلوم ☐ بكالوريوس ☐ ماجستير ☐ دكتوراة ☐

الوظيفة: طبيب ☐ ممرض ☐

سنوات الخبرة: 1-5 سنوات ☐ 6-10 سنوات ☐ 11-15 سنة ☐ أكثر من 15 سنة ☐

سنوات العمل في المستشفى: 1-5 سنوات ☐ 6-10 سنوات ☐ 11-15 سنة ☐ أكثر من 15 سنة ☐

الجزء الثاني: آثار وأسباب توقف HIS

	غير موافق بشدة	غير موافق	محايد	أوافق	أوافق بشدة
أ. سياسات واجراءات التوقف	1	2	3	4	5
1. لدى المستشفى سياسة وإجراءات مكتوبة ومعتمدة للتعامل مع وقت توقف نظام المعلومات الصحية عن العمل					
2. يتم مراجعة وتحديث سياسة التعامل مع وقت التوقف كل عامين على الأقل					
3. يتم استخلاص العبر بعد حدوث التوقف لتحديد المشكلات التي يجب معالجتها في التدريب المستقبلي أو تعديلات السياسات.					
4. يوجد نظام إخطار سريع لإبلاغ الطاقم الطبي بأوقات تعطل النظام غير المخطط لها وتنبيه الطاقم إلى الأنظمة المتأثرة.					
5. يتم إخطار الطاقم الطبي بأوقات تعطل النظام المخطط لها					
6. توجد ألية معينة معتمدة لإبلاغ الطاقم الطبي عند عودة النظام إلى العمل.					
7. توجد إستراتيجية اتصال وتواصل بين الأقسام عند حدوث التوقف					
8. توجد عوائق في التواصل مع الأقسام الأخرى أثناء فترة التوقف					
9. يتم تسجيل البيانات الطبية ورقيا أثناء فترة التوقف					
10. يوجد إجراء واضح لإعادة ادخال البيانات الطبية الى نظام					

المعلومات الصحية عندما يعود الى العمل.					
11. يتم إبلاغ مدير الجودة بالبيانات الطبية المفقودة خلال فترة توقف نظام المعلومات الصحية وتوثيقها بشكل مناسب حسب النظام					
12. يتم التحقيق في نقص أو اخطاء البيانات الطبية، ومراجعة الأسباب					
13. يتم التعامل مع فترات التوقف غير المخطط لها والاستعداد لها مثل أي حالة طوارئ أخرى					
14. يعتبر انقطاع التيار الكهربائي من الاسباب الرئيسية لتوقف نظام المعلومات الصحية					
15. يزيد وقت توقف نظام المعلومات الصحية من مدة إقامة المريض في قسم الطوارئ					
16. يزيد وقت توقف نظام المعلومات الصحية من الازدحام في قسم الطوارئ					
17. يؤثر تعطل نظام المعلومات الصحية على سير العمل					
18. يؤثر تعطل نظام المعلومات الصحية على سلامة المرضى					
19. يتم التأكد من ادخال العلامات الحيوية للمرضى بعد عودة نظام المعلومات الصحية					
20. يتم التأكد من ادخال ملاحظات الطبيب (doctor notes) بعد عودة نظام المعلومات الصحية					
ب. فحوصات المختبر					
1. يوجد تأخير في طلب الفحوصات المخبرية أثناء فترة توقف نظام المعلومات الصحية					
2. هناك آلية متفق عليها عند طلب الفحوصات المخبرية والحصول على النتائج خلال فترة توقف نظام المعلومات الصحية					
3. يقوم الطبيب بطلب الفحوصات المخبرية الضرورية فقط خلال فترة توقف نظام المعلومات الصحية					
4. يستمر الطبيب في طلب جميع الفحوصات الضرورية والاحترازية خلال فترة توقف نظام المعلومات الصحية					
5. يوجد تأخير في الحصول على نتائج الفحوصات المخبرية خلال فترة التوقف					
6. يقوم فني المختبر بتزويد الطبيب بالنتائج عبر الهاتف خلال فترة التوقف					
7. يزود فني المختبر الطبيب بالنتائج بإرسال مستندات ورقية من خلال موظف متخصص خلال فترة توقف نظام المعلومات الصحية					
ت. صور الاشعة					
1. يوجد تأخير في طلب صور الاشعة أثناء فترة توقف نظام المعلومات الصحية					
2. يوجد تأخير في الحصول على نتائج صور الاشعة أثناء فترة توقف نظام المعلومات الصحية					
3. هناك آلية متفق عليها لطلب صور الاشعة ومشاهدة صور الاشعة خلال فترة توقف نظام المعلومات الصحية					
4. يتم طباعة صور الأشعة المختلفة على قرص مضغوط وإرسالها مع موظف متخصص أو مع مرافق المريض إلى قسم الطوارئ أثناء فترة التوقف.					
ث. الدواء					
1. يوجد تأخير في طلب الادوية للمريض خلال توقف نظام المعلومات الصحية					

2. يمكن الرجوع الى السجل الطبي للمريض أثناء توقف نظام المعلومات الصحية لمعرفة الادوية التي تناولها المريض مؤخرا						
3. يتم التأكيد من ادخال جرعة الدواء التي تم اعطاؤها للمريض بعد عودة نظام المعلومات الصحية						
4. يتم التأكيد من ادخال معلومات IV Fluid الذي تم اعطاؤها للمريض بعد عودة نظام المعلومات الصحية						
ج. Admission						
1. يتم استقبال المريض الذي لم يتم تسجيله على نظام المعلومات الصحية بسبب تعطل النظام وتقديم العلاج اللازم له						
2. يتأخر ادخال المرضى من الطوارئ الى الأقسام بسبب توقف نظام المعلومات الصحية						
ح. التدريب						
1. يتم تدريب الموظفين على ما يجب القيام به في أوقات التوقف المخطط لها وغير المخطط لها لنظام المعلومات الصحية						
2. يتلقى الموظفون التدريب والتعليم فيما يتعلق بالسياسات والبروتوكولات والإجراءات الخاصة بأوقات تعطل نظام المعلومات الصحية						
3. يتم تدريب الموظفين على استخدام النماذج الورقية أو النظم البديلة						
4. تتوفر النماذج الورقية أو الأنظمة والبروتوكولات البديلة لتحل محل وظائف السجلات الطبية الإلكترونية الأساسية أثناء فترات التوقف.						
5. يغطي التدريب جميع الموظفين في جميع المناوبات، حسب ما تقتضيه الحاجة، بما في ذلك فترات المساء وعطلة نهاية الأسبوع						
6. يتم اجراء تدريب سنوي غير معلن يحاكي توقف نظام المعلومات الصحية عن العمل.						
7. تُستخدم محاكاة أوقات التوقف كطرق للتحضير لاحتمالية حدوث توقف فعلي لنظام المعلومات الصحية						
8. يتم استخدام أدوات معينة لقياس مدى استعداد المستشفى لأوقات تعطل النظام غير المخطط لها.						

الجزء الثالث: أسئلة عامة

كيف تقيم برنامج HIS من حيث استمرارية العمل بصورة مثالية بما يتعلق بـ "وقت التوقف، بطء البرنامج"؟
ما هي الاقتراحات لتحسين عمل النظام وتقليل فترات التوقف؟
هل تعتقد أن مشاكل بطء وتوقف نظام المعلومات الصحية HIS هي مشاكل تقنية أم مشاكل ادارية وماليه ولماذا؟
كيف يمكن تجنب أي تأثيرات سلبية لتوقف نظام المعلومات الصحيةHIS؟

Appendix A: 2-Questionnaire for Doctors and Nurses

A questionnaire on the impact of the health information system (HIS) downtime on the health services provided to emergency patients in government hospitals in the northern West Bank

Dear Employee:

The researcher is conducting a study on the impact of the Health Information System (HIS) downtime on the health services provided to emergency patients in government hospitals in the northern West Bank in order to complete a master's thesis in health informatics at the Arab American University.

The researcher obtained permission from the Ministry of Health to distribute the questionnaire to workers in the Ministry's facilities. The researcher will be grateful to you if you answer the questions of this questionnaire, while reserving your right not to answer any question that you do not want to answer, noting that it is not permissible for the researcher to use this data except for the purposes of scientific research.

Please read the instructions related to each section and each question carefully, your responses to the questions requested in this questionnaire will be treated with complete and absolute confidentiality, and your responses will not be known to anyone outside the research team, and they will not be disclosed to anyone within your health institution, and no information will be requested in the questionnaire identifies you.

If you have any other questions about the questionnaire, please contact the student according to the information below:

Student: Muath Lahlabat

Mobile: 0598900377

National: 0562401342

Email: muath.lahlabat@gmail.com

Supervisors: Dr. Youssef Al-Mimi, Dr. Rami Hodrob.

PART 1: DEMOGRAPHIC DATA

Gender: ☐ Male ☐ Female

Age: ☐ Less than 30 ☐ 30-40 ☐ 40-50 ☐ More than 50

Workplace: ☐ Rafedia Hosp. ☐ Jenin Hosp. ☐ Tulkarm Hosp. ☐ Tubas Hosp.

Education Level: ☐ Diploma ☐ Bachelor ☐ Master ☐ Doctorate

Job title: ☐ Doctor ☐ Nurse

Years of Experience: ☐ 1-5 years ☐ 6-10 years ☐ 11-15 years ☐ More than 15 years

Years of work in hospital: ☐ 1-5years ☐ 6-10 years ☐ 11-15 years ☐ More than 15 years

PART 2: DOWNTIME

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
A. **Downtime policies & procedures**	1	2	3	4	5
The hospital has a written and approved policy and procedures to deal with the downtime of the health information system.					
The downtime policy is reviewed and updated at least every two years.					
Lessons are learned after the downtime has occurred to identify problems that must be addressed in future training or policy adjustments.					
There is a fast notification system in place to notify medical staff of unplanned system outages and alert staff to affected systems.					
Medical staff are notified of planned system downtime					
There is a certain mechanism approved to notify the medical staff when the					

system returns to work.					
There is a communication strategy and communication between departments when the downtime occurs					
There are obstacles in communicating with other departments during the downtime					
Medical data will be recorded on paper during the downtime					
There is a clear procedure for re-entering medical data into the health information system when it returns to work.					
The missing medical data will be notified to the Quality Manager during the downtime of the health information system and appropriately documented as per the system					
The lack or errors of medical data shall be investigated, and the reasons reviewed					
Unplanned downtime and preparedness are treated like any other emergency					
The power outage is one of the main reasons for stopping the health information system					
The HIS downtime increases the patient's length of stay in the emergency department					
The HIS downtime increases crowding in the emergency department					
The downtime of the health information system affects the workflow					
The downtime of the health information system affects patients safety					
Ensure that patients' vital signs are entered after returning the health information system					
Make sure to enter doctor notes after returning the health information system					
B. Lab tests					
There is a delay in requesting laboratory tests during the downtime of the Health Information System					
There is an agreed mechanism for requesting laboratory tests and obtaining results during the downtime of the health information system					
The physician will only request the necessary laboratory tests during the HIS downtime					
The physician will continue to request					

all necessary and precautionary checks during the downtime of the Health Information System					
There is a delay in obtaining the results of the laboratory tests during the suspension period					
The laboratory technician provides the doctor with the results over the phone during the downtime					
The laboratory technician provides the doctor with the results by sending paper documents through a specialized employee during the downtime of the health information system					
C. Radiology images					
There is a delay in requesting x-rays during the downtime of the health information system					
There is a delay in obtaining X-ray results during the downtime of the health information system					
There is an agreed mechanism for requesting x-rays and viewing x-rays during the downtime of the health information system					
The different x-rays are printed on a CD and sent with a specialized employee or with the patient's companion to the emergency department during the downtime.					
D. Drugs					
There is a delay in requesting medication for the patient during the shutdown of the health information system					
It is possible to refer to the patient's medical record during the shutdown of the health information system to find out what medicines the patient has taken recently					
It is confirmed that the drug dose that was given to the patient has been entered after returning the health information system					
Confirmation of entering the IV Fluid information that was given to the patient after the health information system is returned					
E. Admission					
A patient who was not registered on the health information system due to system					

failure is admitted and the necessary treatment is provided					
The admission of patients from the emergency into the departments is delayed due to the downtime of the health information system					
F. Training					
Staff are trained on what to do during planned and unplanned downtime of the HIS					
Staff receive training and education regarding the policies, protocols, and procedures for when the health information system is down					
Staff are trained to use paper forms or alternative systems					
Paper forms or alternative systems and protocols are available to replace basic electronic medical records functionality during downtime.					
Training covers all employees on all shifts, as needed, including evenings and weekends					
An unannounced annual training is conducted that simulates the downtime of the health information system.					
Simulated downtime is used as methods to prepare for the probability of actual shutdown of the HIS					
Certain tools are used to measure the hospital's readiness for unplanned system downtime.					

PART 3: GENERAL QUESTIONS

How would you rate the HIS program in terms of optimal continuity in terms of "downtime, slowness"?
What are the suggestions to improve system operation and reduce downtime?
Do you think that the slowness and HIS downtime problem is technical or administrative or financial problems, why?
How can any negative impacts of HIS downtime be avoided?

Appendix B: 1-Questionnaire for IT Staff (باللغة العربية)

استبيان حول تأثير توقف نظام المعلومات الصحية (HIS) على الخدمات الصحية المقدمة لمرضى الطوارئ في المستشفيات الحكومية في شمال الضفة الغربية

عزيزي /تي الموظف /ـة:

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لقد حصل الباحث على إذن من وزارة الصحة لتوزيع الاستبيان على العاملين في مرافق الوزارة.

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إذا كان لديك أي استفسار آخر حول الاستبيان يرجى التواصل مع الطالب حسب المعلومات أدناه:

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المشرفون: د. يوسف الميمي، د. رامي حدرب.

الجزء الأول: المعلومات الديموغرافية

الجنس: ذكر ☐ انثى ☐

العمر: أقل من 30 ☐ 30-40 ☐ 40-50 ☐ أكبر من 50 ☐

مكان العمل: مستشفى رفيديا ☐ مستشفى جنين ☐ مستشفى طولكرم ☐ مستشفى طوباس ☐

مستوى التعليم: دبلوم ☐ بكالوريوس ☐ ماجستير ☐ دكتوراة ☐

الوظيفة: مبرمج ☐ مهندس ☐

سنوات الخبرة: 1-5 سنوات ☐ 6-10 سنوات ☐ 11-15 سنة ☐ أكثر من 15 سنة ☐

سنوات العمل في المستشفى: 1-5 سنوات ☐ 6-10 سنوات ☐ 11-15 سنة ☐ أكثر من 15 سنة ☐

الجزء الثاني: آثار وأسباب توقف نظام المعلومات الصحية ***HIS***

	غير موافق بشدة	غير موافق	محايد	أوافق	أوافق بشدة
أ. تكنولوجيا المعلومات					
1. فريق نظام المعلومات الصحية (HIS) متوفر على مدار الساعة حتى خارج ساعات العمل الرسمية طوال أيام الأسبوع لحل أي مشكلة.					
2. تتوفر أجهزة بديلة في حالة حدوث أي تعطل لأجهزة الحاسوب ومرفقاتها أو أجهزة ال network في قسم الطوارئ					
3. المستشفيات لديها مصدر طاقة غير منقطع (UPS) لأجهزة ال (network switches) في قسم الطوارئ					
4. المستشفيات لديها (UPS) مركزي لغرفة الخوادم (servers) الرئيسية					
5. يقوم موظفو تكنولوجيا المعلومات (IT) باختبار UPS مرة واحدة شهريًا على الأقل					
6. يتوفر مولد كهربائي ووقود كافٍ لتشغيل نظام المعلومات الصحية أثناء انقطاع التيار الكهربائي.					
7. يتم تحويل مصدر الطاقة الى المولد الكهربائي بشكل ألي عند انقطاع الكهرباء					
8. المستشفيات لديها مولد احتياطي مخصص لنظام المعلومات الصحية وبنيته التحتية					
9. يقوم موظفو دائرة الهندسة والصيانة بفحص عمل المولد الرئيسي مرة واحدة شهريًا على الأقل					

10. يعتبر انقطاع التيار الكهربائي من الاسباب الرئيسية لتوقف نظام المعلومات الصحية					
11. يعتبر حدوث خلل في شبكة الحاسوب من الاسباب الرئيسية لتوقف نظام المعلومات الصحية					
12. يعتبر حدوث خلل في انظمة التشغيل وقواعد البيانات من الاسباب الرئيسية لتوقف نظام المعلومات الصحية					
13. يوجد لنظام المعلومات الصحية موقع للنسخ الاحتياطي (Warm Site Backup) مجهز ويمكن الاعتماد عليه في حالة حدوث مشاكل في مركز البيانات (data center) الرئيسي					
14. يمكن تجهيز موقع للنسخ الاحتياطي خلال اقل من 8 ساعات ليحل مكان مركز البيانات الرئيسي					
15. تتصل اجهزة الشبكة بغرفة السيرفرات الرئيسة بأكثر من كابل (cable)واحد عبر مسارات مختلفة.					
16. هناك أجهزة شبكة وخوادم (servers) اضافية (stand by) في غرفة السيرفرات بحيث إذا حدث عطل في أحد الاجهزة لا يتوقف النظام					
17. يوجد أكثر من application server لتوزيع الحِمل (load balance) وتقليل احتمالية بطء أو توقف النظام					
18. يحتوي نظام المعلومات الصحية على نسخة احتياطية للقراءة فقط على مستوى المستشفى					
19. يتم إجراء نسخ احتياطي لبيانات المرضى وملفات الاعدادات للبرامج المهمة لعمليات المستشفى					
20. يتم تحديث بيانات النسخ الاحتياطي لملفات المرضى كل 24ساعة على الأقل					
21. يتم اختبار نسخة النظام الاحتياطية الخاصة بالقراءة فقط مرة واحدة في الشهر على الأقل					
22. يوجد نظام إلكتروني مطبق لإخطار الطاقم الطبي وإدارة المستشفى بحدوث توقف لنظام المعلومات الصحية في قسم الطوارئ.					
23. يوجد نظام إلكتروني مطبق لإخطار طاقم ال IT بحدوث توقف لنظام المعلومات الصحية في قسم الطوارئ.					
24. التعطل الوظيفي للنظام يتم تحديده والعمل على معالجته (على سبيل المثال وقت الاستجابة البطيء بشكل غير مقبول)					
25. يتوفر برنامج لمكافحة الفايروسات ويتم تجديد الرخص الخاصة به سنويا					
26. موظفو ال IT مدربين لحل كافة المشاكل المتعلقة بنظام المعلومات الصحية					
27. يتم التواصل مع المهندس المختص في وحدة الهندسة والحاسوب في حالة عدم المقدرة على تحديد أو حل مشكلة معينة.					
28. يتم الاستعانة بالشركات المحلية ذات العلاقة لحل المشاكل المتقدمة الخاصة بنظام المعلومات الصحية وبنيته التحتية.					
29. يتم تجديد كفالات servers وswitches وrouters باستمرار بمجرد انتهاء الكفالة السابقة.					
30. يوجد عقد صيانة مع الشركة المنفذة يجدد سنويا لتجنب حدوث أي طاريء قد يؤثر على توقف النظام بشكل تام.					
ب. التدريب					
1. تم تدريب موظفي المستشفى على ما يجب القيام به في أوقات التوقف المخطط لها وغير المخطط لها لنظام المعلومات الصحية.					

2. يتلقى الموظفون التدريب والتعليم فيما يتعلق بالسياسات والبروتوكولات والإجراءات الخاصة بأوقات تعطل نظام المعلومات الصحية.						
3. يتم تدريب الموظفين من قبل موظفي ال IT على استخدام النماذج الورقية أو النظم البديلة مثل excel datasheet						
4. تتوفر النماذج الورقية أو الأنظمة البديلة في حال توقف نظام المعلومات الصحية						
ت. سياسات واجراءات متعلقة بوقت التوقف Downtime						
1. يوجد في المستشفى سياسات وإجراءات مكتوبة ومعتمدة للتعامل في حال توقف نظام المعلومات الصحية عن العمل 2. يتم اجراء تجربة سنوية غير معلنة تحاكي توقف نظام المعلومات الصحية عن العمل.						
3. تُستخدم محاكاة أوقات التوقف كطرق للتحضير لاحتمالية حدوث توقف فعلي لنظام المعلومات الصحية.						
4. يتم استخدام أدوات معينة لقياس مدى استعداد المستشفى لأوقات تعطل النظام غير المخطط لها.						
5. يتم استخلاص العبر بعد حدوث توقف النظام لتحديد المشكلات التي يجب معالجتها في التدريب المستقبلي أو تعديل السياسات.						
6. توجد ألية معينة معتمدة لإبلاغ الموظفين عندما يعود النظام إلى العمل.						
7. يتم مراجعة وتحديث سياسة التعامل مع وقت التوقف كل عامين على الأقل						
8. تتم إستراتيجية التواصل عند حدوث توقف نظام المعلومات الصحية سواء المخطط أو غير المخطط له عبر البريد الإلكتروني						
9. توجد إستراتيجية اتصال وتواصل بين الأقسام عند حدوث التوقف.						

الجزء الثالث: أسئلة عامة

كيف تقيم نظام المعلومات الصحية من حيث استمرارية العمل بصورة مثالية بما يتعلق بـ "وقت التوقف، بطء البرنامج"؟
ما هي الاقتراحات لتحسين عمل النظام وتقليل فترات التوقف؟
هل تعتقد أن مشاكل بطء وتوقف نظام المعلومات الصحية هي مشاكل تقنية أم مشاكل ادارية وماليه ولماذا؟
كيف يمكن تجنب أي تأثيرات سلبية لتوقف نظام المعلومات الصحية؟

Appendix B: 2-Questionnaire for IT Staff

A questionnaire on the impact of the health information system (HIS) downtime on the health services provided to emergency patients in government hospitals in the northern West Bank

Dear Employee:

The researcher is conducting a study on the impact of the Health Information System (HIS) downtime on the health services provided to emergency patients in government hospitals in the northern West Bank in order to complete a master's thesis in health informatics at the Arab American University.

The researcher obtained permission from the Ministry of Health to distribute the questionnaire to workers in the Ministry's facilities. The researcher will be grateful to you if you answer the questions of this questionnaire, while reserving your right not to answer any question that you do not want to answer, noting that it is not permissible for the researcher to use this data except for the purposes of scientific research.

Please read the instructions related to each section and each question carefully, your responses to the questions requested in this questionnaire will be treated with complete and absolute confidentiality, and your responses will not be known to anyone outside the research team, and they will not be disclosed to anyone within your health institution, and no information will be requested in the questionnaire identifies you.

If you have any other questions about the questionnaire, please contact the student according to the information below:

Student: Moath Lahlabat

Mobile: 0598900377

National: 0562401342

Email: muath.lahlabat@gmail.com

Supervisors: Dr. Youssef Al-Mimi, Dr. Rami Hodrob.

PART 1: DEMOGRAPHIC DATA

Gender: ☐ Male ☐ Female

Age: ☐ Less than 30 ☐ 30-40 ☐ 40-50 ☐ More than 50

Workplace: ☐ Rafedia Hosp. ☐ Jenin Hosp. ☐ Tulkarm Hosp. ☐ Tubas Hosp.

Education Level: ☐ Diploma ☐ Bachelor ☐ Master ☐ Doctorate

Job title: ☐ Programmer ☐ Engineer

Years of Experience: ☐ 1-5 years ☐ 6-10 years ☐ 11-15 years ☐ More than 15 years

Years of work in hospital: ☐ 1-5years ☐ 6-10 years ☐ 11-15 years ☐ More than 15 years

PART 2: DOWNTIME

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
A. IT	1	2	3	4	5
The Health Information System (HIS) team is available around the clock even outside the official working hours, seven days a week, to solve any problem.					
Replacement devices are available in the event of any failure of the computer equipment and its attachments or the network equipment in the emergency department					
Hospitals have UPS for network switches in the emergency department					
Hospitals have a central UPS for the main server room					
IT staffs test UPS at least once a month					
A generator and sufficient fuel are available to operate the health information system during a power outage.					

The power source is automatically transferred to the generator when electricity is cut off					
Hospitals have a backup generator dedicated to the health information system and its infrastructure					
The Engineering and Maintenance Department employees check the operation of the main generator at least once a month					
Power outages are among the main reasons for HIS downtime					
A malfunction in the computer network is considered one of the main reasons for HIS downtime					
A defect in operating systems and databases is considered one of the main reasons for HIS downtime					
The Health Information System has a reliable and equipped Warm Site Backup in the event of problems in the main data center.					
A backup site can be prepared in less than 8 hours to replace the main data center					
Network devices are connected to the main server room with more than one cable through different paths.					
There are additional network devices and servers (stand by) in the servers room, so that if one of the devices malfunctions, the system does not stop					
There is more than one application server to load balance and reduce the possibility of system slowdowns or downtime 18. The Health Information System contains a read-only backup at the hospital level					
Patient data and settings files are backed up for important programs for hospital operations					
Patient file backup data is updated at least every 24 hours					
The read-only system backup is tested at least once a month.					
An electronic system is in place to notify the medical staff and the hospital administration of a health information system downtime in the emergency department.					
An electronic system is in place to notify IT staff of a health information system					

downtime in the emergency department.					
System failure is identified and acted upon (for example, the system or computer's slow response time is unacceptable).					
An anti-virus program is available and licenses are renewed annually					
IT personnel are trained to solve all problems related to the health information system					
Contact the engineer in charge in the Engineering and Computer Unit in the event of unable to identify or solve a specific problem.					
The relevant local companies are sought to solve advanced problems related to the health information system and its infrastructure.					
The guarantees for servers, switches and routers are constantly renewed as soon as the previous warranty expires.					
There is a maintenance contract with the implementing company that is renewed annually to avoid any emergency that may affect the system's complete shutdown.					
B. Training					
Hospital staff are trained in what to do during both planned and unplanned downtime of the HIS					
Hospital personnel receive training and education regarding the policies, protocols, and procedures for HIS downtime					
Employees are trained by IT staff to use paper forms or alternative systems such as excel datasheet					
Paper forms or alternative systems and protocols are available to replace basic electronic medical record functionality during downtime					
C. Downtime Policies and Procedures					
The hospital has written and approved policies and procedures for dealing in the event of HIS downtime					
An annual, unannounced trial is conducted that simulates the HIS downtime					
Simulation of downtime is used as					

methods to prepare for the probability of an actual HIS downtime					
Certain tools are used to gauge the hospital's preparedness for unplanned system downtime					
Lessons are learned after a system downtime to identify problems that must be addressed in future training or policy adjustments					
There is a certain mechanism in place to inform employees when the system is back in					
The downtime handling policy is reviewed and updated at least every two years					
The communication strategy of either planned or unplanned HIS downtime occurs via email					
There is a communication strategy and communication between departments, including the IT department, when the downtime occurs.					

PART 3: GENERAL QUESTIONS

How would you rate the HIS program in terms of optimal continuity in terms of "downtime, slowness"?
What are the suggestions to improve system operation and reduce downtime?
Do you think that the slowness and HIS downtime problem is technical or administrative or financial problems, why?
How can any negative impacts of HIS downtime be avoided?

Appendix C: AAUP Approval

Arab American University
Faculty of Graduate Studies

الجامعة العربية الأمريكية
كلية الدراسات العليا

2020-11-29

الى من يهمه الامر

تسهيل مهمة بحثية

تحية طيبة وبعد،

تهديكم كلية الدراسات العليا في الجامعة العربية الامريكية اطيب التحيات، وبالإشارة الى الموضوع أعلاه، تشهد كلية الدراسات العليا في الجامعة أن الطالب **معاذ عزت جودت لهلبت** والذي يحمل الرقم الجامعي **201820279** هو طالب ماجستير في برنامج المعلوماتية الصحية ويعمل حالياً على دراسة علمية بعنوان:

"تاثير توقف نظام المعلومات الصحية HIS على الخدمات الصحية المقدمة لمرضى الطوارئ في المستشفيات الحكومية في شمال الضفة الغربية" تحت اشراف الدكتور يوسف الميمي، نأمل من حضرتكم الايعاز لمن يلزم لمساعدته للحصول على المعلومات اللازمة للدراسة علماً ان المعلومات ستستخدم لغاية البحث فقط وسيتم التعامل معها بغاية السرية، وقد أعطي هذه الرسالة بناءً على طلبه.

وتفضلوا بقبول فائق الاحترام

عميد كلية الدراسات العليا

د. اشرف الميمي

كلية الدراسات العليا
FACULTY OF GRADUATE STUDIES

Page 1 of 1

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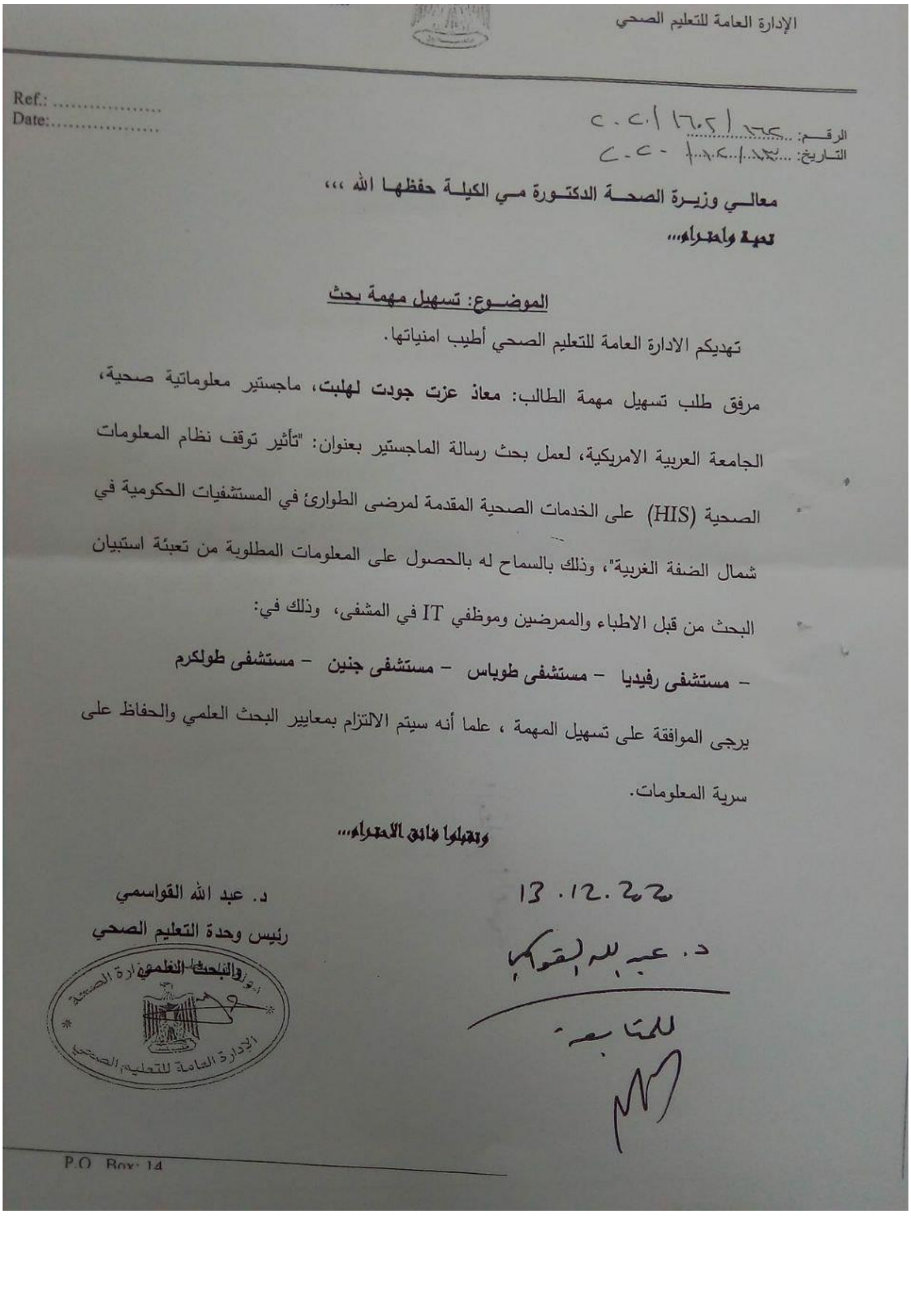
Ramallah Tel: +970-2-2941999 Fax: +970-2-2941979 Abu Qash - Near Alrehan
E-mail: FGS@aaup.edu ; PGS@aaup.edu Website: www.aaup.edu

Appendix D: MOH Approval



الإدارة العامة للتعليم الصحي

Ref.: ....
Date:..................

الرقم:
التاريخ:

معالـــي وزيـرة الصحـــة الدكتـــورة مـــي الكيلـــة حفظهـــا الله ،،،

تحية واحترام،،،

الموضـــوع: تسهيل مهمة بحث

تهديكم الادارة العامة للتعليم الصحي أطيب امنياتها.

مرفق طلب تسهيل مهمة الطالب: **معاذ عزت جودت لهلبت**، ماجستير معلوماتية صحية، الجامعة العربية الامريكية، لعمل بحث رسالة الماجستير بعنوان: "تأثير توقف نظام المعلومات الصحية (HIS) على الخدمات الصحية المقدمة لمرضى الطوارئ في المستشفيات الحكومية في شمال الضفة الغربية"، وذلك بالسماح له بالحصول على المعلومات المطلوبة من تعبئة استبيان البحث من قبل الاطباء والممرضين وموظفي IT في المشفى، وذلك في:

- مستشفى رفيديا - مستشفى طوباس - مستشفى جنين - مستشفى طولكرم

يرجى الموافقة على تسهيل المهمة ، علما أنه سيتم الالتزام بمعايير البحث العلمي والحفاظ على سرية المعلومات.

وتقبلوا فائق الاحترام،،،

د. عبد الله القواسمي
رئيس وحدة التعليم الصحي
والبحث العلمي

13.12.22

د. عبد الله القواسمي

للمتابعة

P.O. Box: 14

ملخص الدراسة

مقدمة

اعتمدت معظم المؤسسات الصحية، وخاصة الحكومية في فلسطين، مؤخرًا السجلات الصحية الإلكترونية، أو ما يعرف بنظام المعلومات الصحية. ينظم نظام المعلومات الصحية جميع الإجراءات الطبية والإدارية في المستشفيات، من تسجيل المرضى والتشخيص وطلبات الأشعة السينية والفحوصات المخبرية والأدوية والتسعير وحتى وجبات الطعام والمزيد. على الرغم من الأهمية الكبيرة للتحول من نظام ورقي إلى نظام إلكتروني، إلا أن هذا النظام يخضع للعديد من التحديات، خاصة أنه يعتمد على شبكة الكمبيوتر والإنترنت. يعد تجنب تعطل نظام معلومات الصحة أحد الاهتمامات الأساسية للمستشفيات.

الغرض من الدراسة

الغرض من هذه الدراسة هو تقييم "تأثير تعطل نظام المعلومات الصحية على تقديم خدمات الرعاية الصحية لمرضى الطوارئ في المستشفيات العامة في شمال الضفة الغربية".

طرق الدراسة

كانت الدراسة عبارة عن دراسة مقطعية. اشتملت الدراسة على 4 مستشفيات حكومية في شمال الضفة الغربية في فلسطين. تألف مجتمع الدراسة من 124 موظفًا، بما في ذلك 40 طبيبًا و76 ممرضًا في أقسام الطوارئ و8 موظفين من قسم تكنولوجيا المعلومات في المستشفيات الأربعة. نظرًا لصغر حجم مجتمع الدراسة، تكونت عينة الدراسة من جميع الأطباء والممرضات وموظفي تكنولوجيا المعلومات العاملين في المستشفيات المستهدفة. في هذه الدراسة تم استخدام المنهج المختلط (الكمي والنوعي) من خلال تصميم استبيانين أحدهما موجه لموظفي تقنية المعلومات والآخر موجه للأطباء والممرضات في أقسام الطوارئ. تم تحليل البيانات باستخدام الإصدار 25 من حزمة IBM الإحصائية للعلوم الاجتماعية (SPSS).

النتائج

تم استكمال مائة وستة من أصل 116 استبانة وإعادتها إلى الباحث (نسبة الاستجابة 91.38٪). أظهرت نتائج الإحصاء الوصفي أن تعطل نظام المعلومات الصحية يؤثر على سير العمل (المتوسط = 4.4490)، يزيد من الازدحام في قسم الطوارئ (المتوسط=4.3367)، مما يتسبب في تأخير طلب الاختبارات المعملية (المتوسط = 4.2551)، مما يتسبب أيضا في تأخير في

طلب صور الأشعة (المتوسط = 4.1633) وزيادة مدة بقاء المريض في قسم الطوارئ (المتوسط = 4.0510). أظهر اختبار ANOVA أن هناك فروق ذات دلالة إحصائية على مستوى ($p\leq0.05$) في متوسط استجابات المستجيبين حول مدى تأثير تعطل HIS على الخدمات الصحية المقدمة لمرضى الطوارئ بسبب متغير الجنس ($p = 0.039$) ومتغير المسمى الوظيفي ($p = 0.0303$).

الاستنتاج

وجدت الدراسة أن فترة تعطل نظام المعلومات الصحية تؤثر بشكل كبير على سير العمل وتقديم الخدمات الصحية للمرضى. شدد الباحث على الحاجة الملحة لاعتماد خطط وسياسات رسمية للتعامل مع التوقف عن العمل وتدريب الكوادر الطبية على ذلك، وإلقاء الضوء على بعض الأسباب التي تزيد من احتمالية توقف نظام المعلومات الصحية عن العمل. علاوة على ذلك، قدمت الدراسة بعض التوصيات لمتخذي القرار للمساعدة في تقليل وقت تعطل نظام المعلومات الصحية.