Evaluating EHR and Health Care in Jordan According to the International Health Metrics Network (HMN) Framework and Standards: A Case Study of Hakeem

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ABSTRACT Hakeem is one of the e-health systems that were implemented in Jordan to support the health care and services of medical sectors by connecting public health hospitals all around Jordan. This paper was carried out as a unique and first study to investigate the effectiveness of Hakeem health system according to the international health information systems standards. The health metrics network (HMN) framework and standards for country health information systems are used to measure the Hakeem system from different perspectives to ensure that it meets its objectives to maintain the required level of medical services in Jordan compared to international systems. The study was conducted on 522 respondents of Hakeem system users from four hospitals and ten health centers in Jordan. Data were collected by a valid and reliable questionnaire and interviews and analyzed by SPSS software. The study results indicated that the conformity extent of Hakeem system's components with HMN framework and standards are in different agreements percentages. Some components are with acceptable percentages such as the integration polices and data processing while other components are with moderate, low, and very lower percentages that needed improvements. In light of the results, the study introduces some recommendations to improve Hakeem systems such as improving the technical support of the entire system and the services used in the pharmacy unit.

INDEX TERMS E-health, electronic health record, Hakeem system, HMN framework, Jordan, national strategy of health sector, world health organization.

I. INTRODUCTION

The health sector in any country should be emphasized to have a healthy community. The historical information about patients should be stored and retrieved when its needed and easily communicated within the health sector itself and patients. Therefore, health care should benefit from the rapid advances in information and communications technology forming the concept of e-health. The e-health is ''an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way

of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology'' [1].

E-health's significant growing nowadays due to the many advantages and capabilities are provided. As an example in a data entry process, it saves the data in small spaces, retrieves data quickly, eliminates data redundancy, allows data communication, reduces errors and increases the data integrity. In addition, EHRs contain the medical history of patient that can be retrieved and accessed at any time in order to show the patient's illnesses, operations, medications, allergies and lab results. The EHR can help doctors to avoid giving the inappropriate medications to patients such as that cause risk or allergy to patient and therefore it might help in saving patients' life and decreasing morbidity and mortality rates.

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In addition, it helps in sharing and communicating data within and among the health service providers that helps in following the patient's case, exploring the x-ray and laboratory results, eliminating paper work, supporting decision makers by choosing the appropriate medications and treatment and consulting specialists. Furthermore, some e-health systems may grant patients access to healthcare services which will save their time and money to visit the health service provider and keep them connected especially in emergency cases [2]. Stored data in EHR can be retrieved and analyzed easily and help in generating medical reports that can be used in education and research purposes [3].

The Hashemite Kingdom of Jordan is one of the Arab countries that is located in the south-west of Asia and considered heart of the Middle East. It is within an easy reach to all major Europeans, Asians and Africans cities. Many tourists from all over the world visit Jordan to discover the Jordanian historical places especially Petra that is considered the capital of Nabataean Arabs and one of the most famous archaeological sites in the world. Recently, Jordan is paying much attention to health service providers and e-health systems.

The National Strategy of Health Sector in Jordan for 2015-2019 was created based on the deep analysis of existing situation of Jordanian health sector with the main structure of health system that was adopted by the World Health Organization (WHO). The main goal of the strategic plan as mentioned in the Ministry's documentation is to ensure a high quality of health services for all people in Jordan. Therefore, health sectors partnership to develop health policies that ensure the excellence and efficiency of health services through using an excellent e-health system [4], [5].

An EHR called Hakeem was launched by his Majesty King Abdullah Bin Al-Hussein to improve the health care and quality of Jordanian medical sectors [4], [6]. The program aims to improve the efficiency and quality of health care in Jordan through nationwide implementation of an EHR solution. The patient's medical records are shared between the health service providers that are connected by Hakeem system. The privileged Hakeem system's users in any health service provider, use the social security number to access all patients' information such as the history visits, allergies, taken medicines, health images, lab results, etc.

It is important to evaluate Hakeem system according to the international health systems standards in order to ensure that it meets its objectives by providing the required level of services to patients, doctors, physicians, pharmacists, accountants, and other users. Therefore, this study aims to investigate the extent of the conformity of Hakeem e-health system with the Health Metrics Network (HMN) framework and standards for country health information systems that is hosted by the World Health Organization [7].

The rest of the paper is organized as follows: the related work is overviewed in Section 2. The HMN framework and standards for country health information systems is listed in Section 3. The study objectives and questions are listed in Section 4. The study methodology is explained in Section 5.

Data analysis and results are reported and discussed in Section 6. Finally, the conclusions of the paper and the study recommendations are presented in Section 7.

II. RELATED WORK

This section introduces some examples of e-health systems that were developed to help improving the health care and health services. Then it presents the conducted health care research in Jordan.

A. EXAMPLES OF E-HEALTH SYSTEMS

A disease surveillance system is a real-time detection system that monitors group of communicable diseases, such as Dengue Fever. It was applied in Sri Lanka and India to solve the problem of manual data processing and sharing between centers which might take between 15-30 days. It facilitates the data communication and provides further analysis of data [8]. Indoor surveillance system was developed to monitor the oxygen level inside the home and then warn people if the safe level of oxygen in the air is decreased [9].

A decision support system (DSS) was presented by Mohktar *et al.* in order to remotely provide healthcare services to patients, to assist home tele-health, to reduce visit costs, to enhance the power of multidisciplinary teams and to provide efficient communication between tele-health users. The system showed its advantages in serving remote patients efficiently especially elderly ones [10].

Another decision support system that is used for early recognition and management of acute kidney injury (AKI) was investigated by Kanagasundaram *et al.* [11]. The study aimed to identify the promoting or inhibiting factors for using this system for in-patients. They undertake qualitative evaluation of an AKI CCDS system within the National Health Service of England and Wales. It has revealed precisely those themes and a tool was developed in-house and required experiential learning to meet some user demands. In addition, it revealed those themes that have affected other CCDS implementations. The study results concluded that in order for AKI interventions to become incorporated into routine clinical practice, a clinician approval should be established. In addition, it recommended designing a suitable interaction between technologies, people and organizations.

Reminder systems were proposed long time ago to alert patients and health care professionals for specific health situations [12], [13]. Recently, Sebastián-Viana *et al.* proposed a new reminder system to improve patients follow up and reduce the risks of developing a bad health situation. The new system alerts healthcare professionals about the health status of patients who suffer from pressure ulcer [14]. The results of the study showed that the system was effective at reducing the risks of developing a pressure ulcer [14].

Another health system is called Appointment System was developed by Abisoye et al. as an online outpatient database system for General Hospital Minna in Nigeria to keep the outpatients records, reduce patients waiting time and improve medical service delivery [15]. They implemented an e-health

application with clear improvements that eliminate the existing obstacles in the manual system [15].

B. HEALTH CARE RESEARCH IN JORDAN

The Hashemite Kingdom of Jordan keeps up with the development in all areas especially the health sector. Several studies of e-health in Jordan were proposed. One of the earliest studies was proposed by Rawabdeh that examined the potential of implementing an e-health strategy that serves patients and health facilities in Jordan [16]. He used qualitative data collection approach and made interviews. He concluded that an e-health in Jordan is a long way to go and insurmountable challenges faces e-health in Jordan [16].

Several other studies investigated the challenges of e-health in Jordan. Nassar *et al.* divided the challenges into general challenges such as: financial, technological, policy and legislative challenges and into specific challenges such as: stakeholder and organizational challenges [17]. Jalghoum and Khasawneh presented that most of the challenges due to human and cultural issues [18]. Both studies presented some suggestions to managers in order to overcome these limitations such as the mission and vision of the health program should be clearly mentioned in the strategic plan, financial support should be considered and stakeholders should be involved in all phases and promoted for their use of the system [17], [18].

Additional barriers to EHR in Jordan were mentioned by Matar and Alnabhan in 2014. They used two surveys: one was distributed to hospital managers and the other one to patients. Additional investigation was done to hospitals' websites. The study concluded several barriers such as the lack of hospital administration awareness and expertise towards e-health, limited financial resources, and restrictive hospitals policies. Patients showed the importance of e-health services to fulfill their needs [19].

Jordan has lunched Hakeem system as an e-health system that aims to solve the mentioned faced challenges. It was a tremendous change that aims to connect all public health service providers in Jordan. Several researchers studied Hakeem system such as Nassar *et al.* [20]. Their study aimed to assess five internal factors: financial, customer, internal process, medical information quality, and growth perspective. The study was based on an interview in addition to a questionnaire that was distributed to Prince Hamzah Hospital. The results showed that all the above mentioned factors are affected by each other and significant to the success of Hakeem system [20].

AlZghoul *et al.* studied e-health in Jordan and found that there is a lack of an appropriate middleware in e-health that causes the electronic health records to be inaccessible on the national level [21]. They suggested a new middleware architecture that facilitates secure data exchange and allows access to the database server regardless of the time or location [21]. Tubaishat and Alrawajfah measured the level of use of e-health records in Jordanian hospitals based on the American Hospital Association annual survey that measures

the level of adoption of e-health services [22]. They concluded that the level is relatively low. A very low percent of hospitals uses EHR in all hospital's divisions; some uses EHR in one division and most hospitals don't use the EHR [22]. Rasmi *et al.* proposed a model that concentrates on the role of the behavior of health care professionals in using EHR system in Jordan [23].

El-Jardali and Fadlallah emphasized the existence of a common standards and policies to improve the health care quality and safety in Jordan and Lebanon [24]. Their research was based on interviews, survey, and documentation review. The study concluded an improvement in health care quality and accreditation policies fulfillment and highlights the importance of unifying policies and strategies in order to improve the health quality care and patient safety [24].

Alsobeh et al. proposed a framework for health data collection and integration for the Jordanian health sector. The study was based on analyzing cancer and diabetes health data. The analysis focused in integration and collection features. As a result, they suggested a common mechanism for data collection to reduce incompatibility and integration problems. In addition, they recommended a common framework between all Jordanian health organizations that should improve the quality of the health service provided [25].

C. THE IMPORTANCE OF THE STUDY

Previous studies in Jordan presented the barriers of implementing the e-health systems and recommended a development of new e-health system. Accordingly, Hakeem system was launched as a pilot deployment that presents the e-health system for public hospitals in Jordan and will be deployed in future for other public and private health service providers. Few studies investigated the Hakeem system such as Nassar et al. in 2015 and Alsobeh et al. in 2019. Nassar et al. evaluated five internal factors of Hakeem system in one public hospital in Jordan while Alsobeh et al. suggested a common mechanism for data collection to reduce incompatibility and integration problems [20], [25].

This study was carried out as a unique and first study that aims to investigate the effectiveness of Hakeem health system according to the international health information systems standards. The HMN framework and standards for country health information systems are used to measure the Hakeem system from different perspectives to ensure that it meets its objectives to maintain the required level of medical services in Jordan compared to international systems.

III. HMN FRAMEWORK AND STANDARDS FOR HEALTH INFORMATION SYSTEMS

The Health Metrics Network (HMN) was started in 2005 and funded by Bill and Melinda Gates Foundation, the UK Department for International Development (DFID), the Danish International Development Agency (DANIDA), the Netherlands Ministry of Foreign Affairs, the United States Agency for International Development (USAID), the European Commission (EC) and by the host of the World Health
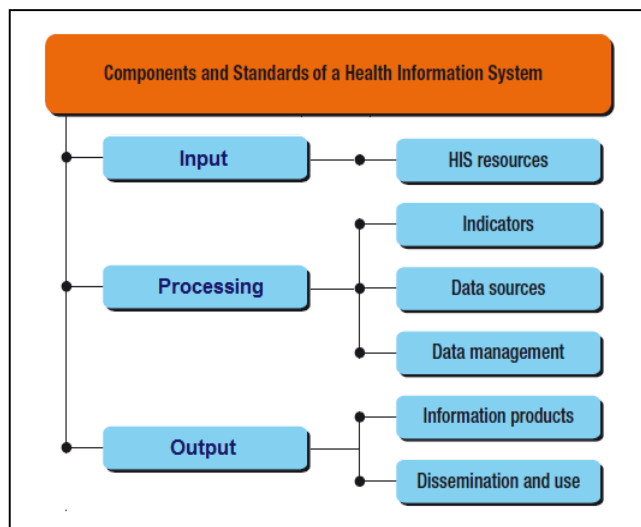
FIGURE 1. Health information system components based on HMN standards and framework.

Organization (WHO). It aims to help countries and other partners improve global health by strengthening the systems that generate health-related information for evidence-based decision-making [7].

HMN is the first global health partnership that focuses on enhancing entire health information and statistical systems and strengthening country leadership for health information production and use in low and low-middle income countries such as Jordan. The HMN Framework and Standards for Country Health Information Systems was coordinated and launched in 2012 to be a standard for developing countries and global agencies that unifies data collection, reporting and use of health information. It divides the components and standards of a health information system into six components under the input, processing and output phases as shown in Fig. 1 [7].

1. HIS resources: include financial and human resources, infrastructure, policies, and coordination.
2. Indicators: are needed to assess changes in three major domains; the determinants of health, health system and health status.
3. Data sources: include health information data sources and are divided into population-based and institution-based.
4. Data management: consists of data storage, ensuring data quality and data processing.
5. Information products: involve transforming data into information.
6. Dissemination and use: contains use of information for decision-making, institutionalizing information use and demand.

IV. STUDY OBJECTIVES AND QUESTIONS
This study aims to investigate the extent of the conformity of Hakeem e-health system with the Health Metrics

Network (HMN) framework and standards for country health information systems that are hosted by the World Health Organization [7].

To achieve the above objective, the study contains three questions:

1. *What is the extent of the conformity of Hakeem e-health system's input with the Health Metrics Network (HMN) framework and standards regarding input components?*
2. *What is the extent of the conformity of Hakeem e-health system's processing with the Health Metrics Network (HMN) framework and standards regarding processing components?*
3. *What is the extent of the conformity of Hakeem e-health system's output with the Health Metrics Network (HMN) framework and standards regarding output components?*

V. STUDY METHODOLOGY
This study uses survey research method through two tools; a questionnaire and an interview to achieve its purposes. An interview was conducted with different users of the following units: doctor, nurse, dentist, pharmacy, maternity, radiology, medical lab and reception. The interview helped in reviewing the Hakeem system interfaces and components and understanding its use, advantages and barriers.

A structured questionnaire with five pages was developed based on the collected information from an earlier reviewed literature, interview, Jordanian Ministry of Health strategic plan as well as the HMN standards and framework. It is consisted of two main sections: one containing three questions related to demographic information, and the other containing 37 questions that aim to investigate the extent of the conformity of Hakeem e-health system with the HMN framework and standards. A 3-point Likert scale with (1) representing 'disagree', (2) representing 'neutral' and (3) representing 'agree' was used.

Before sending the questionnaire to health service providers, it was checked by four IT specialist reviewers in order to obtain their feedback, add questions, if any, missing from the questionnaire, delete any irrelevant questions; and refine/rephrase the language and the flow of the existing questions. Their comments were applied to the questionnaire to validate its content and to bring more clarity to it.

To assess the content validity of original questionnaire, the four judges reviewed the modified questionnaire to solicit their opinions on the clarity and the extent to which the study could meet the intended objectives. The content validity index (CVI) as well as the internal consistency by Cronbach's alpha were used. In the phase of CVI assessment, 5 questions obtained a score of less than 0.61, and were omitted while the rest 40 questions obtained a score of more than 0.79. The Cronbach's alpha coefficient of the whole questionnaire was 0.916.
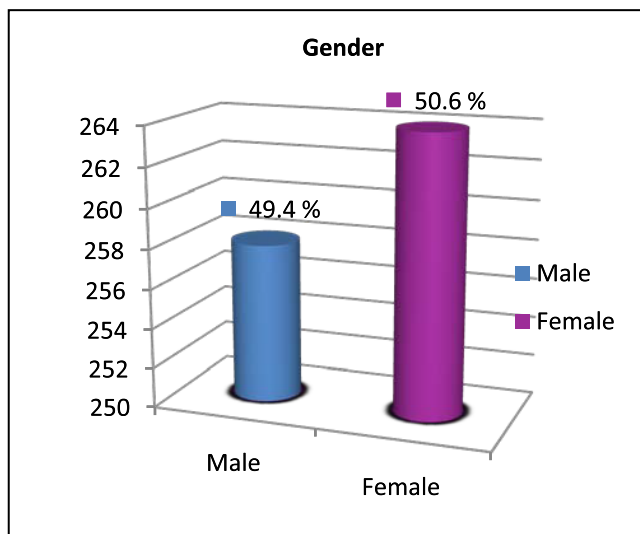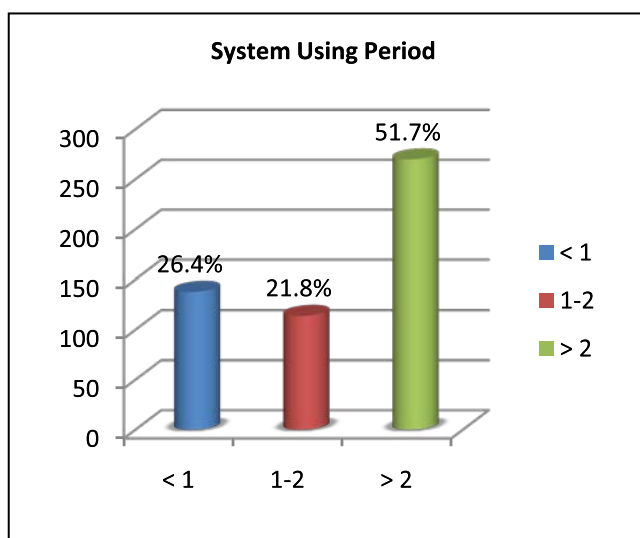
FIGURE 2. Distribution of respondents based on gender.

FIGURE 3. Distribution of respondents based on system using period.

A. CHARACTERISTICS OF STUDY RESPONDENTS

A total of 800 questionnaires were distributed to four hospitals; Prince Rahma, Prince Badeeaa, Yarmouk and Raya hospitals and ten medical centers; Kufuryoba, Yarmouk University, Al Farooq, Houwara, Ibn Sina, AlRazi, Bayt Ras, Al Tatweer Alhathary, Bishra and Altwal health centers. Only 522 (65.3%) of distributed questionnaires were returned.

Demographic characteristics of respondents illustrate their gender, duration of the use, and the working units. Fig. 2 shows 258 (49.4%) of the respondents were male and 264 (50.6%) were female.

Almost half of the respondents (51.7%) used the system for more than two years, while the other half is almost equally distributed between a period of less than a year (26.45%) and between one and two years (21.8%) as shown in Fig. 3.

Fig. 4 shows that the respondents are distributed over ten units, 72 (13.8%) in reception unit, 198 (37.9%) in doctors unit, 30 (5.7%) in radiology unit, 25 (4.8%) in medical lab

unit, 72 (13.8%) in pharmacy unit, 15 (2.9%) in accounting unit, 38 (7.3%) in accident and emergency unit (A&E), 2 (0.4%) in endoscopy unit, 54 (10.3%) in nursing unit, 16 (3.1%) in maternity unit.

VI. DISCUSSION AND RESULTS

The study contains three questions, they are:

1. *What is the extent of the conformity of Hakeem e-health system's input with the Health Metrics Network (HMN) framework and standards regarding input components?*

According to the HMN framework and standards the input component includes the IT recourses which contain the financial and human resources, infrastructure, policies, and coordination. Fig. 5 identifies the percentages of Hakeem system's IT recourses conformity with HMN framework and standards as following: (45%) to Human resources, (29%) to(42%) to infrastructure, (70%) to integration polices and (43%) to coordination.

2. *What is the extent of the conformity of Hakeem e-health system's processing with the Health Metrics Network (HMN) framework and standards regarding processing components?*

According to the HMN framework and standards the processing component includes three sub-components; the indicators, data sources and data management. The indicators include determinants of health, health system and health status. The data sources include population-based and institution-based data. The data management includes data storage, ensuring data quality and data processing.

Fig. 6 identifies the percentages of Hakeem system's indicators conformity with HMN framework and standards as following: (54%) to determinants of health, (44%) to health system and (23%) to health status.

Fig. 7 identifies the percentages of Hakeem system's data sources conformity with HMN framework and standards as following: (79%) to institution-based data source and (20%) to population-based data source.

Fig. 8 identifies the percentages of Hakeem system's data management conformity with HMN framework and standards as following: (56%) to data storage, (42%) to ensuring data quality and (63%) to data processing.

3. *What is the extent of the conformity of Hakeem e-health system's output with the Health Metrics Network (HMN) framework and standards regarding output components?*

According to the HMN framework and standards the output component includes two sub-components; the information products and information dissemination and use. The information products include transforming data into information while the information dissemination and use include the decision making and the use of this information.

Fig. 9 identifies the percentages of Hakeem system's information products conformity with HMN framework and
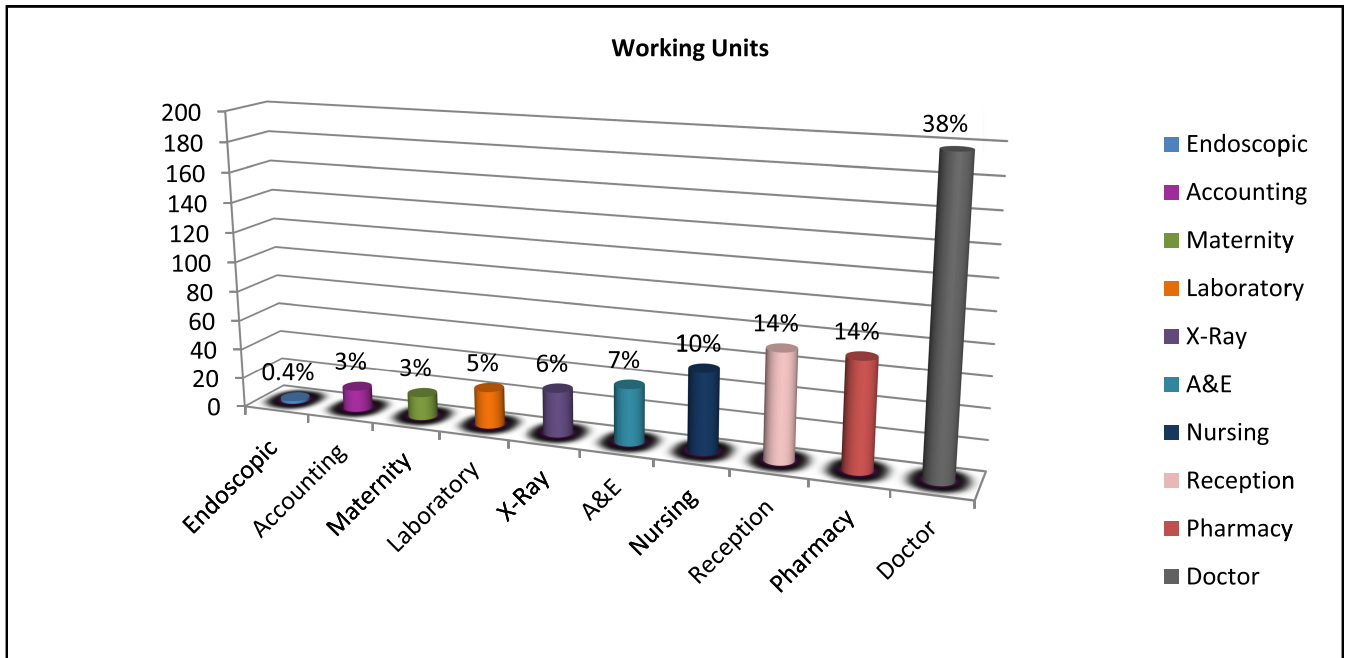
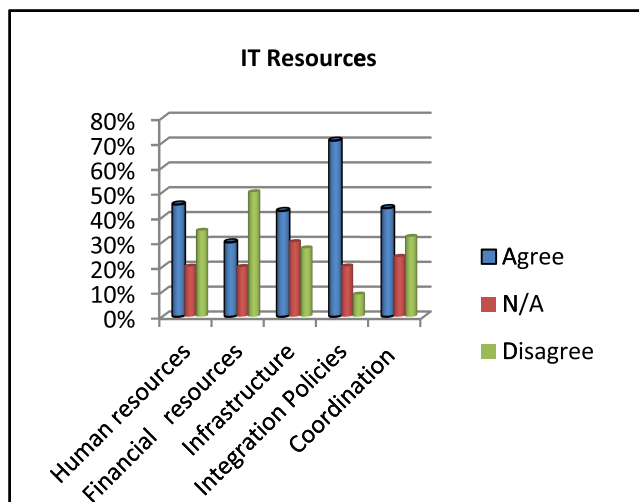**FIGURE 4.** Distribution of respondents based on working uints.

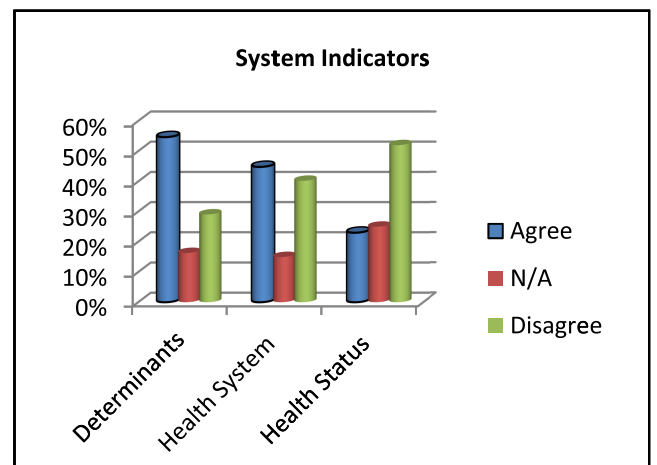**FIGURE 5.** Respondents answers about IT resources in Hakeem.

FIGURE 6. Respondents answers about indicators in Hakeem.

standards as (52%) to transforming the input data into useful information.

Fig. 10 identifies the percentages of Hakeem system's information dissemination and use conformity with HMN framework and standards as (49%) to evidence-based decision making and (38%) to the use of information to prioritize and allocate resources.

According to the results in Figures 5 – 10, Table 1 illustrates a summary of the respondents' agreements levels on the conformity of Hakeem system's components with HMN framework and standards.

As shown in Table 1, the conformity extent of Hakeem system's components; the institution-based data, integration polices and data processing with HMN framework and

standards is acceptable with percentages between 60-79%. Most data of clinical services or health status at the time of clinical encounters are generated routinely during the recording and reporting of delivered services to present the institution-based data. The integration process in Hakeem system is referred to the integration between the Hakeem system, the Jordanian Health Ministry and the Jordanian Ministry of Information and Communications Technology which is responsible on designing, strengthening and supporting data collection, transmission, analysis, reporting and dissemination. The data processing in Hakeem system includes data extraction, data usability and data validity.

The conformity extent of Hakeem system's components; the determinants of health, data storage and transforming data into information with HMN framework and standards is
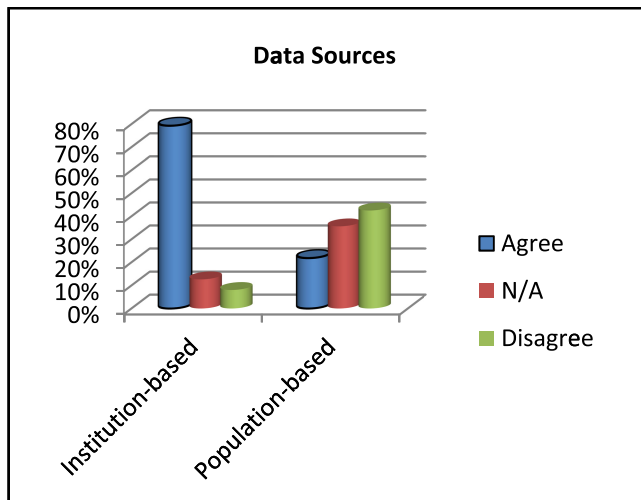
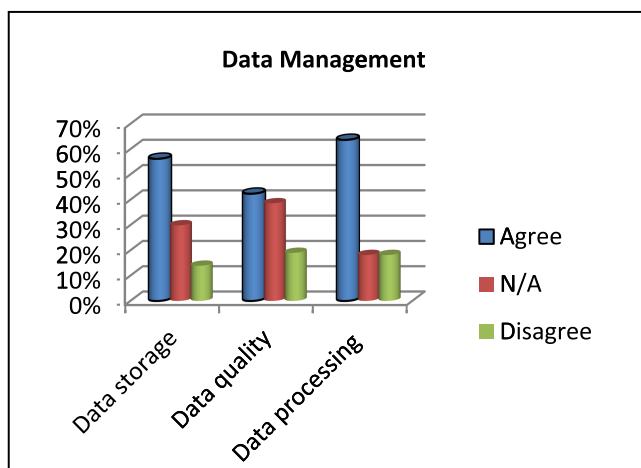**FIGURE 7.** Respondents answers about data sources in Hakeem.

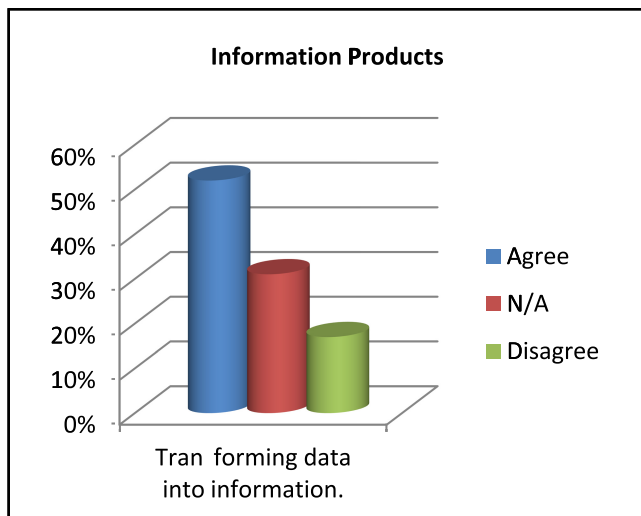**FIGURE 8.** Respondents answers about data management in Hakeem.

FIGURE 9. Respondents answers about information products in Hakeem.

FIGURE 10. Respondents answers about information dissemination and use in Hakeem.

TABLE 1. Respondents' agreements levels on the conformity of Hakeem system's components with HMN framework and standards.

Agreements with acceptable percentage	
Components	**Percentage**
Institution-based data source	79%
Integration polices	70%
Data processing	63%
Agreements with moderate percentage	
Determinants of health	54%
Data storage	56%
Transforming data into information	52%
Agreements with low percentage	
Decision making	49%
Human resources	45%
Health system	44%
Coordination	43%
Ensuring data quality	42%
Infrastructure	42%
Agreements with very low percentage	
The use of information	38%
Financial recourses	29%
Health status	23%
Population-based data source	20%

moderate with percentages between 50-59%. It might be due to the fact that much of these indicators come from other secto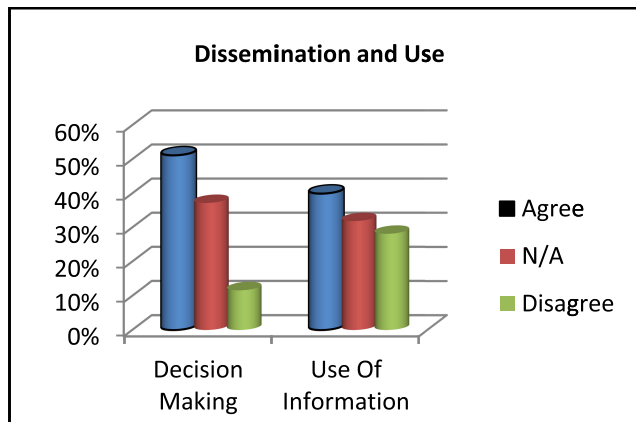rs than the health sectors and the interrelationship between them is not very strong. In addition, the connectivity to data storage is not very stable and there is a delay in recovering the failed connection or in the required maintenance that might affect transforming the input data into useful information.

The conformity extent of Hakeem system's components; the decision making, human resources, health system, coordination, ensuring data quality and infrastructure with HMN framework and standards is low with percentages between 40-49%. The data is used in decision making immediately without using analysis and knowledge management tools that could help in decision making process. The training and educational schemes that are provided to human resources and the coordination of health information system components

are not enough. Many of health service providers' infrastructures are not very suitable due to the lack of financial budget that uses old buildings and obsolete technology and computers that effect health system utilization, service coverage, data quality and prevent appropriate communications.

The conformity extent of Hakeem system's components; the use of information, financial recourses, health status and population-based data with HMN framework and standards is very low with percentages between 20-39%. The use of information to prioritize and allocate resources is very low due to the fact that there are no clear policies that help in allocating data to actual resources. In addition, the lack of budget and funds for health sectors is presenting the low percentage of financial resources. Responses indicated a very low adherence to the health status component and this might due to the absence of statistical information such as the level of mortality, morbidity and disability. The generated data from censuses, civil registration or population surveys are not used in Hakeem system which causing the system to use individual-based data sources rather than the population-data sources.

VII. CONCLUSION AND RECOMMENDATIONS

Jordan is concentrating on having good health services and e-health system that improve the efficiency and quality of health care. Therefore, Hakeem system as an e-health system has been launched to connect public health facilities in Jordan. The current study investigated the extent of the conformity of Hakeem e-health system with the HMN framework and standards to ensure that it meets its objectives to maintain the required level of medical services in Jordan compared to international systems. An interview and a questionnaire have been conducted to achieve the purpose of the study.

The study results indicated that the conformity extent of Hakeem system's components with HMN framework and standards are in different agreements percentages; acceptable percentages, moderate percentages, low percentages and very low percentages.

In light of what this study has found, the following recommendation could be taken in consideration to enhance the Hakeem e-health system:

- Upgrade the current infrastructure to increase the system performance.
- Increase the training and educational schemes for employees.
- Connect the public health sector with private health sectors and other government sectors.
- Improve the communication between all shared sectors.
- Use analysis and knowledge management tools that could help in decision making process.
- Connect patients with the Hakeem system to allow them to check their examination or lab results anywhere and anytime.
- Security and privacy issues should be emphasized, especially when allowing patients to access the system.

- Transforming patients from one health center to another one should be implemented electronically in order to eliminate all paper work.
- Speed up the data entry processes to help doctors entering the patients' information quickly and serve more patients.
- Add statistical reports to the system that measure the health status in the Jordan such as morbidity and mortality ratios.
- Strengthen the system in pharmacy unit to reduce the time needed for dispensing medical prescription for patients as well as providing a mechanism to determine the number of remaining medicines in the pharmacy with its expiry dates and its alternative choices.
- Connect the accounting system with pharmacy to help in counting the medicines prices.

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