

## Effectiveness of Health Information System Applications: Clinical Information and Diagnosis-Treatment Systems in Turkey

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### Abstract

The distinctive quality of the new social structure is that information becomes the only factor of production. In today's organizations, public administrators are directly responsible for applying information to administrative processes. In addition to his managerial responsibilities, a knowledge based organization requires every employee to take responsibility for achieving efficiency. This has increased the importance of information systems in the decision-making process. Information systems consist of computer and communication technology, data base management and model management and include activity processing system, management information system, decision support systems, senior management information system, expert systems and office automation systems. Information systems in the health sector aim at the management and provision of preventive and curative health services. The use of information systems in healthcare has the benefits of increasing service quality, shortening treatment processes, maximizing efficiency of the time, labour and medical devices. The use of information systems for clinical decision making and reducing medical errors in the healthcare industry dates back to the 1960s. Clinical information systems involve processing, storing and re-accessing information that supports patient care in a hospital. Clinical information systems are systems that are directly or indirectly related to patient care. These systems include electronic health/patient records, clinical decision support systems, nurse information systems, patient tracking systems, tele-medicine, case mix and smart card applications. Diagnosis-treatment systems are information-based systems used in the diagnosis and treatment of diseases. It consists of laboratory information systems, picture archiving and communication system, pharmacy information system, radiology information system, nuclear medicine information system. This study aims to evaluate the effectiveness of health information system applications in Turkey. The first part of the study focuses on the concept of information systems and the types of information systems in organization structures. In the second part, clinical information systems and applications for diagnosis-treatment systems in Turkey are examined. Finally, the study evaluates applications in the health sector qualitatively from the new organizational structure, which is formed by information systems.

**Keywords:** Healthcare, Information Systems, Clinical Information Systems, Diagnostic-Treatment Systems, Turkey Case.

### Introduction

One of the most important characteristics of the information society is that rapid developments in information and communication technologies force global organizations to change. Citizens are more likely to benefit from the educational opportunities and have expectations from the government for more service provision. The quality of the services provided by the public administration has increased. One of the key functions of the public sector is to effectively create information systems that take into account internal and external environmental conditions to enhance corporate performance. Information systems enable that information society monitor to closely developments at the global level. It shapes institutional politics. It provides a clearly flow of information between units. The strength of horizontal and vertical communications makes a positive contribution to institutional performance.

The performance indicators that public administrators will determine and in the strategic plans they prepare are used the data provided by the information systems. It is imperative that the public staff in the lower levels be informed of fundamental changes in public policy through the managerial information system in order to achieve their strategic objectives. The objectives of the public organizations are to receive opinions on service provision and quality from the target audience through a healthy information system. Information systems in this respect are one of the tools for the democratization of public administration.

This study focuses on the increasing importance of information systems with globalization. Information systems developed in the health sector, which is a semi-public service, are examined in Turkey. The purpose of the study is to evaluate the clinical information systems and diagnosis-treatment systems in Turkey by referring to the historical development of health information systems. The study is methodologically theoretical and is based on a literature review of qualitative analyses. Administrative information systems in health institutions are classified as activity processing system, management information system, decision support systems, senior management information system, expert systems and office automation system. In the second part; clinical information systems and diagnosis-treatment systems being applied in Turkey have been examined and evaluated in detail.

### **1- CONCEPT of INFORMATION SYSTEM and CLASSIFICATION**

An important characteristic of today's capitalist society is that formal knowledge becomes a personal and key economic resource. In organizational structures, the duty of non-physical workers is gaining importance and this is possible only when this information is applied to the work. Public administration is now a generic body of information society, responsible for the effectiveness of information which focused on the results (Drucker, 1993: 63-72). In a way, public institutions are to apply to information work, tools, products, processes, work design, and the information itself. Also; they should work to bring about innovation a systematic process by organizing for continuous change (Drucker, 2009: 78-81). Every organization in the information society has to be competitive globally with the internet spreading in the service sector. The public service policies focus on efficiency and productivity with the citizens' evaluations of the quality of public service. In this regard, the importance of information systems in storing, organizing and communicating information in a holistic sense is increasing. Analysing the problems, developing new products, evaluating the performances of the public personnel, determining the citizens' preferences, providing the internal and external communication within a organization are among the benefits of the information systems (Güleş and Özata, 2005: 36). The most important component of information systems is computer and communication technology. The second component of the information system is the database management. Database management provides storage, organizing and processing of data. The third component of the information system is model management. Model management includes persons and programs that produce information and process data stored in the database (Kavuncubaşı and Yıldırım, 2015: 426).

Health information systems enable each individual to obtain current and accurate information about health. With this system, individuals can easily access their own health information. All health-related data from birth to death are shared through a nationwide healthcare network (Ceylan, 2012: 4). Health information systems are the complete set of hardware, software and guidelines used for the production, transmission and effective use of all information related to the management and presentation of preventive and curative health services (Güleş and Özata, 2005: 89).

Health information systems are an old system. The first hospital to institutionally keep patient records is the Pennsylvania Hospital, which was founded in Philadelphia in 1752. The use of information systems in the modern sense for the clinical decision making and reduction of medical errors in the health sector dates back to the 1960s. The first systems developed concern billing and payments. In the 1970s, departments-based systems were developed to support clinical processes. With the 1980s, more information systems than managerial activities and business processes aimed to support health workers. Today, these systems aim to empower patients in the field of health (Van de Velde and Degoulet, 2003; Hollingworth and et al., 2007; Işık and Güler, 2010).

The development of Health Information Systems can be categorized as follows (Haux, 2006):

**1- Migration from Paper Based System to Computer Based System and Data Increase in Health Systems:** The paper based system in which transactions are executed and stored is abandoned. Transactions are now carried out via computers and data is stored in an electronic environment.

**2- Transition from Part-Based Health Information System to Organization Based, Regional and Global Based Health Information System:** The first applications of health information systems have been realized in certain departments such as laboratory, radiology systems. After the 1990s, hospital-based systems were transferred to regional and even global systems by integrating data from different health institutions.

**3- Health Information System Users can be Health Personnel and Administrators as well as Patients and Patient Relatives:** Computer aided informatics applications primarily aim to support physicians. Later on, nurses and other health personnel also entered the system. Today, the practices are widespread for citizens and patients in general.

**4- Expansion of Use of Health Information System Data:** Health information system data was used for patient care and administrative purposes in the 1980s. Today, these data are also used in clinical and epidemiological studies.

**5- Transition from Technical Knowledge Management to Strategic Knowledge Management:** Until the 1990s, technical problems experienced in computer-aided information systems were considered. However, with the use of these systems, problems related to organizational changes, social issues, change management and strategic knowledge management in the long run have come to the fore.

**6- Incorporation of New Data Types:** By the 1990s it became possible to store images such as film, MR as well as alpha-numerical data. Today, it is also possible to store data at the molecular level (DNA, Protein Data).

**7- Emergence of New Technologies:** The functionality of computer-aided information systems has increased steadily. Thanks to the latest technologies, it is possible to collect data continuously from the patients.

The benefits of information systems in health institutions can be listed as follows (Zafar, 2005):

- Providing the necessary data during the examination
- Contributing to the medical decision-making process
- Provide support for patient education and preventive health care applications
- Facilitating the filing process, organizing intensive workflows, increasing patient satisfaction
- Helping care of the patients at a distance, reducing the costs of health care
- Better coordination of health care delivery by strengthening communication between patients and health workers

Attention should be paid to some points in the structuring of information systems in health institutions: Information systems should be integrated with internal and external systems. Patient information should be provided at the desired time and place. Confidentiality and security of data must be observed. Patient management process should be controlled effectively. Decision making in management and patient care should be enhanced. Revenue leaks should be avoided. The usefulness of information for audit and research purposes should be assessed (Herbst, et al., 1999: 308).

Information systems used in health institutions can be grouped into two main groups as clinical information, diagnostic treatment systems and administrative information systems. A wide variety of Managerial Information Systems are used in health institutions. These are Activity Processing System, Management Information System, Decision Support Systems, Senior Management Information System, Expert Systems and Office Automation System. Activity processing systems are a data collection system. It provides taking programmatic decisions and operational control. The management information system is often used for administrative control and provides information to the mid-level managers. This system is computer based. It regulates information production and information flow in the institutions. Decision support systems are used to solve unprogrammed problems in health care institutions. The senior management information system provides senior managers with the information they will use to monitor activity results or general operating conditions. Expert systems often

include computer applications that enable unidentified tasks to be performed. Office automation system is used in daily communication and information processing activities in offices and administrative units (Kavuncubaşı and Yıldırım, 2015: 427-431). In the following section, clinical information and diagnosis-treatment systems are examined in Turkey.

## **2- Development of Clinical Information Systems in Turkey**

The largest organization using information systems in Turkey is the Ministry of Health, where 65% of the hospitals in the country are affiliated. Initiatives to establish information systems in the field of health began in the 1990s to pass the Health Information Systems Project, which was jointly organized by the ministry and the World Bank. This project followed the second health project funded by the World Bank and Turkey, covering 1995-2001. The Health Information Systems Project started in 1992 with the planning phase. At this stage, problems related to the quality and information validity of the hospitals were evaluated. Information systems have a 20-year history in Turkey. In the health sector, the use of information systems has been made compulsory in some sense with efficiency-based reforms based on cost-benefit analysis (Dağlı, 2011: 11-14). For this purpose, the General Directorate of Health Information Systems established in 1996 has attained a contemporary structure with the decree of law published in 2011. The General Directorate of Health Information Systems is responsible for spreading the use of health information systems throughout the country. It is responsible for establishing the Ministry of Health's Information Systems. It follows the development of informatics technologies in the world and carries out national and international relations in the field of health (T.C. Resmi Gazete No. 663, article 11, [www.resmigazete.gov.tr](http://www.resmigazete.gov.tr), 12.04.2017).

Clinical Information Systems are a system directly related to patient care. It provides the creation, storage and reuse of necessary information to support patient care. These systems support diagnosis and treatment services. It makes it easier for physicians to take clinical decisions more effectively. With Clinical Information Systems, improvements have been made in the health sector such as the elimination of disease causes, the development of qualifications, the reduction of medical errors, and the increase of the productivity of health personnel (Demirel, 2013: 69). Clinical information systems used in health institutions include many different information systems. These systems see the function of gathering, processing, storing and transmitting all kinds of information in picture, text, image and audio format and they are used in the decision making process (Austin and Boxerman, 2013: 167).

Clinical Information Systems reduce the in-service waiting times of patients. It facilitates communication between patient care-servers and doctors. It provides the development of standards for the diagnosis and treatment process. The information gathered in the Clinical Information Systems is well organized. These systems improve drug dosing. They reduce adverse side effects of drug interactions. However, the infrastructure of clinical information technology is costly. There are great concerns about the confidentiality and preservation of patient data in the computer system. Integration of old systems into clinical information systems can also take time (Raymond and Dold, 2002: 1-7).

### **2.1. Patient Files**

It is a collection of documents that contains information obtained from studies conducted in relation to diagnosis and treatment of patients. These information and documents relate to the diagnosis and treatment of patients and injured persons during their stay in the health institutions. The first step in the development of clinical information systems is the regular keeping of patient files (Kavuncubaşı and Yıldırım, 2015: 441).

### **2.2. Electronic Health/Patient Records**

It ensures that all information about the patient is collected and used in the computer environment. This system requires that electronic medical records belonging to the patient should be in full, useful, effective, ethical and legal manner. It allows all records acquired over time to be stored in a holistic way (Blobel, 2001: 81). Thus, health staff reaches different information sources in less time and at lower cost. Thanks to the system, reliable information can be easily obtained by scanning and filtering medical information (Küyük et al., 2005: 3-14).

### 2.3. Clinical Decision Support Systems

Clinical decision support systems are computer programs that provide support to clinicians or other health care staff in clinical decisions. These systems are computer systems that are interested in clinical data or medical information to provide a decision support (Eneida, 2004: 591). These systems are designed to help doctors who make decisions by providing the most up-to-date informations. Clinical decision support systems are divided into passive and active: Passive clinical decision support systems are an information system that collects, organizes and provides information to the physician for patient information.

The main purpose is to provide direct information on the subject. The active clinical decision support system combines medical information or medical science with patient information. It gives various suggestions to physicians in decision-making process (Kavuncubaşı and Yıldırım, 2015: 445-446). By means of this system, mistakes due to negligence in health are prevented and possible side effects of drugs are eliminated by avoiding wrong drug usage (Özata and Aslan, 2004: 16-17).

### 2.4. Nurse Information Systems

Systems in which information and communication technologies operate on fields and processes related to nursing services. It allows the nursing tasks to be done easily and quickly (Saba, 1997: 59), such as assessment, monitoring, identification of the nursing aspects of the disease, preparation, presentation and analysis of health care plans., The nurse informatics which was recognized as a new field of specialization by the American Nurses Association in 1992, it provides a decision support system for nurses in nursing practice, nursing process, development of phases through the data management (Erdemir, 2008). By using information technology in nursing services, workload and error rates have decreased. Communication between the nurse and the patient has been strengthened (Chang et al., 2011: 332-340).

### 2.5. Patient Monitoring Systems

It is the system in which the patients who apply to the health institutions and organizations can follow the treatment in the hospital and after the discharge, the treatment results are evaluated and the healing process can be monitored. Thanks to these systems, the frequency of patients' referral to hospitals and the success rates of the treatments applied are clear. Hospital performance and quality-focused health services are evaluated with patient satisfaction by monitoring patients with developing mobile technologies (Tan et al., 2009). This system, also known as the intensive care unit, is equipped with specially trained medical personnel along with high-tech medical devices, which are distinguished from other hospital services in terms of medical treatment and patient care. Patient monitoring systems can follow vital signs such as heart rate, blood pressure, respiratory rate, and body temperature from the monitor (Ömürbek and Altın, 2009: 215).

### 2.6. Telemedicine

Telemedicine is a method of providing physiological signals for the diagnosis, treatment, follow-up and evaluation purposes between physicians and patients in different places (Ganapathy, 2005: 851). Telemedicine applications include the ability to perform remote operations using information systems and communication technologies aimed at conducting health-related researches (Işık and Güler, 2010: 2). Telemedicine in Turkey is one of the projects that the Ministry of Health has dealt with in the context of e-health applications. This project was used in the first stage in the form of health service presentation in the field of radiology and pathology. Some of the current tele-medicine applications are (Demirel, 2013: 77-81):

✓**Tele-Radiology:** Radiological images and related information are sent electronically from one place to another and interpreted or consulted.

✓**Tele-Pathology:** It is the process of transferring images via telecommunication methods for diagnosis, consultation and training.

✓**Tele-Cardiology:** It refers to the remote collection of all cardiologic data such as ECG, echocardiography, heart rhythms, pictures and sounds, and then transfer to a service center.

✓**Tele-Surgery:** The surgeon who is not in the place of operation and he remotely controls and performs the surgery with a surgical robot (Rayman, 2009: 8).

✓**Tele-Care (Health Care at home):** With Tele-Care, video cameras are located in the patients' homes for remote diagnosis and treatment without going to the hospital. In Turkey, the Ministry of Health has begun to provide home health care services for some diseases since February 2010. It includes phototherapy practices for new-borns (0-1 month old), respiratory system diseases as "Chronic Obstructive Pulmonary Disease", bedside patients, terminal period palliative care patients, advanced muscle diseases (Akça, 2013: 169).

## 2.7. Case Mix

Case Mix, Health Management Information Systems, provide links and balance between the clinical aspects of health care services and the financial aspects of budget and policy development activities. It categorizes the health system outcomes and the conditions of the patients by grouping them according to similar characteristics in a clinically and economically meaningful way. The system consists of diagnostic groups and information systems with similar financial management (Ömürbek and Altın, 2009: 216; Güleş and Özata, 2005: 116).

## 2.8. Virtual Reality

A virtual reality is a simulation created using computer graphics, sounds, and other sensors that have a real world-like appearance and interact with the user (Gregg, Tarrier, 2007: 343). In the fields of basic medicine education, such as anatomy, physiology, biochemistry, virtual reality applications are utilized. It is used in computer processing of data obtained for training, diagnosis and treatment in medicine. It allows different medical procedures to be supported by other medical information and methods (Özkurt, 2003: 55).

## 2.9. Smart Card Applications

It is not enough to store medical records only in the computer environment. It is also important that medical information can be accessed at the desired location and in the right way when needed. One of the methods developed in this regard is smart card applications. In this application, the patient can take his medical history with him everywhere and present it at the time of consultation (Müldür, 1999: 8; Kardas and Tunali, 2006: 66-67). Smart cards have advantages such as high memory capacity, identification of the cardholder, waterproofing, and readability without the need for a computer and quick access to the medical history of the patients (Rosli et al., 2009: 136). In Turkey, studies are being carried out for the transition to smart card system. Thus, pharmacists will be able to see the hospital where the patient comes, doctor, written prescription via smart medical cards.

## 3. Evaluation of Diagnosis-Treatment Systems in TURKEY

Information-based systems and equipment used in the diagnosis and treatment of patients are generally referred to as diagnosis and treatment systems. These systems come from other applications with imaging and laboratory diagnostic systems that support the diagnosis and treatment process (Güleş and Özata, 2005: 131).

### 3.1. Laboratory Information System

The laboratory information system was prepared by considering all the information management needs of the hospital laboratories. With the system, the information processing process is controlled easily and effectively and the system provides a faster and more efficient workflow (Sümen et al., 2005: 103). The laboratory information system supports the laboratory's functions of collecting information, verifying and reporting the test results. Laboratory tests required for patients are requested via outpatient clinics or other units, and results from automated laboratory equipment are delivered directly to the service units in hospital. In addition to analysing and reporting functions of laboratory information systems, it is also

used in the acquisition of analysis requests, ordering and planning necessary resources for these analyses (Kavuncubaşı and Yıldırım, 2015: 447).

### **3.2. Picture Archiving and Communication System (PACS)**

PACS systems make it possible to archive images in different units within a place. It is an electronic film archiving system that allows digital images to be served to users at different points when necessary (Ulaş and Tatar, 2005: 245). The system has beneficial aspects for hospitals and patients. It has reduced film costs for hospitals. It provides convenience in the archiving system. Millions of images can be stored in a disc without any deformation. For patients, however, the risk of loss and deformation of the films is ended. Patients do not have to carry a film when they go to the physician's control. If necessary, the patient's data can be sent to medical centers abroad. The patient's previous images and his later images after years can be successfully compared (Güler, 2008: 74-76).

### **3.3. Pharmacy Information System**

Pharmacy Information Systems include drug use, drug stock and management activities in patient care. These systems support treatment services besides pharmacy activities (Demirel, 2013: 70-71). The pharmacies are particularly among the departments that use the most information in the hospitals. The Pharmacy Information System examines patient prescriptions. The system follows medications given to the patient. It warns health staffs about the effects and side effects of medicines (Kavuncubaşı and Yıldırım, 2015: 447).

### **3.4. Radiological Information System**

Radiology information systems can take automatic images from the radiology system. It can transfer bi-directional digital information to hospital information system. It also carries out the data transfer of the radiotherapy planning information with the patient's appointment, examination, diagnosis information in the clinic. It has also the ability to archive data (Akman, 2005: 4).

### **3.5. Nuclear Medical Information System (NMIS)**

Nuclear Medicine is a scientific discipline that uses radioactive substances to diagnose and treatment processes. The Nuclear Medicine Information System has versatile functions ranging from the entry and changing of nuclear medicine requests to appointment planning and the entry of patients' information. In addition, it provides follow-up of the film recordings. It provides the preparation of radiology reports and performs the function of transmitting information to existing patient information systems (Bayraktutan et al., 2010: 14).

### **3.6. Electronic Document Management System**

It enables to transfer the Ministry of Health's documents and information exchanges to electronic environment. The system aims to manage this information instantly over the internet. Document management is a discipline that ensures that documents are controlled and regulated by standard rules in health institutions. It also standardizes processes related to internal and external correspondence (T.C. Sağlık Bakanlığı, [www.saglik.gov.tr](http://www.saglik.gov.tr), 09.04.2017).

The advantages of electronic document management system are as follows (Güler, 2008: 36):

- It increases document security
- Quality of service is increasing with easily sharing of documents
- A copy of the archive is easily created elsewhere
- The archive area is shrinking. As a result, archive costs are decreasing
- Staff mistakes are decreasing. The accuracy rate of existing information is increasing

- The costs of copying documents, faxing, sending by courier are reduced

## Conclusion

Information has become a major factor in production in the post-industrial period. The importance of communication between the administrative units has increased in the structure of the organization. The quality of the human capital appears to be decisive on the organizational performance. Information workers are in a central position in the service sector, both institutionally and personally. In this respect, the creation of in-house information systems through effective use of information and communication technologies is necessary to improve the quality of public services. Information systems have significant benefits in solving intra-organizational problems, evaluating citizen requests, and providing horizontal and vertical communications within the organization. Administrators can easily make strategic decisions about public institutions by using the data of information systems. Health information systems play an important role in the management and presentation of preventive and curative health services. Information systems are used for the production, transmission and efficient use of information related to the health field. Information systems in the health field have been used effectively since the 1960s. In the 1970s, systems for various units in health institutions were developed. Since the 1980s, information system applications have been widespread which will enable the health staff to work quickly, efficiently and effectively. At the same time, it is aimed that the citizens benefit from health service provision in a short time with less cost. Following the global technological developments in the health sector, especially in the development of information systems will increase patient satisfaction. Information systems offer a better coordination terms institutionally. It regulates intensive workflows of healthcare providers. It offers a competitive advantage in the health sector with increasing quality in institutional service delivery.

Information systems in health institutions are classified as clinical information, diagnosis-treatment systems and management information systems. Management information systems are more concerned with the effectiveness and control of in-house information flows. In the study, clinical information and diagnosis-treatment systems have been examined in Turkey. Initiatives for the establishment of health information systems in Turkey started in the 1990s with the "Health Information Systems Project" funded and coordinated by the Ministry of Health and the World Bank. The Ministry of Health has actively implemented projects and studies on information systems in the health care system, especially after 2000's, with a radical modernization. Clinical Information Systems have provided the direct renewal of patient care processes on the basis of quality orientation. For this purpose patient files have been converted into electronic patient record form. Current developments in the field of healthcare have been presented to physicians with clinical decision support systems. With nurse information systems, it is becoming possible for nurses to learn the current information about the patients instantaneously, and the nurses are more interested in the problems of the patients. Patient monitoring systems allow patients to be closely monitored during treatment and after treatment. The success rate of the treatment method applied with this system is clearly observed. Tele-medicine applications have enabled actively the flow of information between physicians and patients in different locations. It is especially convenient for the patients to provide health care services at home. Similar patient profiles are grouped together by the case mix application. It is a clinically and economically useful application. Virtual reality applications have increased the productivity of basic medical education, diagnosis and treatment processes through simulations. Turkey has not yet passed the smart card application. However, the necessary works are being carried out urgently to move to this service which enables the patient to access the medical places and information at the desired place and time.

Diagnosis and treatment systems have increased the ability to make accurate decisions in the diagnosis and treatment processes. One of these systems, laboratory information systems collects information from laboratories, verifies existing information and reports test results. With the picture archiving and communication system, digital images can be presented for the evaluation of users in different units. Pharmacy information systems are useful in regulating patient prescriptions, following daily doses of medications, and identifying side effects of medications. The radiology information system automatically transfers images from the radiology system. With the Nuclear Medicine Information System, preparation of



radiology reports has become easier. The electronic document management system is an important institutional tool for storing, sharing and transmitting documents within electronic environment. Thanks to the system, document security is increased and the institutional archive space is narrowed. With the reduction of red tape, the cost of service has decreased and the quality of the service provided has increased. When assessed in general, it can be predicted that the efforts of the health sector to activate the health sector through information and communication technologies will be increased in order for Turkey to adapt to global competition conditions. One of the indispensable requirements of the information society is the citizen-focused effective provision of public services in a way that is based on continuous progress and development.

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