Chapter 17

Brief Introduction to Hospital Information System

Cendra Devayana Putra

A. Overview of Hospital Information System

A Hospital Information System (HIS) is not a novel piece of healthcare technology. Large hospitals have adopted mainframe computers since the 1960s, mainly focused on business and administrative needs. Then, the development of inexpensive minicomputers in the 1970s enabled the installation of smaller, specialized clinical application systems in various hospitals, followed by subsequent technological advancements until today. One of the systems innovation goals is to aid the hospital's operational departments to become more efficient and structured. For instance, an internal medicine specialist may require an interesting radiological report. Hospitals frequently rely on staff to provide patient records without a HIS. Delivering docu-

C. D. Putra
National Cheng Kung University, Taiwan, e-mail: cendradevayanaputra@gmail.com

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ments takes time, depending on the distance between the source and destination of the information. The condition contrasts with hospitals that utilize HIS. The physician may readily access the required item via the HIS. Compared to nurses, the time necessary to provide the patient medical record through the system significantly decreases. This decreased time would undoubtedly result in reduced patient wait times and increased patient satisfaction. Therefore, this chapter will intensely discuss hospital information systems deeper. In more detail, I briefly present hospital information systems worldwide in this chapter. The reader would learn about hospital information systems' definition, importance, and application. This chapter helps students know hospital information systems and use quickly learned words in the hospital and information system domain.

B. The Importance of Hospital Information Systems

Almost all sectors have implemented information systems for over two decades to support their operations since 1991. Many researchers have published their information system innovations to satisfy humans. The first research on an information system that we track was created by Thomas Haigh, then followed by considerable research that covers many other sectors like Economy (Uribe-Toril et al., 2022), Social (Thomas et al., 2022), Government (Aggarwal et al., 2012), Education (Bourcier et al., 2022), and Health (Aggarwal et al., 2012). The need for information systems is still increasing until now. Moreover, with global social developments that have influenced social 5.0, information systems have integrated into our daily lives.

Currently, information systems innovations have also become a part of hospitals. Almost all big hospitals require a plethora of data, and it is critical for the quality of patient care and hospital management that these information needs are met. Moreover, aligned with an ever-growing patient, the information system and hospital cannot be separated.

When a patient is admitted to a hospital, a physician or nurse must first get information regarding their purpose for admission and

Source: Penn Medicine (2022)

Figure 17.1 Musculoskeletal Imaging

medical history. Later, they will require the findings of clinical, laboratory, and radiologic investigations, among the most often performed diagnostic procedures. In general, clinical patient information should be accessible on a timely basis and be accurate and current (e.g., the recent lab report should be available on the ward within 2 hours). If this is not the case, if the information is received too late, outdated, or even incorrect, patient care quality is jeopardized (e.g., an inaccurate lab report may lead to erroneous and even harmful treatment decisions). Health care expenses may rise if this results in repeated tests or costly information searches. Therefore, information should be accurately documented by machines or humans to enable healthcare practitioners to obtain the necessary information and make intelligent decisions quickly.

Machines or humans must highly inform health professionals and paramedics to do their duties. For example, administration staff in cashiers should be notified promptly and with up-to-date information.

If information flow is insufficient, bills are generated days, if not weeks, after the patient is discharged; the patient may be dissatisfied or get away from the account. Moreover, if required information is lacking, payable services cannot be billed, reducing the hospital's revenue.

Hospital administration also has a sizable information requirement. Current cost and revenue information is required to run the organization. Equally critical is information about the quality of patient treatment, such as the nature and severity of patients' illnesses, nosocomial infections, and complication rates of therapeutic procedures. Without accurate, timely, and complete information, the hospital's operations cannot be appropriately controlled, raising the risk of management errors. Thus, information processing is critical to the quality of health care, particularly in hospitals.

In particular, in Indonesia, information exchange is seen as critical for the benefit of hospitals. Since 2013, the Ministry of Health has mandated that all hospitals keep at least one HIS, called SIMRS, to assist with hospital operations. The Indonesian Ministry of Health (Kemenkes) urges hospitals to modernize their information systems to increase efficiency and effectiveness (Bureau, 2013). The big intuitive is a promising advancement for future hospital operations in Indonesia.

C. The Massive Cost of Information Processing

Not only is information critical, but processing it incurs high costs. Based on data, in 2018, private hospitals in the United States (US) spent approximately $732.2 billion on operating expenses, and 44% of that operation was related to information exchange. Specifically, spent worth to maintain information is follows: administrative and general (21.4%); pharmacy (4.8%); operational plan (2.3%); nursing and administration (1.3%); and others (14.2%) (Bai & Zare, 2020). In 2019, The European Union (EU) spent 3,476.433 euros per capita on healthcare, with approximately 3,026 hospitals. European Union spent cost represents 9.916% of the total gross domestic product (GDP) of the European Union (Health Care Resources: Hospitals, n.d.). In 2018, the Australian government also spent $195.7 billion on Healthcare,

covering 1,339 hospitals (Health Care Resources: Hospitals, n.d.). In 2018, the Indonesian government spent $336,726 per capita on health care, including individual and collective services. The amount spent on costs increased significantly from the previous year, 2017, when the Indonesian government spent $316,239 per capita (Penn Medicine, 2022). Even though fees for managing information appear to be relatively high, they can only be estimated as a minimum. Additional expenses for managing other information may not be calculated, resulting in the total costs exceeding the written estimate. Also, the total percentage of information processing, on the other hand, can only be estimated (Wackers et al., 2021).

D. Information: A Factor in Productivity

Numerous societies in the nineteenth century were characterized by increased in industry and industrial production. By the latter half of the twentieth century, the concept of communicating and processing data via computers and computer networks had already begun to take shape. Today, we refer to the twenty-first century as the information technology century or the "information society." It is anticipated to be defined by informatics and information and communication technology (ICT). People shall have access to information bound to a medium of matter or energy but is mainly independent of place and time and in any position imaginable. The information must find its way to people, not the other way around.

Today, data is one of the most critical factors affecting a hospital's productivity. The hospital information system must make complete and accurate information available for high-quality patient care and cost-effective hospital management. HIS is also becoming increasingly critical for hospitals' competitiveness (Tiankai et al., 2018).

1. The Information Processing System Should Provide a Comprehensive View of the Patient and the Hospital

Information processing should provide a comprehensive, holistic perspective of the patient and the hospital. "holistic" in this context

refers to a comprehensive view of a patient's treatment, regardless of where the patient has been or will be treated in the hospital. This holistic approach to patient care can help mitigate the negative impacts of highly specialized medicine, which involves several departments and healthcare specialists. Despite the highly diverse diagnosis and therapy and the diversity of people and regions inside a hospital, appropriate information processing (and a well-designed hospital information system) may assist in making all patient information accessible. As specialization in medicine and healthcare expands, so does fragmentation of knowledge, making it increasingly vital to combine data into a holistic picture. However, it must be apparent that only authorized workers have access to patient data and information about the institution.

2. A Hospital's Information System Serves as its Memory and Nervous System.

Over 100 billion patients visit hospitals annually, including routine checkups, recovery, treatment, etc. The number of patients varies

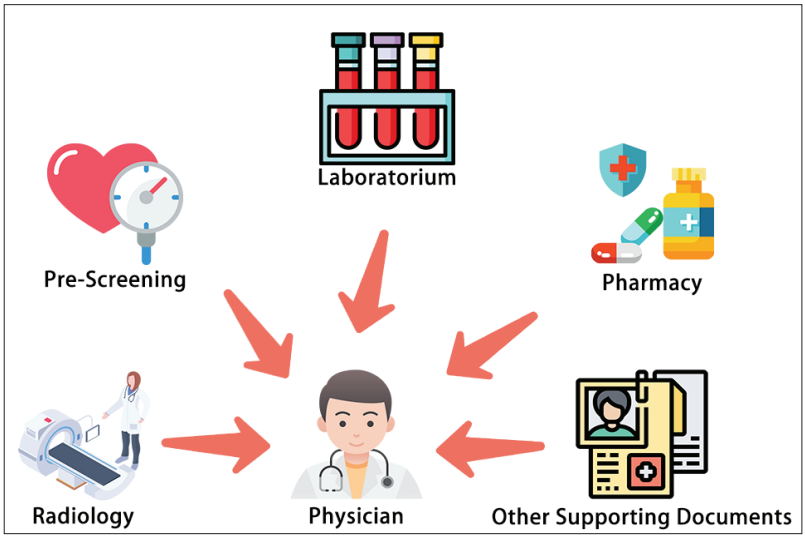


Figure 17.2 General Patient Diagnosis Scheme

according to the hospital's class and services, and the more benefits and hospital classes available, the more patients will come. Due to many patients, hospitals must maintain patient data regularly, as it is impossible to remember all patient information individually.

Traditionally, hospital information has been stored on paper-based medical records. The traditional method frequently uses paper and patient indexing. This method is simple because it only requires a small amount of space and a few people to organize it regularly. However, this traditional method has several disadvantages, including flammability, the requirement of a large area as the number of patients increases, and susceptibility to damage. As a result, some hospitals are in the process of transitioning to computer-based medical records.

In keeping with technological advancements, computer-based medical records, later dubbed electronic medical records (EMR), have grown in popularity among hospital information system administrators. The EMR performs the same function as its predecessor, namely patient data storage. The distinction is that EMR stores data with the assistance of a system (software) and a server (hardware). This method

Source: Astorino (2019)

Figure 17.3 Paper-Based Medical Record

Source: Digitimes (n.d.)

Figure 17.4 Server in Hospital

necessitates the aid of an information management expert to ensure that the information distribution process is not redundant and runs smoothly. Again, the quality of an organization's information system is critical to its ability to recognize and store facts correctly, recall them, and act on them (Tiankai Wang et al., 2018).

E. The Advancement of Information and Communication Technologies in Hospital

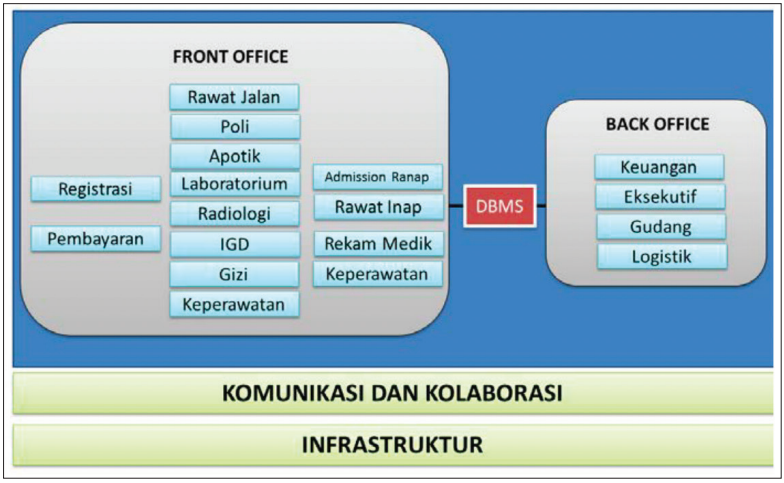
Every business, from banking to healthcare, has incorporated technology. This advancement is necessary to improve an organization's efficiency and effectiveness. Technology is well suited for use in health, particularly in hospitals. We saw in the previous subchapter that information is critical for hospitals, and that subsection demonstrates how news affects the hospital's cost, productivity, view, and memory. This subchapter illustrates how information technology is transforming

the hospital paradigm, commonly used modules, and research that has the potential to alter the future image of hospitals.

1. Basic Modules of Hospital Information System

Hospital information system modules vary significantly in functionality and cost, depending on the hospital's needs and finances. I use the standards established by the Ministry of Health in Indonesia (Kemenkes) in this chapter to make the hospital information system module easier to understand.

The Indonesian Ministry of Health's (Kemenkes) information management process is divided into two major components. This division operates following the hospital's established business procedures. *The front office* is the primary service provided by the hospital. These significant components assist patients with all aspects of their care, including registration, diagnosis, appointments, and pharmacies. On the other hand, *the back office* is a service section that supports primary services. This significant component manages physical



Source: Bureau (2013)

Figure 17.5 Minimal Hospital Information System Architecture in Indonesia

hospital resources, including people, money, tools, assets, reagents, and stationery.

This Ministry of Health policy must be tailored to each hospital since every hospital has a different policy and treatment procedure. Additionally, this policy is still far too broad to be effective. I want to take a different, more detailed approach in this book to help readers understand the hospital information system's components. I divide a hospital information system into several standard modules for most hospitals.

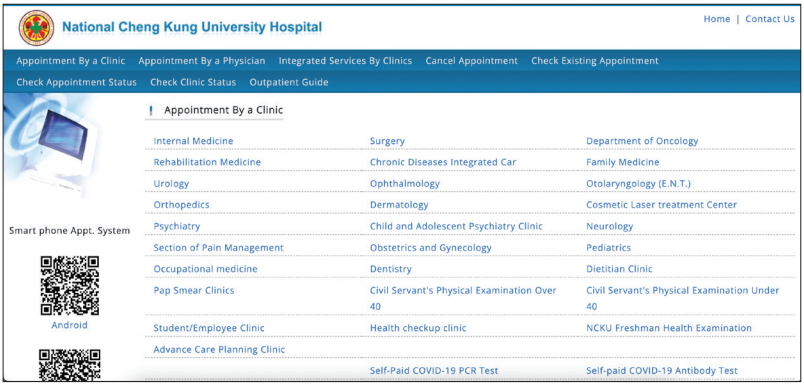
a) Online Appointment Module

Since 1991, healthcare information systems have incorporated an online appointment module as a significant advance. Online appointment scheduling enables the automated scheduling of patient appointments, follow-ups, and any special procedures that may be necessary. The online appointment module allows the hospital to manage medical professionals' availability at the optimal time, ensuring that the appropriate patient is loaded at the optimal time via services such as appointments, bulk cancellations, appointment rescheduling, and scheduling history management (Collen, 1991).

Patients can book physical or virtual appointments quickly, and doctors receive the patient's complete health history before the visit via healthcare provider solutions. The Online appointment modules can be customized by the hospital's need to assist patients in booking lab tests and radiology appointments through patient engagement systems. Directly affecting patient wait times will increase patient engagement and trust in hospital administration. According to a study, online meetings can minimize the likelihood of patients not showing up by 39% and boost patient satisfaction by 29% when automated (Hasvold & Wootton, 2011).

b) Payment Module

The Hospital payment module is a part of a complex hospital system responsible for managing patient payments. Payment is a critical



Source: Huey-Jen Jenny Su (2022)

Figure 17.6 Online Appointment Modules

module because it has a wide range of effects on the hospital, including the cost of care, admission and readmission rates, and patient satisfaction. However, specific payment module systems may require hospital, insurance, and government policy adaptations. These payment systems must integrate with third-party insurance, appointment scheduling, banking, and pharmacy systems. As a result, hospitals typically include the payment module as one of the information system modules that must be available, costly, and monitored properly.

Although many hospitals have struggled to integrate their financial management, the hospital system continues to lose money. According to a survey by the American Hospital Association, 26.4% of hospital finances in America are lost each year[2]. According to recent data, hospitals lose an average of $50 billion per month[3]. This loss is caused by various internal and external factors, including patient cancellations, service changes without proper documentation, and poor management patterns. Combined with COVID-19, which requires

2 https://www.cnbc.com/2020/05/05/hospitals-losing-millions-of-dollars-per-day-in-covid-19-pandemic.html

3 https://www.itij.com/latest/news/us-hospitals-losing-around-50-billion-month-due-covid-19

hospitals to take extra precautions when treating patients, hospitals risk losing more money. The cost may also be why healthcare institutions in the United States of America have declared a financial crisis.

Therefore, the payment module needs to be placed in the general module of the hospital system, which is essential to consider. However, the system's accuracy still needs to be studied more deeply in related research (American Hospital Association, 2017).

c) Laboratory Integration module

Laboratory Integration Module is a critical component of the hospital's information management system. The laboratory management module provides access to patient test results, uploads reports and findings, and manages hospital blood banks. Staff can access laboratory data and generate reports for patients. It is frequently integrated with other hospital information system modules to improve overall system functionality and streamline patient registration. When a physician orders a specific test panel, the information is updated in the healthcare system and transmitted directly to the diagnostic laboratory. This interface assists in minimizing human error. Because all data is entered into the clinical information system, previous medical reports can be retrieved and reviewed.

d) Pharmacy Integration Module

HIS may include document management modules for documenting and managing each patient's Electronic Health Records (EHR) and Electronic Medical Records (EMR), which may include doctor's notes, supporting documents, scans, x-rays, claims, and billing-related information as demographic data. The pharmacy data management system also incorporates audit requirements, billing updates, and modifications. Through integration with healthcare automation, hospital management information systems can combine the pharmacy's compounding capabilities and multiply them to create customized medication packages for each patient based on their unique needs. The success of this method is critical to the hospital's overall revenue

generation, as it provides patients with a value-based caregiving experience tailored to their unique needs.

e) Emergency Department Module

For many patients, the hospital entrance is not through the lobby but the through the swinging doors of the emergency department. As the initial stop on any patient's journey, it is self-evident that a hospital's emergency department, or ED, must be fully optimized to provide the best possible initial medical care in emergent situations.

Historically, hospitals have struggled to automate clinical processes and documentation in the ED. In contrast to an inpatient or outpatient setting, with the emphasis on longitudinal care, a typical ED scenario is episodic, focusing on individual encounters and complex clinical workflows. Speed and accuracy are critical when triaging patients, capturing clinical data, communicating with clinicians and hospital staff, or processing admissions and discharges.

Historically, hospital emergency departments have provided emergent care to patients using manual processes and tools, such as communicating verbally, using paper charts, or using whiteboards for patient tracking purposes. However, as the number of ED patient visits continues to grow, hospital administrators have recognized the proportionately increasing need to improve emergent care within the organization by streamlining processes, workflows, and documentation. A widely believed condition can be met using clinical information systems, such as an Electronic Health Records (EHR) system.

Hospitals successfully implemented EHRs in inpatient and outpatient settings and have realized significant benefits. However, even for the most technologically savvy clinical staff, implementing these EHRs in the ED has proven challenging. The emergency department environment is unique, with the full spectrum of disease relentlessly arriving on the doorsteps of overburdened emergency clinicians without warning. Workflows are intricate and vary by patient, and the pace is frenetic. The EHRs being used across these hospitals are

not designed for the ED, necessitating the need for a more specialized solution—an Emergency Department Information System (EDIS).

According to the HL7 Emergency Care Special Interest Group's 2007 EDIS Functional Profile document, an Emergency Department Information System is "an extended EHR system used to manage data in support of Emergency Department patient care and operations." While the primary purpose of an EDIS is like that of a basic HER, it aims to support and document the patient's direct care in a patient record, and EDIS focuses on specific core functionalities (Rothenhaus et al., 2007).

f) Intensive Care Unit Module

Intensive care is becoming more necessary as the population ages, and socioeconomic factors influence health interventions. Several issues in the Intensive Care Unit (ICU) must be addressed, including the following: a shortage of beds and skilled personnel, high medical costs, a high mortality rate, severe nosocomial infections, low adherence to standards, low quality of care and improvement, an epidemic of medical and medication errors, and poor coordination of inpatient care. Additionally, several factors should be considered, including the inability of an automated scoring system to predict disease severity and mortality, the inefficiency of integrated clinical alerts, clinically significant workflow disruption, and resource constraints.

The following are some issues that may arise from insufficient information exchange within the hospital. Every decision-maker requires factual and accurate information, such as a physician who needs information about a patient's condition or a nurse who requires information about bed availability. Otherwise, the treatment process of the patient will lose.

g) Electronic Medical Record (EMR) Module

Typically, patient health information is stored on physical media such as notes, images, or other media. However, these media have high operational and maintenance costs. As a result, the Electronic Medical

Record (EMR) is considered a more efficient method of storing patient health information such as the following: 1. Allergies; 2. Diagnosis; 3. Medications; 4. Medical history; 5. Immunization date; 6. Radiology Image; 7. Treatment plan; 8. Laboratory Result; 9. Other Important Information. An EMR can manage medical records and patient care in a single practice. Electronic Medical Records (EMRs) have several advantages over traditional paper medical records. For instance, electronic medical records enable physicians to:

1. Conduct periodic data monitoring.
2. Quickly identify patients who will undergo examination or screening.
3. Evaluate their patients' performance on specific measures—for instance, blood pressure readings or vaccinations.
4. Monitor and improve the practice's overall quality of care.

2. Advanced Modules of Hospital Information System

We already discussed several operating system modules required by hospitals in the preceding subsection. With the knowledge of that chapter, we can conclude that the fundamental module required by hospitals facilitates information exchange between doctors or units within the hospital. Of course, the operating system leverages only a fraction of the technology available in healthcare era 4.0.

Healthcare 4.0 enables health technologies to leverage industry 4.0 advancements such as IoT, cloud manufacturing, big data, and artificial intelligence. This is a challenge and opportunity for all parties to form a comprehensive hospital information system in Indonesia. Therefore, this chapter tries to summarize some research on hospital information systems to discover the future of hospital information systems worldwide (Jiangshan Li & Carayon, 2021).

a) Patient Engagement

A disease is not always present because of an incident soon, but also because of a poor long-term lifestyle. For example, consider a father who smoked for decades and then developed cancer at 50 or an

adolescent who drank alcohol and then developed the liver disease at 30. These are two examples of diseases that develop because of an unhealthy lifestyle. Indeed, diseases can be avoided if individuals have a sincere desire to maintain a healthy body. However, hospitals' continued perception as a place to cure patients ensures that such diseases continue to occur frequently in society.

Hospital information systems utilize digital technologies to increase patient engagement and promote positive patient behavior. Mobile applications, interactive patient portals, text messaging, and e-mails all help to improve patient health outcomes. These channels provide critical information to patients, such as their health records and education about their specific medical conditions. Additionally, they enable patients to manage their care plans, schedule appointments, manage medications, and take an active role in treatment decision-making.

According to study in 2018, several hospitals have recently implemented patient engagement initiatives (Asagbra et al., 2018). This could be because the hospital is structured so that it is not only a place of healing but also a place that enables patients to maintain their health independently. When patients become aware of their bodies, hospital revenue will remain stable and may even increase, as will the overall quality of care provided to their patients (Asagbra et al., 2019).

b) Health Analytics

The unprecedented rise of medical data created by HIS has ushered in a new era of healthcare analytics and artificial intelligence. The collection and analysis of data from patient records, drug administrations, operational data, insurance billing, and regulatory sources can result in various benefits:

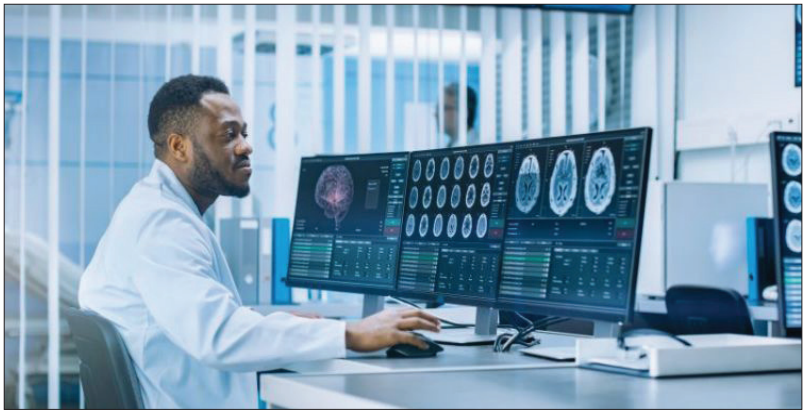
1. **Performance management**: Analyzing a hospital's performance using key metrics (related to outcomes and financials) to better understand its clinical, operational, and financial performance by department/clinical condition/physician, to identify and drive performance improvement initiatives. For instance, research on

the ordering and operational distribution of medical supplies. If this material is not correctly handled, it will result in cost inefficiency for storage or losses owing to a lack of inventory. To solve this problem, a dash of artificial intelligence is required to improve logistics (Ying Yang et al., 2021).

2. **Pathway management**: By coordinating treatment across settings, optimize patient paths across the network and clinical pathways within the hospital. A clinical pathway is a procedure and standard-based diagnosis and treatment plan based on Evidence-Based Medicine and/or doctor physician experience to standardize medical service behaviors and eliminate recovery delays and resource waste so that patients can get the best possible medical care (Xinyu Wang et al., 2021; Wind et al., 2021).
3. **Clinical decision support system (CDSS)**: Clinical, physiological, and longitudinal patient data are used to inform clinical personnel and physicists about the most appropriate diagnostic and treatment choices. Today's decision-making is not only informed by physicians' expertise but may also be aided by specific artificial intelligence technologies. For instance, a physician seeking to diagnose a patient can utilize a clinical decision support system to advise physicians on the medications, dosages, and therapies that are most appropriate for the patient. To begin, CDSS will get information about patients such as their age, duration of therapy, etc. The data will then be utilized parallel to feed into artificial intelligence models such as decision trees. Finally, the system can predict the appropriate medicine, dosage, and course of therapy for the patient. (Kharat et al., 2014; Sutton et al., 2020).
4. **Population health management**: Using analytics in epidemiology, for example, by connecting Electronic Medical Records to geographic information systems to determine healthcare patterns in specific areas (Hebert & Root, 2019).

c) Biosensing Wearables

Wearables with biosensing allow continuous monitoring of a wide range of variables, and recent technological advances have made them



Source: Cote (2021)

Figure 17.7 Implemented Health Analytics Tool

inexpensive. These wearables come in a variety of forms, including watches and clothing, as well as digestible and smart implants. These biosensors monitor and track various parameters, including movement, heart rate, sleeping quality, temperature, and glucose level, and offer critical data points to users and healthcare practitioners who previously needed a disruptive way to access. However, the sheer number of sensors and applications accessible has created software integration problems for healthcare providers. These wearable sensors can be used to help a cloud-based digital healthcare platform connect doctors, pharmaceutical companies, payers, healthcare providers, and healthcare systems to more than 400 home devices, wearables, and patient care applications (Sharma et al., 2021).

d) Telemedicine

Hospitals increasingly rely on telemedicine as they shift to a patient-centered strategy. Historically, hospitals followed a centralized model, resulting in huge increases in operational expenses and significant transport challenges for patients living outside of major cities. Thanks to the usage of telemedicine, patients and healthcare practitioners may

now connect in real-time via several communication channels, the transfer, and storage of medical data, as well as remote monitoring. Telemedicine enables physicians to give care remotely via computers and mobile devices. This system allows for clinicians to interact with patients and coworkers in realtime, using the same workflow tools they use to write charts, access patient information, and manage treatment. Telemedicine helps hospitals to save money by reducing their need for additional staff and space while boosting their ability to treat more patients (Jnr, 2020).

F. Conclusion and Recommendations

Information is a critical component of the hospital that cannot be ignored. Hospitals squander a significant amount of money on their information management because the information contained within the hospital is intrinsically linked to the patient. Additionally, information plays a role in the productivity of a hospital's operating activities. This information must be supplied holistically to ensure that the patient diagnostic process is not harmed. As a result, a hospital information system is required.

Hospital information systems have become a critical component of hospitals worldwide, particularly in Indonesia. The Indonesian Ministry of Health has enacted laws governing hospital information systems, requiring that each hospital have at least one. Additionally, the Ministry of Health has recommended a hospital information system adaptable to the hospital's capabilities.

I reduced the hospital system's components for study purposes by dividing it into seven critical parts: online appointments, payment modules, laboratory integration, pharmacy integration, emergency department integration, intensive care unit modules, and electronic medical record modules. The seven modules are typical components found in hospital information systems. The module's primary objective is to assist operational and middle management workers in completing their responsibilities.

Since AI, big data technologies, and the Internet of Things have become widely employed, hospital information systems are evolving in operational areas and other areas of analysis. The author included various development modules that the hospital information system may use. The first consideration is patient engagement. Patient engagement is a method of increasing patient awareness to avert the onset of illness (preventive). The second type of analysis is health analytics. AI and analytics are inextricably linked. Health analysis simplifies complex processes such as resource allocation, clinic routes, disease prediction, and geographic information systems. Then there are biosensing wearables. Biosensing wearables are often third-party devices linked to patients that are not integrated into the hospital information system. These tiny devices collect patient monitoring data for doctors, such as heart rate, respiratory rate, and other bodily conditions. Some researchers have attempted to include this biosensing into a component of the hospital information system to obtain holistic data. Finally, there is telemedicine. Telemedicine is a technological advancement in hospital information systems that enables patients and doctors to communicate over distances utilizing a reliable connection. The advantage of this technology is that no interaction is necessary because not all patients can walk (disabled).

Technology has become an integral component of Indonesian life, from waking up to sleeping. The phenomenon was seen in the number of gadgets we carry daily. Regrettably, some hospital information systems in Indonesia continue to play a minor role and cannot completely replace the paper-based system. The drawback might result from a shortage of in-depth research on usage, user acceptability, and security in hospital information systems.

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