

Integrated Information System Smart E: Hospital the Innovation and Improvement of the Services and Management Hospital

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Abstract

The use of technology can transform conventional systems into electronic-based systems. Electronic systems have been widely used in governance, organizations, and companies where administration is carried out electronically (e-Government). Hospitals usually already have systems in place, but they are not yet integrated, including integration with BPJS Services, EClaim, and the SATUSEHAT Platform, a new policy from the Ministry of Health Republic of Indonesia starting July 2022. BPJS integration includes diagnosis standards guided by Minister of Health Regulation No. 76 of 2016 concerning INA-CBGs Technical Guidelines, funds application to BPJS, cost proportions, and medical personnel fees. Another service at the Teaching Hospital is the management of Education for Professional Doctors (Co-ass) and Specialists (Residents). Another service at the Teaching Hospital is the management of Education for Professional Doctors (Co-ass) and Specialists (Residents). The solution provided is to create E-Hospital. It is an integrated hospital management information system with an SSO Model and Multi-Channel Access Technology for notification. This system consists of Front Office Modules, including Admission Queues, Medical Services, Pharmacy, Employment, Payroll and Medical Personnel Fees, Automatic integration with BPJS, EClaim, SATUSEHAT, Finance, and Warehouse and Equipment.

Keywords: EClaim, eHospital, Integrated Services, INA-CBGs, MCA.

1. Introduction

Hospitals are a part of health services developed through health development plans. Implementing health services in the hospital has complex characteristics and organization [1]. Hospitals must provide quality patient services as public health service institutions tasked with carrying out health service activities. Thus, it can produce fast and accurate information for the health service needs of patients and hospital management [2].

Data management in the hospital is one of the essential components in realizing a quality hospital service. For example, health data and information in medical record files are beneficial for the management of healthcare institutions to assess their services, whether they are high quality, efficient, and effective [3].

The hospital has many social interactions, such as interactions between patients, doctors, nurses, hospital staff, and others. The number of social interactions creates many activities, and indeed, there are many problems in the hospital [4], such as service administration management where there is no data integration between service units. It causes repeatedly conducting the same data recording process. Recording data repeatedly in each service unit can increase the risk of data recording errors and require more time to carry out the same process. In addition to repetitive

data recording, the absence of data integration between service units affects the patient service process. For example, delays in providing medical record files affect medical services to patients. The longer the provision of medical record files, the longer the time of medical services provided to patients [3]. The implementation of medical records at a healthcare facility is one indicator of the quality of service at the institution [5]. Indeed, various obstacles that exist can hamper the process of health services to the community [6].

Implementing a hospital management information system that can manage all service administration activities should be necessary to improve the performance of all organizations within the hospital based on the problems described [7]. The large number of visitors requires good management to manage the hospital services administration. Besides, visitors need fast and precise information about the services provided [8]. Data integration is a combination of data from various sources to be integrated and ready to be supplied to users [9]. Integrating data between departments in the hospital can facilitate the administrative management of hospital services so that the services provided can be better.

Information systems and information technology fundamentally play an essential role in developing organizations in various sectors, including government, private, industrial, and health [10]. Information systems display precise data and have been widely applied in various fields of health because the relationship between technology in the form of information systems and the world of health is very close [11]. One example of the application of an integrated information system to help accelerate the process of health services to the community is an integrated hospital information system. The integrated hospital information system can help optimize existing activities, especially in the service section, one of the most essential parts of the hospital. Thus, such an information system can help hospital leaders make projections in monitoring hospital services to improve the quality of their services in implementing hospital implementation procedures [12].

Research on hospital management information systems had been carried out previously by Regina Pricilia [13], who produced an application for inpatient and outpatient management in the hospital. It aimed to design an information system to manage patient data in the administration, inpatient, and outpatient departments. The research method was the waterfall method, which began with communication, planning, modeling, construction, and deployment. The research produced a hospital management information system with various displays that users could use. The study was limited to inpatient and outpatient management processes and was not integrated with other processes in the hospital.

Similar research was also conducted by Mohamad Topan [14], which resulted in designing a web-based hospital management information system. The study was conducted using the waterfall method, which began with the communication process to the deployment process. The final result of the research was a web-based hospital management information system that displayed a login page, registration admin page, poly admin page, inpatient admin page, pharmacy admin page, and cashier admin page.

The design of the hospital service module's information system was previously done by Primanggara Gamaswara [15]. This research clearly showed the hospital's medical service implementation process management. In addition, it was supported by system modeling, such as a system overview, context diagram, database design, and GUI of the hospital management information system.

An integrated information system can record the entire service process in the hospital since patients interact with registration services, interact with doctors both in outpatient services and in the emergency department, interact with medical support facilities, such as laboratories and pharmacies, interact with inpatient facilities, and others [7]. The amount of data to be managed and the need for rapid information delivery in hospital service activities make information technology a medium considered capable of assisting easy, fast, accurate, and integrated data management and presenting information [16].

The use of technology can transform conventional systems into electronic-based systems. Electronic systems have been widely used in governance, organizations, and companies where administration is carried out electronically (e-Government). Hospitals usually already have systems in place, but they are not yet integrated, including integration with BPJS Services,

EClaim, and the SATUSEHAT Platform, a new policy from the Ministry of Health Republic of Indonesia starting July 2022. BPJS integration includes diagnosis standards guided by Minister of Health Regulation No. 76 of 2016 concerning INA-CBGs Technical Guidelines, funds application to BPJS, cost proportions, and medical personnel fees. BPJS and General Patient queuing model is also a separate problem in hospital services, causing services to get a lot of complaints, especially from BPJS patients. Another service at the Teaching Hospital is the management of Education for Professional Doctors (Co-ass) and Specialists (Residents). The solution provided is to create E-Hospital. It is an integrated hospital management information system with an SSO Model and Multi-Channel Access Technology for notification. This system consists of Front Office Modules, including Admission Queues, Medical Services, Pharmacy, Employment, Payroll and Medical Personnel Fees, Automatic integration with BPJS, EClaim, SATUSEHAT, Finance, and Warehouse and Equipment.

2. Research Methods

2.1. Proposed System

This study was conducted in multiple phases, as shown in Figure 1. In the first phase, we endeavor to obtain authorization to undertake investigative inquiries within hospital settings. After permission was obtained, the observation related to the hospital's service process was started to define the problem faced by the hospital, followed by gathering the data through interviews, direct observation, and extensive literature studies. Then, we formalized the model processes, represented in the form of a general description of the proposed system, standard operating procedures, user interface design, database design, data flow diagram, and context diagram based on the inputs from the previous step. Furthermore, we implemented the proposed system according to the final design and evaluated it by inputting sample data. The testing phase involved several hospital employees according to the needs of each service unit and was accompanied by a questionnaire. The testing results will be analyzed for system feasibility so the proposed system can be implemented in existing business processes at the hospital.

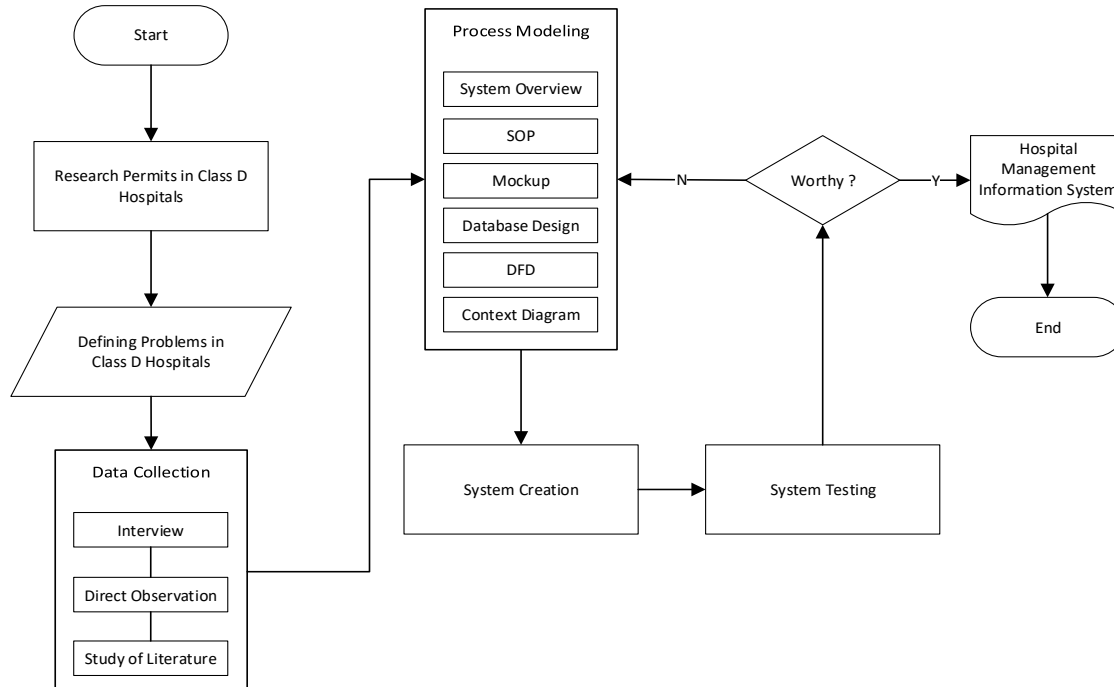


Figure 1. Proposed System

2.2. System Overview

The suggested Hospital Management Information System comprises several interconnected modules, enabling seamless data access between them without re-inputting. Integration is

achieved by using a single sign-on mechanism, illustrated in Figure 2. Users seek system access via the single sign-on tool, and the credential checker engine verifies access rights in the database. Upon successful validation, the system proceeds to the main menu through the single sign-on process.

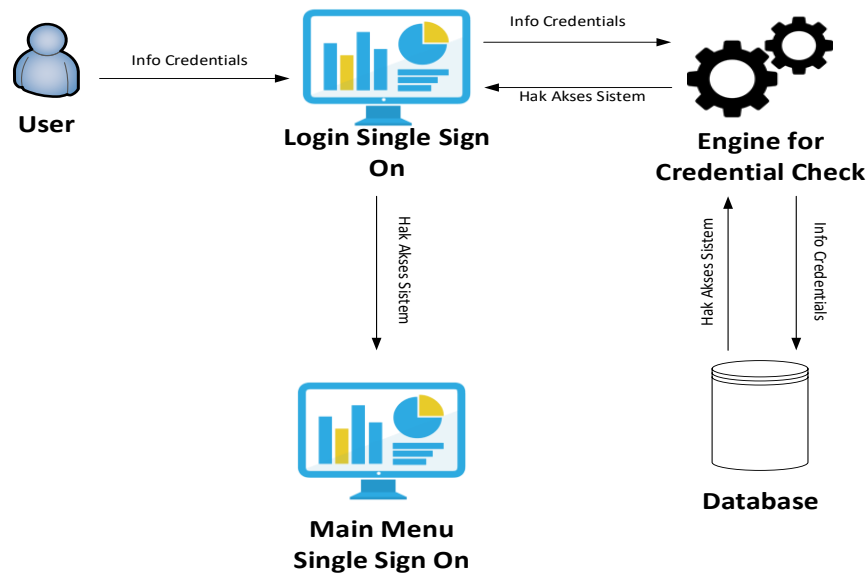


Figure 2. The overview of the single sign-on model on the integrated E-Hospital

Figure 3 depicts the system overview of the proposed administrative management of hospital services. This system interfaces with various established subsystems, including the front office, payroll, Human Resources Department (HRD), pharmacy, and facilities and infrastructure systems. Several entities are involved in these systems, including doctors, nurses, medical staff, and the director. Additionally, Figure 3 highlights the distinct data access permissions assigned to these entities. For example, doctors have access to diagnostic data, while medical staff do not have such access.

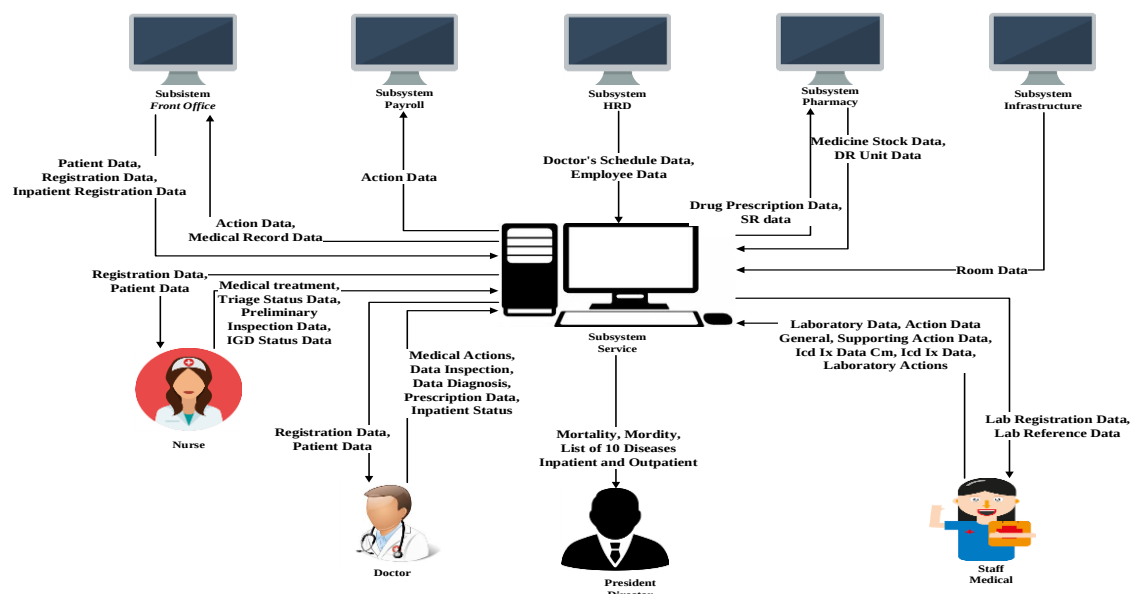


Figure 3. System Overview

2.3. Hospital Services

Law No. 44 of 2009 states that every hospital must carry out social functions, such as providing service facilities for poor patients, emergency services without down payments, free ambulances, assistance for victims of disasters and extraordinary events, or social services for humanitarian missions.

The community service industry is also inseparable from competition between its actors, namely hospitals [17]. Hospitals have various health services that can be seeded to maintain patient loyalty.

The excellent service strategy is that every hospital must take a complete quality approach oriented towards patient satisfaction so that the hospital continues to exist amid the increasingly strong growth of the health service industry [18]. Hospital services vary from primary patient care to hospital accreditation and quality improvement trends to medical research and education [15].

2.4. Hospital Information Systems

Hospital Management Information System is a computerized system that processes and integrates health service business processes through coordination networks, reporting, and administrative procedures to obtain information precisely and quickly [15]. Electronic recording systems can document the results of patient identification, including problems, treatment, patient progress, medical history, laboratory data, and other medical service data [19].

Law of the Republic of Indonesia on Hospitals Article 52 paragraph (1) of 2009 states that every hospital is obliged to record and report on all activities of hospital organization in the form of a hospital management information system. Through this statement, the hospital management information system is fundamental to running a hospital.

Regulation of the Minister of Health of the Republic of Indonesia No. 82 of 2013 states that a hospital management information system is a communication information technology capable of processing and integrating the entire flow of hospital service processes in the form of coordination networks, reporting, and administrative procedures to obtain precise and accurate information, and is part of the health information system.

A hospital management information system supports primary and secondary processes by integrating organizational structure, information flow, and solutions using information and communication technology [20].

2.5. Context Diagram

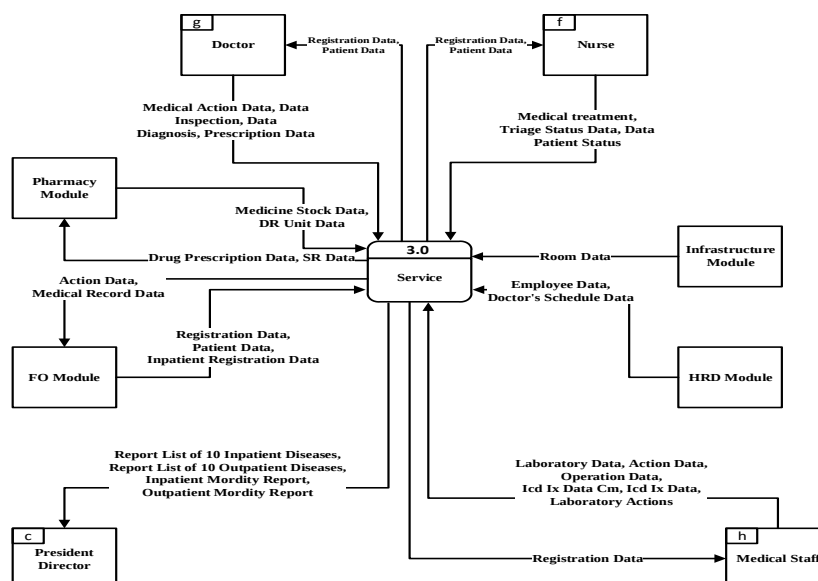


Figure 4. Context Diagram

The contextual diagram in Figure 4 depicts the enhancement of governance in hospital service administration by implementing an integrated system. This system involves eight entities: director, doctor, nurse, medical staff, pharmacy module, front office module, HRD module, and facilities and infrastructure module. Each entity has its relationship to the services module, as listed below.

- The relationship between the service module and the principal director entity, namely when the service module provided a list of 10 inpatient diseases, ten outpatient conditions, inpatient morbidity reports, and outpatient morbidity reports.
- The relationship between the service module and the front office entity, namely, the service module provided overall medical action data, and the front office provided registration data and patient data.
- The relationship between the service module and the pharmacy entity, namely when the service module provides medicine prescription data and store request data. Then, the pharmacy provided medicine stock data and delivery request data.
- The relationship between the service module and the doctor entity, namely when the service module provided registration data and patient data. Then, the doctor offered medical actions, patient examinations, diagnosis data, and prescription data.
- The relationship between the service module and the nurse entity, namely when the service module provided registration data and patient data. Then, the nurse provided patient examination data, medical actions, triage, and patient status data.
- The relationship between the service module and the medical staff entity, namely when the service module provided registration data. Then, medical staff provided laboratory action data, laboratory data, action data, surgery data, and ix cm data, and icd x data.
- The service module's relationship with the facilities and infrastructures entity, namely when the service module was given room data.
- The relationship between the service module and the HRD entity, namely when the service module was given employee data and doctor schedule data.

3. Results and Discussions

3.1. System Integration

The integration model in E-Hospital was very complex and complicated. The model used in this E-Hospital innovation is shown in Figure 5.

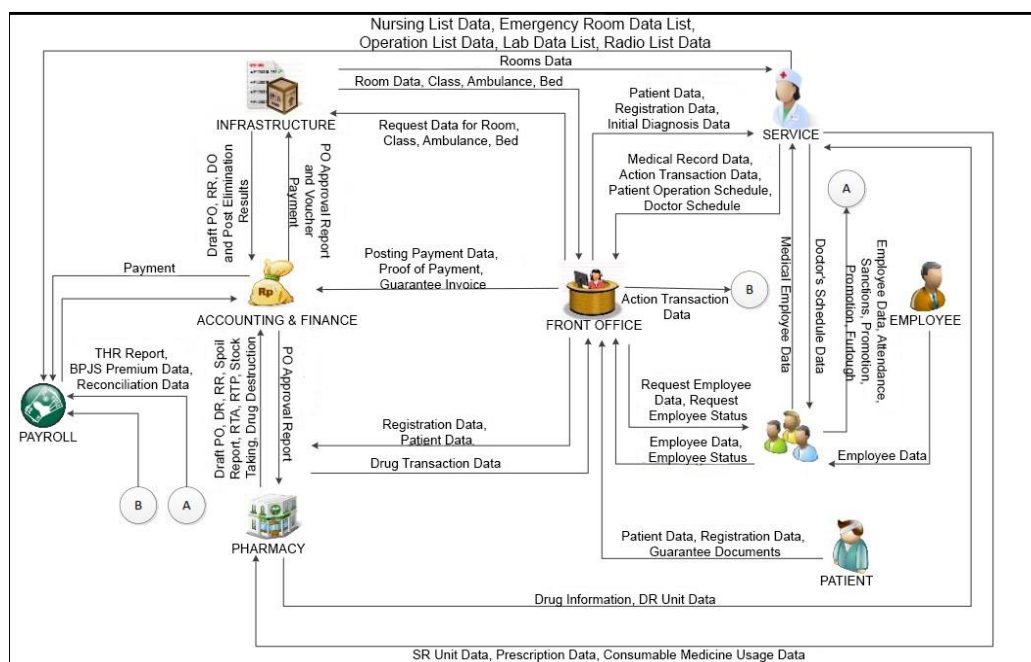


Figure 5. E-Hospital Integration Model

Poli Gigi || LIST PASIEN REGISTRASI

Show 10 entries

No.	No. Registrasi	Nama Pasien	Keluhan Pasien	Penerimaan Awal	Poli Rujukan	Aksi
1	REG00057	Meg Carbot	demam	Poli Umum	Poli Gigi	+ Pemeriksaan Perawat

Showing 1 to 1 of 1 entries

Previous 1 Next

Poli Gigi || PASIEN YANG SUDAH DIPERIKSA

Status Pemeriksaan

Show 10 entries

No	No. Registrasi	Nama Pasien	Penerimaan Awal	Rujukan Rawat	Tanggal	Status Inap	Status Pemeriksaan	Diagnosa Dokter	Action
1	REG00053	amelia situmorang	Poli Gigi	Poli Penyakit Dalam	12-Dec-2020	Rawat Jalan	Selamat Selesai		

Showing 1 to 1 of 1 entries

Previous 1 Next

Figure 6. Results of implementing the patient examination feature

Figure 6 illustrates the examination functionality, wherein patient data has been seamlessly amalgamated with registration data in the front office segment. Patient information registered at the front office is automatically populated within the examination feature of the service department. This feature exhibits a comprehensive list of patients based on their assigned registration numbers. The examination display comprises the patient registration list and the section detailing patients undergoing examination.

Resep Obat || DATA RESEP OBAT

Nama Pasien: amelia situmorang

Tanggal Pemberian Obat: 2021-06-06

Ketersediaan Obat: ☐ Obat Tidak Tersedia ☒ Obat Tersedia

Selesai

Resep Obat || DETAIL RESEP OBAT

Show 10 entries

No.	Nama Obat	Jumlah Obat	Satuan	Keterangan	Aksi
1	ALKOHOL 70%	Jumlah Obat	Botol	Keterangan	Tambah
2	AMITRIPTYLLINE 25 MG	Jumlah Obat	STRIP	Keterangan	Tambah
3	ASAM MEFENAMAT KAPS 250 MG	Jumlah Obat	BLISTER	Keterangan	Tambah
4	ASAM MEFENAMAT TAB 500 MG	Jumlah Obat	STRIP	Keterangan	Tambah
5	CARBAMAZEPINE 100 MG	Jumlah Obat	BLISTER	Keterangan	Tambah
6	KOLKISIN 0.5 MG	Jumlah Obat	STRIP	Keterangan	Tambah
7	NATRIUM DIKLOFENAK 25 MG	Jumlah Obat	STRIP	Keterangan	Tambah
8	NATRIUM DIKLOFENAK 50 MG	Jumlah Obat	STRIP	Keterangan	Tambah
9	PANADOL	Jumlah Obat	Butir	Keterangan	Tambah
10	PARACETAMOL 100 MG	Jumlah Obat	STRIP	Keterangan	Tambah

Showing 1 to 10 of 12 entries

Previous 1 2 Next

Figure 7. Results of the implementation of the integrated drug prescribing feature

Figure 7 depicts the prescription medication feature, wherein the display exhibits data on available drugs in the pharmacy section. The list of drugs shown in the prescription medication feature is seamlessly integrated with the available drug inventory in the pharmacy. The prescription medication feature display provides an option to include medicines unavailable in the pharmacy inventory through manual input.

UGD LIST PASIEN REGISTRASI										
Show 10 entries		Search:								
No.	No. Registrasi	Nama Pasien	Keluhan Pasien	Tujuan Rawat	Aksi					
1	REG00054	Giant Tom	Sakit Perut	UGD	+ Pemeriksaan Perawat					
2	REG00055	Nel Falisha	sakit perut	UGD	+ Pemeriksaan Perawat					
3	REG00062	Anggaaaa	Sakit	UGD	+ Pemeriksaan Perawat					
4	REG00078	Arif	-	UGD	+ Pemeriksaan Perawat					
5	REG00079	vera	-	UGD	+ Pemeriksaan Perawat					
6	REG00083	Made Wibawa	Sakit	UGD	+ Pemeriksaan Perawat					
Showing 1 to 6 of 6 entries										Previous 1 Next

UGD LIST PASIEN										
Status UGD										
Show 10 entries		Search:								
No	No. Registrasi	Nama Pasien	Status Triage	Rujukan Rawat	Status Inap	Tanggal Masuk	Status UGD	Pemeriksaan Dokter	Aksi	
1	REG00046	Nichiban Akasuki	Kuning		Rawat Jalan	12-Jun-2021	Belum Selesai			

Figure 8. Integration of Emergency Room (ER) feature

Figure 8 shows the Emergency Room (ER) feature integrated with the front office section. Patient data will automatically appear in the ER feature once the patient has been registered at the front office. The ER feature serves to verify patients receiving emergency care. All treatment data will be recorded in the patient's medical record, and the procedural information obtained during the treatment will be integrated with the cashier section.

Rawat Inap || DATA REGISTRASI RAWAT INAP BARU

Show10entries

Search:

No.	No. Registrasi Inap	Nama Pasien	No Bed	No Kamar	Nama Ruangan	Aksi
1	RWI00041	Arif	55	104	Melati	+ Rawat Inap
2	RWI00048	Febby	2	100	Melati	+ Rawat Inap

Showing 1 to 2 of 2 entries

Previous1Next

Rawat Inap || PASIEN RAWAT INAP

Status Pasien

Show10entries

Search:

No	No. Registrasi Inap	Nama Pasien	Nama Ruangan	No Kamar	No Bed	Status Pasien	Tanggal	Action
1	RWI00047	verania	Melati	104	55	Dirawat	06-Jun-2021	
2	RWI00040	Neni Jahar	Melati	100	4	Dirawat	11-Dec-2020	

Showing 1 to 2 of 2 entries

Previous1Next

Figure 9. Inpatient Feature Integration

Figure 9 illustrates the patient admission interface in the service unit for patients who have completed inpatient registration at the front office. Patient data is also integrated with the facility management section, including information on rooms ready for patient use. The patient data registered is verified in the service unit before inpatient care is provided.

Rekam Medis || PERAWATAN

Riwayat Poli Umum

Riwayat Poli Gigi

Riwayat Poli Kandungan

Riwayat Poli Penyakit Dalam

Riwayat UGD

Riwayat Rawat Inap

Show10entries

Search:

No	No. Registrasi	Tanggal Masuk	Keluhan Pasien	Rujukan Rawat	Status Pasien	Dokter Pemeriksa	Hasil Perawatan
1	REG00039	21-Nov-2020	Panas dalam,,	Laboratorium	Rawat Inap	R. Arif Yudarmawan	
2	REG00035	20-Nov-2020	Peradangan Sendi	Poli Gigi	Rawat Jalan	R. Arif Yudarmawan	
3	REG00047	18-Nov-2020	tes paket 1	Poli Penyakit Dalam	Rawat Jalan	R. Arif Yudarmawan	
4	REG00047	16-Nov-2020	tes paket 1			Isna Wanda Robiulla	

Showing 1 to 4 of 4 entries

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Figure 10. Integration of Medical Record Features

Figure 10 presents the patient record display in the service unit, showcasing the treatment history for each available service unit. The patient's treatment history automatically appears once they have received care in each respective unit. The treatment history can be utilized to determine the subsequent course of patient management.

Rekam Medis RIWAYAT KUNJUNGAN							
Diagnosa		Tindakan	Resep Obat		Hasil Lab		
No.	Tanggal Kunjungan	Diagnosa	Kode Icd X	Icd X	Dokter	Tujuan Rawat / Status Pasien	
1	2020-11-25 21:16:54	-	-	-	-	UGD /	
2	2020-11-21 00:36:14	-	-	-	-	Poli Umum / Rawat Inap	
		Diare	A01	Typhoid and paratyphoid fevers	R. Arif Yudarmawan	-	
		test mod	A08	Viral and other specified intestinal infections	R. Arif Yudarmawan	-	
3	2020-11-19 23:14:39	-	-	-	-	Poli Umum / Rawat Jalan	
		pengapuran	A09	Other gastroenteritis and colitis of infectious an	R. Arif Yudarmawan	-	
		gigi berlubang	A05	Other bacterial foodborne intoxications, not elsew	R. Arif Yudarmawan	-	
		tes	A00	Cholera	R. Arif Yudarmawan	-	
4	2020-08-25 21:25:08	-	-	-	-	UGD / Rawat Inap	

Figure 11. Patient diagnosis history based on patient visitation date

Figure 11 displays the diagnostic history based on the patient's last visit to the hospital. The developed system can record the diagnostic history, interventions, treatments, and laboratory results based on the patient's most recent visit. All this data is derived from the records made in each service unit during the patient's visit.

2.6. Proposes System Comparison with Existing System

In this section, we compare our proposed system against an existing system that has been developed. Table 1 presents a comparative analysis between the current system and the implemented system [2][13][14]. The implemented system features support for functionalities such as cross-process data integration, Single Sign-On (SSO) and access rights provision, recording of outpatient service data, recording of Emergency Department (ED) service data, recording of inpatient service data, recording of prescription medication service data, and recording of ancillary service data. In contrast, the existing system lacks support for several of these features. For instance, the proposed method by Topan et al. [14] only has two features, namely F3 and F5.

Table 1. System comparison analysis based on the system features between the proposed system and the existing system

Features	Proposed system	Topan et al. [14]	Robot et al. [13]	Cahyanigrum et al. [2]
F1: Data integration between process	•	-	-	•
F2: Feature and Granting Access Rights	•	-	-	-
F3: Polyclinic Service Data Recording	•	•	•	•
F4: ER Service Data Recording	•	-	-	•
F5: Inpatient Service Data Recording	•	•	•	•
F6: Prescription Service Data Recording	•	-	-	-
F7: Support Services Data Recording	•	-	-	•

2.7. System Evaluation

The implemented system was evaluated by collecting respondents' assessments through a questionnaire. We divide the questions into four sections: suitability, performance, security, and usability aspects. We constructed 28 questions, each with five different options, as shown in Table 2.

Testing was carried out by 22 examiners, consisting of 10 medical service employees at the hospital and 12 who had used web-based information systems. Testing is carried out by the tester filling out a system assessment questionnaire comprising 28 statement items divided into four aspects: conformity, performance, security, and usability. The questionnaire results that respondents had filled out were then processed using the UAT method and LSR scaling of 1 to 5. Respondents were divided into two categories, namely R1 for medical service employees in hospitals and R2 for user respondents who had used web-based information systems.

Table 2. The results of questionnaire-based system evaluation

Aspects	Response frequency (%)									
	1		2		3		4		5	
	Strongly disagree		Disagree		Neutral		Agree		Strongly Agree	
	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2
Suitability	0	0	6	0	9	1	64	73	21	46
Performance	0	0	0	0	8	0	55	60	37	40
Security	0	0	10	0	30	0	45	70	10	30
Usability	0	0	0	0	6	0	30	61	64	39

Table 2 presents the questionnaire responses, yielding the highest percentage for each aspect. Regarding suitability, 64% of Respondent R1 chose 'agree,' and 73% of Respondent Group R2 chose 'agree.' Regarding performance, 55% of Respondent Group R1 selected 'agree,' and 60% of Respondent Group R2 chose 'agree.' For security, 45% of Respondent Group R1 agreed, while 70% of Respondent Group R2 agreed. Regarding usability, 64% of Respondent Group R1 opted for 'strongly agree,' and 61% of Respondent Group R2 chose 'settle.'

4. Conclusions

Implementing the Integrated E-Hospital, a novel iteration of the Hospital Management Information System has demonstrated its capability to enhance service delivery and contribute to the

governance and management of the hospital. The integrated information system developed in this research introduced features such as doctor examination, Emergency Room (ER) actions, medicine prescription, laboratory testing results, medical records for treatment and support history, and medical records for diagnosis history. The data recording flow, culminating in the medical record, was established across all service units, streamlining health administration management in the hospital. Respondents with diverse backgrounds acknowledged the integrated information system's positive outcomes and perceived success. This system effectively managed the service administration processes in the hospital, proving instrumental, particularly in the medical records section, where it played a pivotal role in informing subsequent treatment recommendations based on prior medical interventions.

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