Designing Minimum Data Set and Data Model for Electronic Health Record Systems in Indonesia

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***Abstracts*—This study aimed to design a minimum data set (MDS) and Data Model for electronic health record system (EHRS) in Indonesia. The content of the MDS in this study is different from the MDS from the results of the study in other advanced countries. The technical preparation of the MDS in this study follows the medical service process provided to patients from the time they first enter the hospital until they complete receiving services at the hospital with the aim that the MDS designed is aligned with real-world hospital workflows. The initial stage of this research began by identifying data elements through literature reviews sourced from medical record documents of general hospitals and psychiatric hospitals in Indonesia, papers regarding minimum data set in other advanced countries, websites, and clinical guidelines. The Delphi technique was employed to validate the identified data elements through a survey of medical experts. A questionnaire was designed to determine data elements in both administrative and clinical departments. There were 5 and 21 data classes agreed upon by experts in the administrative and clinical sections with 28 and 858 data elements, respectively. This MDS could be a reliable tool for data standardization in EHRS that can improve the quality of data and medical services in hospitals. The designed data model consist of conceptual, logical and physical component. This MDS and data model can facilitate system developers to build physical EHRS database and health surveillance center for more efficient health data management.**

Keywords*—Minimum data set; data element; data model; electronic health record; electronic health record system

I. INTRODUCTION

A collection of data items arranged in a standardized manner to facilitate clinical and research use is known as the Minimum Data Set (MDS). It outlines the precise data pieces that must be captured, how they should be stored, and the connections and limitations between them [1]. Standardizing data items and their definitions is the aim of the Minimum Data Set, which is a fundamental component of health data [2]. A well-defined question (variable) and a predetermined range of answers that are used in different studies or shared across data sets make up a common data element [3].

MDS is in the forefront of creating and putting into place an information management system that could enhance the quality of health data and, consequently, services [4]. By consistently identifying necessary data items, the Minimum Data Set (MDS) is a method for standardizing important data within a particular domain and improving the quality of information. Therefore, by standardizing these components, MDS can guarantee data quality and make comparisons easier at the national and international levels [5].

MDS seeks to create a common language for all registry and documentation participants by clearly defining data pieces. Additionally, it guarantees the efficient gathering, evaluation, reporting, and selection of important data [6]. Moreover, MDS improves medical history records, encourages data comparability, helps establish a data repository, makes it easier to share electronic data between various healthcare systems, and eventually raises the quality of data [7].

Administrative and clinical data are two categories into which disease data pieces can be divided according to their nature and purpose. In addition to location, phone number, patient referral information, and the major occupation of healthcare practitioners, administrative data usually includes demographic and socioeconomic information [5]. In contrast, clinical data vary based on the disease type. Typically, they encompass diagnosis, medical history, laboratory results, medical imaging findings, treatment interventions, disease progression, and outcomes [8].

Data sets in the healthcare system provide standardized definitions for each data piece and describe which data items should be gathered for each patient. Research and statistical analysis, internal performance review, and external accreditation are just a few of the uses for data comparison [9]. In order to manage the clinical performance of health organizations in every nation, it is imperative to define standard data models and minimal data sets [10]. The creation of MDS must take into account national norms, needs, and expert viewpoints in addition to the experiences of industrialized nations [11].

Data modelling is the process of determining how data are to be stored in a database. A data model specifies features and relationships, such as: data types, constraints, relationship, metadata. In healthcare system, a data model is an abstract structure that organizes and standardizes data sets and data elements, defining their properties and relationships [12].

The conceptual data model (CDM) in healthcare is to provide a high-level, abstract representation of the data that an organization uses or intends to use in its business operations [13]. In the context of healthcare, a CDM helps bridge the knowledge gap between subject matter experts, IT architects, and designers by depicting the major business information

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objects and their relationships to each other using business terminology. Logical data model (LDM) for an electronic health record system (EHRS) would define the structure of the data elements, their relationships, and the business rules that govern them. It would be used to develop a visual understanding of the data entities, attributes, and relationships specific to the EHRS. Physical data model (PDM) for an EHRS would detail how the logical model is to be implemented in a specific database management system, including the specific data types, constraints, and other implementation detail [14].

Designing a conceptual, logical and physical data model for standardized data collection supports disease information management and leads to better quality of care [15]. Standard health care data model usually indicate minimum data elements that should be collected, a data set is a standard data collection tool [3]. The main objective of the data set is to build a national database that can serve as an information management source to equip decision-makers and policy-makers with accurate and up-to-date information [16].

In recent years, significant research has focused on the MDS and data model for advancing EHRS. Most of these studies concentrate on developing MDS tailored to specific diseases, injuries, or patient groups [17]. MDS for holistic health recording that combines general and specialist MDS is not widely available in the literature.

By taking a case study in Indonesia, where the Indonesian Ministry of Health has never published guidelines on the standardization of MDS and also data models for hospitals or health service centers that want to build or develop EHRS, this study aims to design MDS and data models for the Indonesian EHRS. It is expected that this MDS and data model will facilitate information system developers to build physical EHRS databases and health surveillance centers for more efficient health data management.

II. METHOD

The initial stage of this research began by studying the medical services process and identifying data elements through literature reviews sourced from papers regarding minimum data sets (MDS) and data model in other advanced countries, websites, and clinical guidelines, medical record documents of general hospitals and psychiatric hospitals in Indonesia (Table I). A comprehensive review of recovered resources was carried out until saturation.

In the second stage, the data elements were classified as the leading group, data classes, and data elements. Data class and data element divided into two section data: administrative data and clinical data. Different from the data element content in preliminary research, the design of MDS in this study follows the process of medical services in hospital.

In the third stage, the Delphi technique was employed to validate the identified data elements through a survey of medical experts. A questionnaire was designed to determine data elements in both administrative and clinical section. The questionnaire included administrative data elements and clinical data elements. A five-point Likert scale was used to measure responses of items (strongly agree, agree, enough, disagree, strongly disagree). Additionally, an open-ended question was included at the end of each data element category, allowing experts to suggest additional essential data for the electronic health record system (EHRS).

TABLE I. SEARCH STRATEGY FOR RETRIEVING DATA ELEMENTS FOR EHRS

Sites, Criteria, Strategy	Description
Website	World health organization
Search Engine	Google, Google Scholar
Database	Scopus, PubMed, Web of Science (Up to 30 July 2024)
Inclusion Criteria	Literature in the English language; scientific papers; annual reports; guidelines; books.
Exclusion Criteria	Non-peer-reviewed, reports and forms retrieved from personal blogs and abstracts with no accessible full text.
Keyword	"Electronic Health Record" AND "Data element", "Electronic Health Record" AND "Minimum data set", "Electronic Health Record" AND "Data Model"

The expert selection criteria were knowledge related to medical records and medical services. Experts for the Delphi technique were selected using a purposive sampling method. Overall, 8 (eight) experts were chosen in this step (Table II).

TABLE II. DEMOGRAPHIC CHARACTERISTICS OF EXPERTS

Demographic Characteristic	Amount
Speciality	
Medical Record	2
Physician	2
Nurse	2
Nutritionist	2

The criterion for selecting a data element in the questionnaire was 75% consensus of experts over that. In the first round of Delphi decision-making, the data elements with a consensus of less than 50% were removed. Also, the data elements within 50%-70% were re-examined in the second round, and in case of acquiring more than 75% consensus, that element was considered the final element.

In the fourth stage, technically, the design of the EHRS data model will be carried out in three ways, namely: Transforming and designing EHRS Minimum data set to Conceptual data model, Designing EHRS Logical data model, Designing EHRS Physical data model.

III. RESULTS

The proposed minimum data set (MDS) for Indonesian electronic health record system (EHRS) is more extensive than comparable MDS from hospitals in Iran [18], Australia [19], India [20], and the United States [10] [21]. The design of MDS in this study follows the process of medical services provided to a patient from the beginning of registration to the completion of receiving services at the hospital according with Indonesian regulations on healthcare services [22], can be seen in Fig. 1.

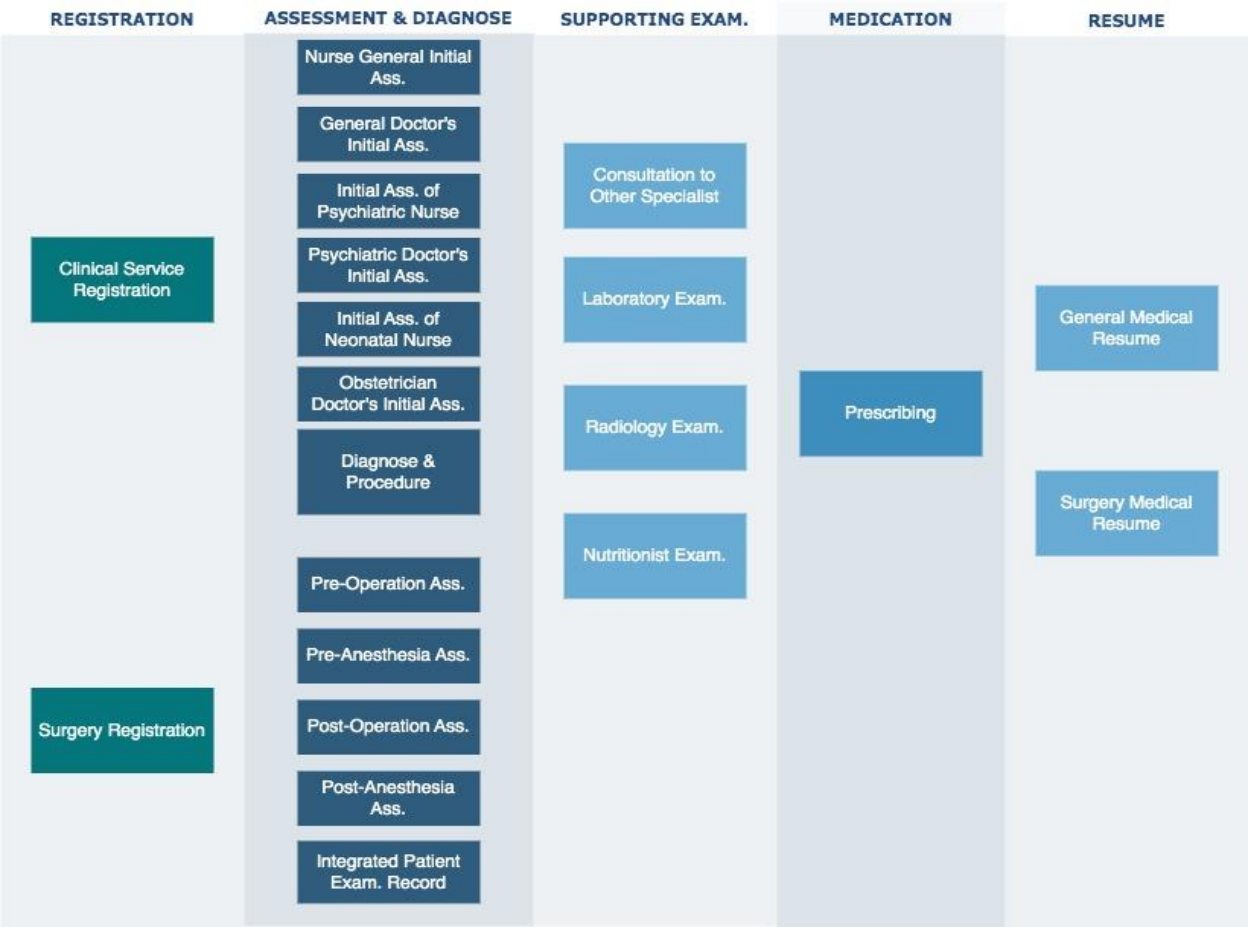

Fig. 1. Medical services process in hospital.

Based on Fig. 1, it can be seen that there are five main processes in medical services where in each process there are 21 sub-processes, which will be explained as follows:

1st Process is the process of registering the patient, divided into:

- Clinical Service Registration
- Surgery Registration

2nd Process is the process of assessing, diagnosing and integrating all the patient's condition by all medical staff providers, divided into:

- Nurse General Initial Assessment
- Initial Assessment of Neonatal Nurses
- Initial Assessment of Psychiatric Nurses
- General Doctor's Initial Medical Assessment
- Obstetrician's Initial Medical Assessment
- Psychiatric Doctor's Initial Medical Assessment
- Initial Nutrition Assessment
- Pre-Operation Assessment
- Pre-Anesthesia Assessment
- Post-Operation Assessment
- Post-Anesthesia Assessment
- Diagnose and Procedure
- Integrated Patient Examination Records

3rd Process is the process of request supporting examinations (if needed):

- Consultation to others specialist
- Laboratory Examination
- Radiology Examination
- Nutrition Examination

4th Process is the process of requesting prescriptions from pharmacies:

- Prescribing

5th Process or the last is the final reporting process:

- General Medical Resume
- Surgical Medical Resume

Based on the analysis of the processes running in medical services, 21 data classes have been determined whose data

elements will be proposed to be identified in the clinical data section, according to the number of sub-processes that exist in medical services. Meanwhile, administrative data elements will be proposed in five different data classes.

To prepare the desired minimum data sets (MDS), two Delphi decision-making stages were done. In the first stage of the Delphi technique, 898 data elements were proposed, which included 37 elements for the administrative data and 861 for the clinical data. In the groups of administrative data, 9 data elements were eliminated out of the 37 proposed ones, due to less than 50% consensus among the experts. Moreover, 21 data elements related to the administrative data underwent a second opinion in the second stage of the Delphi study due to 50%−75% agreement among the experts.

Among the 861 proposed elements for the group of clinical data, only 3 data elements were eliminated. Further, the experts were asked again about 25 data elements, due to 50%−75% agreement over them. In the second stage of the Delphi technique, a total number of 46 data elements (21 administrative data and 25 clinical data in 50%−75% agreement in the first stage) were provided to the experts and all of the data elements were approved.

There were 12 data elements that were eliminated because they did not reach 50% consensus by experts. The final MDS included 886 data elements (28 administrative and 858 clinical data elements) which are summarized in Tables III and IV.

The detailed list of Main, classes and data elements of administrative and clinical data elements in the final model are reported in Tables V and VI.

TABLE III. ADMINISTRATIVE DATA CLASS

Administrative Data Class	suggest D.E	< 0.5%	50-75%	> 75%	< 0.5%	50-75%	> 75%	Final D.E
Demography	8	0	4	4	0	0	4	8
Socio economy	7	0	7	0	0	0	7	7
Residence	5	2	2	1	0	0	2	3
Patient Referral Data	9	3	5	1	0	0	5	6
Healthcare Identifier	8	4	3	1	0	0	3	4
TOTAL	**37**	**9**	**21**	**7**	**0**	**0**	**21**	**28**

TABLE IV. CLINICAL DATA CLASS

Clinical Data Class	Suggested D.E	< 0.5%	50-75%	> 75%	< 0.5%	50-75%	> 75%	Final D.E
Clinical Service Registration	6	1	0	5	0	0	0	5
Nurse General Initial Assessment	107	0	4	103	0	0	4	107
Initial Assessment of Neonatal Nurses	117	0	5	112	0	0	5	117
Initial Assessment of Psychiatric Nurses	85	0	0	85	0	0	0	85
General Doctor's Initial Medical Assessment	59	0	4	55	0	0	4	59
Obstetrician’s Initial Medical Assessment	73	0	7	66	0	0	7	73
Psychiatric Doctor's Initial Medical Assessment	114	1	0	113	0	0	0	113
Pre-Operation Assessment	41	0	0	41	0	0	0	41
Pre- Anesthesia Assessment	56	0	0	56	0	0	0	56
Post Operation Assessment	56	0	0	56	0	0	0	56
Post-Anesthesia Assessment	13	0	0	13	0	0	0	13
Initial Nutrition Assessment	28	0	0	28	0	0	0	28
Surgery Registration	4	0	0	3	0	0	0	4
Integrated Patient Examination Records	14	0	4	10	0	0	4	14
Consultation	8	0	0	8	0	0	0	8
Diagnose & Procedure	4	0	0	4	0	0	0	4
Laboratory Examination	6	0	0	6	0	0	0	6
Radiology Examination	6	0	0	6	0	0	0	6
Prescription	17	1	0	16	0	0	0	16
General Medical Resume	26	0	0	26	0	0	0	26
Surgical Medical Resume	21	0	1	20	0	0	1	21
TOTAL	**861**	**3**	**25**	**833**	**0**	**0**	**25**	**858**

TABLE V. DETAILS OF ADMINISTRATIVE DATA

No	Administrative Data Class	Administrative Data Elements
1	Demography	identity/passport number, med rec number, patient name, patient father's name, sex, nationality, place of birth, date of birth
2	Socio economy	education degree, employment status, type of job, job description, average working hours/week
3	Residence	type of residence, address, mobile phone number
4	Patient Referral Data	medical appointment, type of visit, date of registration, service provider, referral number
5	Healthcare Identifier	Id healthcare, healthcare name, healthcare type/class

TABLE VI. DETAILS OF CLINICAL DATA

No	Clinical Data Class	Clinical Data Elements
1	Clinical Service Registration	Reg ID, Patient ID, Employee ID, Date Check-in, Medical Service Unit
2	Nurse General Initial Assessment	Patient ID, Nurse ID, Reg ID, Complaints, Current Disease History, Past Disease History, Family Disease History, Allergy History, Consciousness Level, Blood Pressure, Temperature, O2 Saturation, Weight, Height, Pain Assessment Score, Fall Risk Score, Nursing Problem Diagnosis, Care Plan and Implementation
3	Initial Assessment of Neonatal Nurses	Patient ID, Nurse ID, Reg ID, Complaint, Family Child Referral, Meconium Aspiration, Umbilical Cord Prolapse, Amniotic Fluid Rupture Time, Family Disease History, Mother's Age, Type of Childbirth, Weight Before Pregnancy, Weight During Pregnancy, Habits During Pregnancy, Baby Weight, Baby Length, Level of Consciousness, Blood Pressure, O2 Saturation, Grasp Reflex, Crying Reflex
4	Initial Assessment of Psychiatric Nurses	Patient ID, Nurse ID, Reg ID, Marital Status, Family Existence, Activities, Suspicions of Abuse/Neglect, Emotional Status, Religion, Educational History, Patient and Family Health History, Self-Concept, Appearance, Conversation, Feelings, Interactions in Interviews, Perception, Thought Flow, Memory, Concentration Level, Suicide Risk, Suicide Risk Category, Violence Risk, Violence Risk Category, Protective Factor, Nursing Diagnosis, Nursing Management Plan
5	General Doctor's Initial Medical Assessment	Patient ID, Physician ID, Reg ID, Complaints, Current Disease History, Past Disease History, Family Disease History, Allergy History, Consciousness Level, Blood Pressure, Temperature, O2 Saturation, Weight, Height, Pain Assessment Score, Fall Risk Score, Nutritional Status, General Condition, Physical Examination, Laboratory Examination, Radiology Examination, Primary Diagnosis, Additional Diagnosis, Management, Advanced Examination, Care Plan, Local Status
6	Obstetrician's Initial Medical Assessment	Patient ID, Physician ID, Reg ID, Complaints, Current Disease History, Past Disease History, Family Disease History, Allergy History, Surgery History, Transfusion History, Trauma History, Consciousness Level, Blood Pressure, Temperature, O2 Saturation, Weight, Height, Pain Assessment Score, Fall Risk Score, Nutritional Status, General Condition, Physical Examination, obstetrics and gynecology Status, Clinical Pelvimetry, Laboratory Examination, Radiological Examination, Primary Diagnosis, Additional Diagnosis, Management, Advanced Examination, Care Plan, Local Status
7	Psychiatric Doctor's Initial Medical Assessment	Patient ID, Physician ID, Reg ID, Main Complaint, Current Mental Disorder History, Past Mental Disorder History, Genogram, Drug History, Personality History Before Illness, Mental Treatment History, Appearance, Awareness, Orientation, Behavioral Attitudes, Thinking Process, Thought Content, Mood, Affect, Hallucinations, Illusions, Concentration Power, Memory, Level of Trustworthiness, Menigeal Signs, Cranial Nerves, Motor System, Vegetative, Laboratory and Radiological Examinations, Panss EC, GAF Score, Psychiatric Diagnosis, Medical Rehab Procedures, Therapy, Follow-up Plan
8	Initial Nutrition Assessment	Patient id, Reg ID, nutritionist id, medical diagnosis, malnutrition risk category, special conditions, dietary prescription, weight, height, nutritional status, general clinical, clinical complaints, dietary history of food intake, dietary history of food abstinence, intervention, monitoring evaluation
9	Surgery Registration	Surgery ID, Registration ID, Employee ID, Diagnose
10	Pre-Operation Assessment	Surgery ID, Patient ID, Surgery Time, Respiration, O2 Saturation, Blood Pressure, Pulse, Temperature, Consciousness Level, Action Plan, Implementation, Orientation Evaluation, Vital Evaluation, Surgical Tools Evaluation, Antibiotic Evaluation
11	Pre-Anesthesia Assessment	Anesthesia ID, patient ID, pre-operative diagnosis, action plan, anamnesis, anesthesia history, systole, diastole, pulse, respiratory, temperature, respiratory system, cardio system, hepatic system, ECG examination, anesthesia risk, anesthesia plan, pre-medication
12	Post Operation Assessment	Surgery ID, Patient ID, Entry Time, Exit Time, Respiration, O2 Saturation, Pulse, Temperature, Consciousness Level, Pain Scale, Pain Location, Action Plan, Implementation, Pain Evaluation, Pulse Evaluation, Respiratory Evaluation, Therapy Evaluation, Analgetic Evaluation
13	Post-Anesthesia Assessment	Anesthesia ID, Patient ID, Entry Hours, Exit Hours, Tools Type, Tools Score, Infusion, Transfusion, Analgetic Program
14	Integrated Patient Examination Records	Patient id, Reg ID, employee id, SOAP, Instruction, Physician verifier id, Physician verification date
15	Consultation	Consultation ID, Reg ID, Consular Doctor, Diagnosis, Clinic History, Type of Consultation, Destination Unit, Consular Destination Doctor
16	Diagnose & Procedure	ICD 10 code, ICD 10 description, ICD 9 code, ICD 9 description
17	Laboratory Examination	Lab ID, Reg ID, Unit, Doctor, Diagnosis, Lab Record
18	Radiology Examination	Rad ID, Reg ID, Unit, Doctor, Diagnosis, Rad Record
19	Prescription	Prescription ID, Reg ID, Patient ID, Doctor ID, Pharmacy ID, Chronic Status, Concoction Status, Diagnosis, Quantity, Dosage, Dosage, Instructions

20	General Medical Resume	Resume ID, Reg ID, patient ID, doctor ID, complaints, disease history, vital sign examination, lab examination, radiology examination, primary diagnosis, action, discharge status, follow-up plan
21	Surgical Medical Resume	Surgery ID, Reg ID, Patient ID, Pre-Operative Diagnosis, Primary Diagnosis, Operating Hours Started, Surgical Procedure, Surgical Procedure, Surgical Procedure, Surgical Details, Instructions

After the final version of MDS that has been selected and validated by experts is determined, the next stage is the design of the conceptual, logical and physical data model for EHRS. The conceptual data model of EHRS can be seen through Fig. 2.

Furthermore, after designing the conceptual data model, the next step is to design the logical and physical data model [13]. Logical data models help to define the detailed structure of the data elements in a system and the relationships between data elements. A physical data model is a representation of how data is stored, organized, and accessed in a database system. It takes into account the specifics of the underlying hardware, software, and database management system (DBMS). Unlike a logical data model, which focuses on abstract relationships and structures, the physical model is concerned with how data is physically implemented. The Physical data model of EHRS can be seen in Fig. 3.

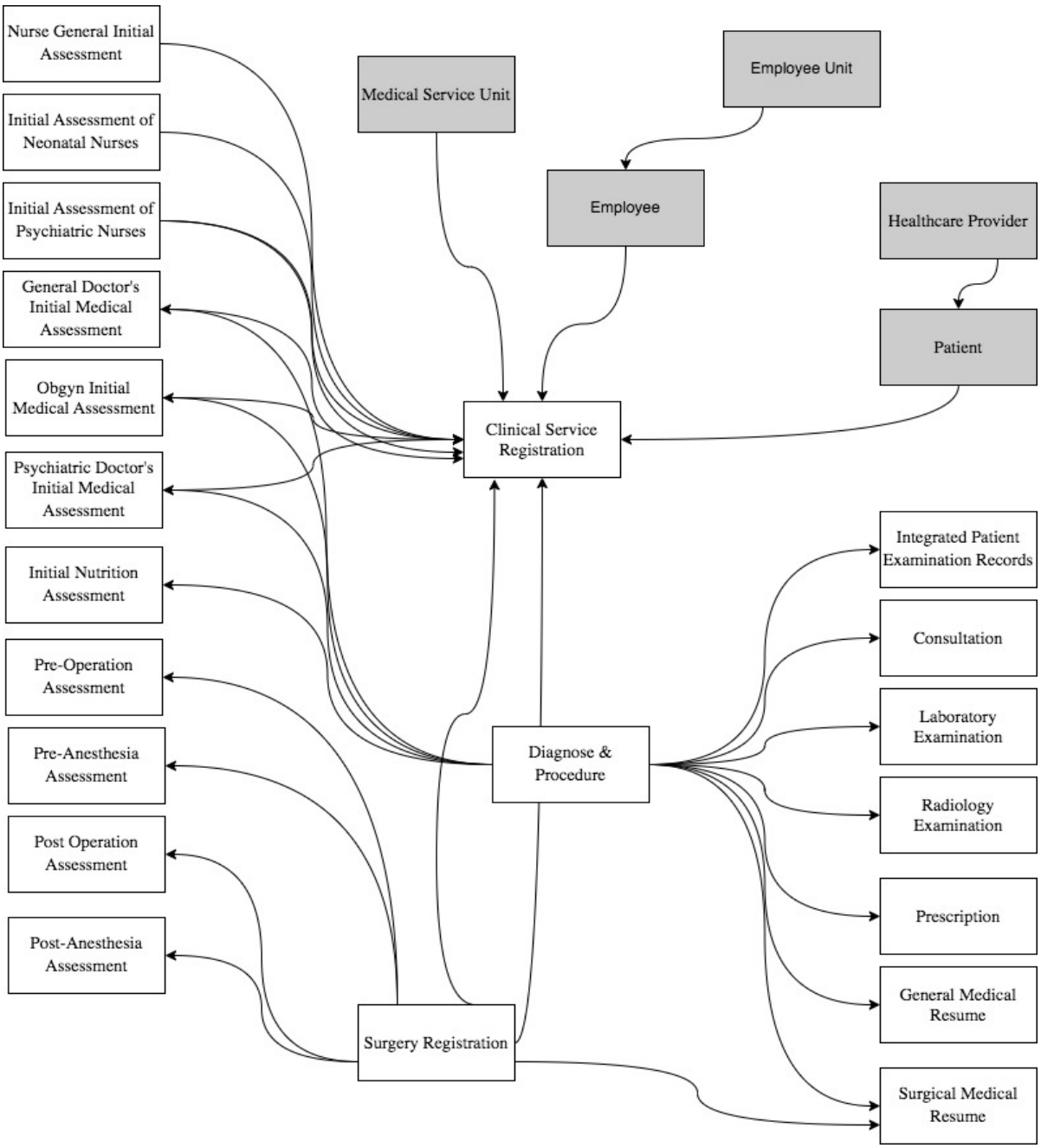

Fig. 2. Conceptual data model of EHRS.

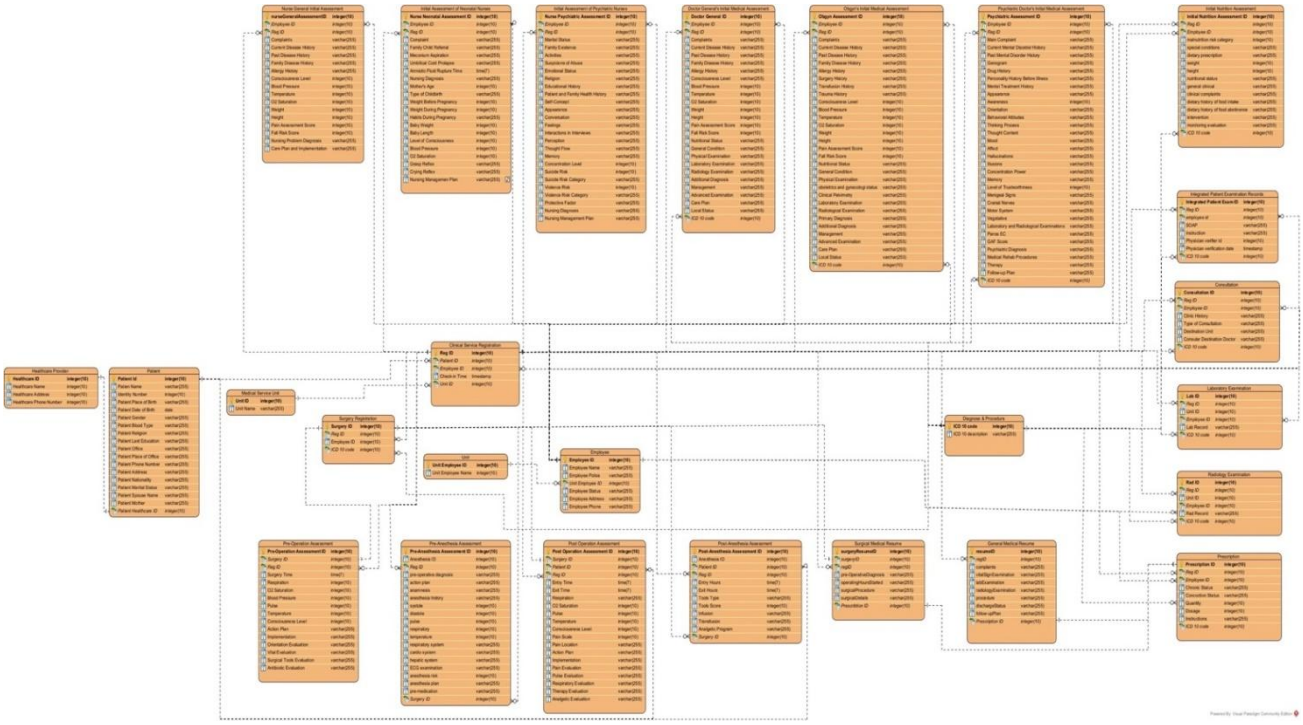

Fig. 3. Physical data model of EHRS.

IV. DISCUSSION

The designed minimum data set (MDS) for Indonesian electronic health record system (EHRS) has administrative and clinical sections. In this study, the administrative data were categorized into five different data classes. The first class of this data set is demographics. In this section, there are several data elements including identity/passport number, medical rec number, patient name, patient father's name, sex, nationality, place of birth, and date of birth. These data elements are used in most minimum data sets in countries with ethnic and migratory populations.

In the class of socio economy, some data elements related to patient socio economy are education degree, employment status, type of job, job description, and average working hours/week. Most of these data elements are similar to data elements for admission in other studies in the Islamic Republic of Iran [18] and the minimum data sets of other countries: Australia [19], India [20], and the United States [10][21]. In the class of residence, type of residence, address, and mobile phone number are the proposed data elements.

In the class of patient referral data, medical appointment, type of visit, date of registration, service provider, and referral number are the proposed data elements. Followed by Id healthcare, healthcare name, and healthcare type/class as part of the data class of healthcare identifier. These data are similar to the financial data elements in most minimum data sets in other countries [10][11][18][19][20].

The proposed clinical section had 21 data classes. Compared with similar minimum data sets in other countries [10][11][18][19][20], our proposed clinical data set has more data elements. We tried to include as many clinical data elements of the patient's medical record as possible.

In contrast to the minimum data sets of other countries, the nurse assessment data class is divided into three types, according to the medical services provided by the nurse, including the initial assessment data class of general nurses, the initial assessment of neonatal nurses, and the initial assessment of psychiatric nurses. The nurse general initial assessment data class was the first class of the clinical section with 107 data elements. This class includes anamnesis, physical examination, vital sign examination, nursing problems, nursing intervention, and nursing care plan, etc. This data element is generally the content of nursing assessments that are used according to the world's health service standard [23][24].

The initial assessment of neonatal nurse class is a data class that represents the need for data in the medical service process for babies born prematurely commonly called neonatal services. Data elements that distinguish it from the general nurse assessment include the order of the child in the family, meconium aspiration, umbilical cord prolapse, time of amniotic fluid rupture, family history of disease, mother's age, type of childbirth, weight before pregnancy, weight during pregnancy, habits during pregnancy, baby's weight, baby length, baby's level of consciousness, baby's grip reflex, baby's crying reflex and others. This is the data class with the highest number of data elements from other data classes, which is as many as 117 data elements. The data element in this data class also refers to the neonatal nursing assessment used in various health services [25][26].

The psychiatric nurse initial assessment data class is a data class that represents data needs for medical services for patients with mental disorders, generally, these services are provided in

mental hospitals with data elements including Family Existence, Activities, Suspicions of Abuse/Neglect, Emotional Status, Religion, Educational History, Patient and Family Health History, Self-Concept, Appearance, Conversation, Feelings, Interactions in Interviews, Perception, Thought Flow, Memory, Concentration Level, Suicide Risk, Suicide Risk Category, Violence Risk, Violence Risk Category, Protective Factor, Nursing Diagnosis, Nursing Management Plan. This reference is taken from several studies related to psychiatric medical services [27] [28] [29][30].

Furthermore the data class for services provided by doctors, including the data class of general doctor's initial medical assessment, Obstetrician doctor's initial medical assessment, and psychiatric doctor's initial medical assessment. The general doctor's initial medical assessment data class has 59 data elements including previous disease history, family disease history, allergy history, nutritional status, physical examination, laboratory examination, radiological examination, primary diagnosis, additional diagnosis, management, advanced examination, care plan, and local status, others. This data element is generally the content of the initial medical assessment used according to health service standards in other studies [23][24].

All data elements in the general doctor's initial medical assessment data class are also found in the obstetrician doctor's initial medical assessment data class. What distinguishes this class is the existence of data elements: pregnancy status, and clinical pelvimetry which is useful for representing the patient's pregnancy condition, others. The data elements in the obstetrician assessment data class are referenced from the common and specific neonatal studies [25] [26].

In contrast to the data class in the general doctor and obstetrician initial medical assessment, the psychiatric initial medical assessment data class focuses on medical services for patients with mental disorders, and has 113 data elements including Current Mental Disorder History, Past Mental Disorder History, Genogram, Drug History, Personality History Before Illness, Mental Treatment History, Appearance, Awareness, Orientation, Behavioral Attitudes, Thinking Process, Thought Content, Mood, Affect, Hallucinations, Illusions, Concentration Power, Memory, Level of Trustworthiness, Menigeal Signs, Cranial Nerves, Motor System, Vegetative, Laboratory and Radiological Examinations, Panss EC, GAF Score, Psychiatric Diagnosis, Medical Rehab Procedures, Therapy, Follow-up Plan, Others. The data elements in the psychiatric initial medical assessment data class are referenced from the common and specific studies [27][28] [29][30].

The next class of data is for the assessment of medical services in the operating room, divided into two types of services, namely surgical medical services and anesthesia medical services. Surgical medical services consist of pre-operative assessment data classes and post-surgical assessments. Referring to the literature on surgery [31][32][33], the data elements in the preoperative assessment class include operation time, respiration, O2 saturation, blood pressure, pulse, temperature, level of consciousness, action plan, implementation, orientation evaluation, vital evaluation, surgical tools evaluation, antibiotic evaluation. What is bold with data elements in the post-operative assessment class includes pain scale, pain location, action plan, implementation, pain evaluation, pulse evaluation, respiratory evaluation, therapy evaluation, and analgetic evaluation.

Meanwhile, medical anesthesia services, it is divided into pre-anesthesia assessment data classes and post-anesthesia assessment data classes. Referring to the literature on anesthesia studies [31][32][33], the pre-anesthesia assessment data class consists of data elements: pre-operative diagnosis, action plan, anamnesis, anesthesia history, systole, diastole, pulse, respiratory, temperature, respiratory system, cardio system, hepatic system, ECG examination, anesthesia risk, anesthesia plan, premedication. Meanwhile, what distinguishes it from the post-anesthesia assessment data class are the data elements: entry hours, exit hours, types of tools, tool scores, infusions, transfusions, and analgetic programs.

The last data class that is included in the assessment category is the nutrition assessment data class which contains data elements: malnutrition risk category, special conditions, dietary prescription, weight, height, nutritional status, general clinical, clinical complaints, dietary history of food intake, dietary history of food abstinence, intervention, monitoring evaluation [34][33] [36] [35].

After all classes of assessment data are identified, it continues to the class of integrated patient development records which contains data elements regarding Subject, Object, Action, and Planning referring to the international standard for writing integrated patient development records [23][24] [25]. The Consultation data class is required for the consultative process with other doctors in handling a patient, with data elements including consular doctor, diagnosis, clinical history, type of consultation, destination unit, and consular destination doctor.

Diagnosis and Procedure are two important data classes that must be present in the medical service process referring to many existing MDS, where each data class contains data elements regarding the description of the diagnosis along with the ICD-10 code and the description of the procedure along with the ICD-9 code [37][38]. The other two data classes that fall under the pre-clinical data category are the Laboratory and Radiology data classes. Each data class contains data elements: sending unit, doctor, diagnosis, laboratory record, or radiology record. Some other studies have included most of these data [39][40][41].

The important data class at the end of the medical service process is the resume data class, which is divided into the general medical resume data class and the surgery medical resume. Referring to minimum data sets in various studies [23][24][25][26][27][28] , the data element in the general medical resume data class, contains about: lab examination records, radiological examination records, primary diagnosis, actions, discharge status, and follow-up plans, others. Meanwhile, the data element in the surgery medical resume data class contains data on preoperative diagnosis, primary diagnosis, operating hours, surgical procedures, surgical actions, surgical details, and instructions, others referring to the international surgical MDS [31][32][33].

V. Limitations and Future Work

The results of this research have limitations that allow for development in subsequent research. Because the main focus of this research is to design the Minimum Data Set (MDS) and data model for the electronic health record system (EHRS) in Indonesia, this research does not discuss data security and data privacy of the designed data set.

The completeness of the MDS and data model that have been designed for EHRS in Indonesia should also be compared with the internationally used data framework standards such as Health Level 7 (HL7) and Fast Healthcare Interoperability Resources (FHIR), so that in the future it can develop into a data architecture that can be used on enterprise scale and can accommodate the process of data interoperability between health care facilities.

Furthermore, the follow-up to the results of this research, the MDS and data model that have been designed should also be evaluated and implemented in hospitals through the development of EHRS Applications, and evaluated by IT Hospital Experts or database experts to measure correctness, integrity and flexibility through data evaluation metrics [42].

VI. Conclusion

Designing MDS and data model is the first fundamental step to establish electronic health record systems (EHRS) in Indonesia. The design of MDS in this study follows the process of medical services provided to a patient from the beginning of admission to the completion of receiving services at the hospital, complies with Indonesian regulations on healthcare services.

The Delphi technique was employed to validate the identified data elements through a survey of medical experts. A questionnaire was designed to determine data elements in both administrative and clinical departments. There were 5 and 21 data classes agreed upon by experts in the administrative and clinical sections with 28 and 858 data elements, respectively. The design of the EHRS data model carried out in three ways, namely: Conceptual data model, Logical data model, and Physical data model.

This MDS could be a reliable tool for data standardization in EHRS that can improve the quality of data and, thus care and services related to medical services in hospitals. Therefore, decision-makers, policy-makers, and information system vendors can use this tool as a prerequisite for the selection or development of an EHRS.

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