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IoT-Based Community Smart Health Service Model: Empowering Entrepreneurs in Health Innovation

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ABSTRACT

The Indonesian government aims to improve public health by integrating a unified health platform with regional systems for effective decision-making. However, the existing health information system is inadequate for broader decision-making needs, focusing primarily on individuals with existing health issues and not adequately addressing the needs of disaster victims, such as those affected by floods, accidents, and burns. Tangerang City, located in Banten Province, is a flood-prone area that faces annual disasters, highlighting this gap. **To address this issue**, this study proposes the development of a Health Internet of Things (HIoT) model designed to support rapid decision-making and enhance community health services. **The proposed IoT-based** network will be implemented in residential complexes, private clinics, schools, and places of worship, enabling real-time monitoring of health conditions and facilitating disaster or pandemic mitigation. Data collected from these communities will be transmitted to nearby hospitals for immediate medical assistance. **Preliminary findings** suggest that the IoT-based e-health system offers significant benefits, including faster patient care, improved data accuracy, and reduced operational costs. These results underscore the potential of HIoT to enhance community-based health services. **The study provides** a foundation for future research and practical applications. Further investigation will be conducted to evaluate the scalability of the system in diverse communities and its impact on long-term health outcomes.

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1. INTRODUCTION

Tangerang City, located in Banten Province, Indonesia, spans 164,55 km² and comprises 13 subdistricts with a population of 2,093,706 as of 2021. The city faces challenges in health service infrastructure, with 23 hospitals and 38 community health centers serving a dense population [1]. This study proposes an innovative IoT-based Community Smart Health Service Model designed to address existing gaps by integrating community-level data with regional health systems. Specifically, the model aims to enhance health monitoring,

improve rapid response to emergencies, and mitigate disaster impacts by utilizing advanced IoT technologies. The proposed model also emphasizes the use of secure and scalable cloud computing to ensure data integrity and privacy. Additionally, it leverages real-time analytics to provide actionable insights for policymakers and healthcare providers. Key innovations include a community network for collecting real-time health data, which is analyzed and routed to healthcare facilities. This research aligns with Sustainable Development Goals (SDG 3 and SDG 11) by fostering good health and sustainable community development.

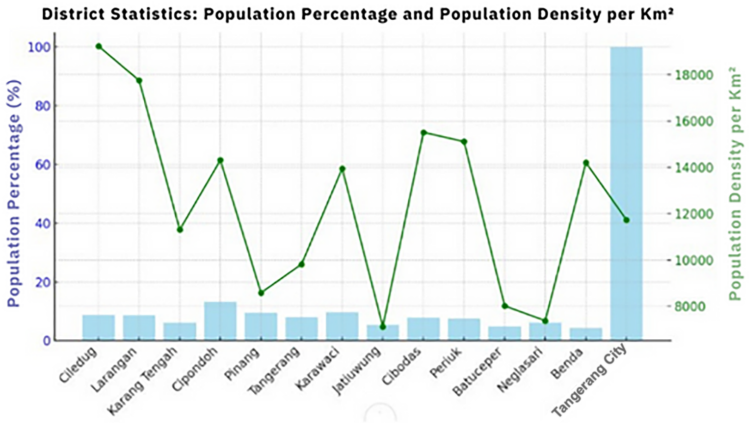

Figure 1. Number of residents and population density level of Tangerang city

Figure 1 illustrates the distribution of population density and the associated health service coverage challenges. Data derived from BPS Tangerang City 2021.

District	Health Facilities in Tangerang City								
	Hospital			Health Center			Posyandu		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
Ciledug	-	2,00	2,00	-	3,00	3,00	-	110,00	112,00
Larangan	3,00	1,00	1,00	3,00	2,00	2,00	109,00	105,00	105,00
Karangtengah	1,00	3,00	3,00	2,00	3,00	3,00	105,00	71,00	71,00
Cipondoh	3,00	2,00	2,00	3,00	4,00	5,00	70,00	101,00	102,00
Pinang	2,00	2,00	2,00	4,00	3,00	3,00	101,00	96,00	96,00
Tangerang	2,00	2,00	2,00	3,00	3,00	3,00	96,00	76,00	76,00
Karawaci	4,00	6,00	6,00	3,00	4,00	4,00	76,00	134,00	134,00
Jatiuwung	8,00	1,00	1,00	4,00	2,00	2,00	134,00	60,00	60,00
Cibodas	2,00	2,00	2,00	2,00	3,00	3,00	60,00	97,00	97,00
Periuk	2,00	2,00	2,00	3,00	3,00	4,00	97,00	73,00	75,00
Batuceper	2,00	0,00	0,00	3,00	2,00	2,00	73,00	54,00	55,00
Neglasari	-	0,00	0,00	2,00	2,00	2,00	54,00	60,00	60,00
Benda	1,00	0,00	0,00	2,00	2,00	2,00	60,00	46,00	46,00
Tangerang City	1,00	23,00	23,00	2,00	36,00	38,00	46,00	1 083,00	1 089,00

Figure 2. Health Facilities: Hospitals, Community Health Centers and Posyandu

Table 2 illustrates the distribution of healthcare facilities in Tangerang City from 2018 to 2020, covering Hospitals, Health Centers (Puskesmas), and integrated Healthcare Posts (Posyandu) across various sub-districts. Hospitals remained stable in most sub-districts, with Jatiuwung having the highest number (8 in 2018), while Neglasari had none during the entire period. Health centers showed little variation, averaging 2–3 per sub-district, with Jatiuwung leading again with 4 in 2020. Posyandu were the most widespread facilities, with Tangerang City having the highest number (1,089 in 2020), while others ranged between 70 and 134 units. Some areas, such as Ciledug, saw a slight increase in Posyandu (from 110 in 2018 to 112 in 2020). Overall, the data highlights a significant disparity in healthcare infrastructure, with Tangerang City dominating and certain areas like Neglasari lacking critical facilities like hospitals.

These disparities in healthcare infrastructure reflect the uneven distribution of resources across Tangerang City, potentially contributing to unequal access to essential health services among its population. Sub-districts

with more comprehensive facilities, such as Jatiuwung and Tangerang City, are better equipped to meet public health demands, while others like Neglasari remain underserved. Addressing these imbalances requires targeted policies and investments to ensure equitable healthcare provision, particularly in sub-districts with critical shortages. Strengthening the availability of health centers and Posyandu in underprivileged areas could significantly enhance community health outcomes and overall service coverage.

District	Number of Health Workers by Subdistrict in Kota Tangerang				
	Doctor	Nurse	Midwife	Pharmacy	Nutritionist
	2020	2020	2020	2020	2020
Ciledug	167	367	59	67	9
Larangan	71	123	35	49	6
Karangtengah	132	272	87	60	17
Cipondoh	235	276	62	80	11
Pinang	135	153	117	62	14
Tangerang	416	495	108	194	20
Karawaci	404	601	160	163	25
Jatiuwung	31	26	36	35	3
Cibodas	151	81	139	81	7
Periuk	90	155	67	68	7
Batuceper	15	31	28	11	2
Neglasari	86	190	25	27	23
Benda	28	18	38	29	3
Tangerang City	1 961	2 788	961	926	147

Figure 3. Number of Health Workers by District in Tangerang City 2021

The Table 3 shows the distribution of healthcare workers across sub-districts in Tangerang City in 2020, including doctors, nurses, midwives, pharmacists, and nutritionists. Tangerang sub-district has the highest number of healthcare personnel, with 416 doctors, 495 nurses, 108 midwives, 98 pharmacists, and 20 nutritionists, reflecting its role as a central hub for healthcare services. In contrast, Neglasari and Jatiuwung have significantly fewer healthcare workers, highlighting disparities in resource allocation. Overall, Tangerang City employs 1,961 doctors, 2,788 nurses, 961 midwives, 926 pharmacists, and 147 nutritionists, suggesting a need for better distribution of healthcare personnel to underserved areas [2].

Based on data ratios of rapid population growth and the distribution of health service infrastructure which includes posyandu, health centers, hospitals, medical personnel and health insurance which is far from ideal [3]. This is shown by the 3000 population compared to 32 available hospitals. Additionally, health promotion related to disease prevention, vaccines and mitigation of disaster victims is difficult because the ratio of hospitals and health centers is not adequate. The health service sector in the city of Tangerang requires a network connection to the community to provide information about the health conditions of the community and its services.

Apart from that, a smartphone application is needed that is capable of providing data, images and sound to transmit the latest data [4]. Data sent through the community will be received by the city hospital to immediately carry out medical treatment and other health services. Adequate network infrastructure is necessary to guarantee data transmission. The novelty of this research is:

- Application of a network to collect data on individuals from birth to death in a community involving smart technology [5].
- Data collection on pregnant women which produces health data about birth failure, baby defects and deaths connected directly to the community service server. This includes health promotion, patient medical records and outpatient services [6, 7].
- Data on drug readiness, facilities such as ambulances for victims who need immediate assistance and the readiness of health workers are also needed.
- Social media can also support this health service by providing accurate and up to date information regarding fatalities due to natural disasters [8, 9] malpractice cases in hospitals, etc.

The Introduction should provide a clear background, statement of the problem, the relevant literature on the subject, the proposed approach or solution, and the new value of research which is innovation. It should be understandable to colleagues from a broad range of scientific disciplines [10, 11].

2. LITERATURE REVIEW

In Indonesia, Health Centers is at the sub-district government level under the district government. The need for integration of public health service data from the lowest level of government aims to monitor, prevent and improve citizens health [12]. In addition, the integration of health practice data supported by computer technology that runs via the internet can help citizens and the government with:

- Information about areas affected by disease outbreaks. availability of medical personnel, hospitals and patients.
- Clinical Decision Support System (CDSS), which provides digital information for health professionals to use in diagnosing or treating patients in districts in Indonesia.
- Telemedicine, where physical and psychological diagnosis and treatment is done remotely [13, 14].
- Citizen health informatics, which uses digital medical information [15].
- Health knowledge management, where health care data is processed in the form of tacit and explicit knowledge [7].
- Health Informatics or Health Information Systems, where special applications are built to serve health business processes such as scheduling appointments, managing patient data , managing work schedules, and other tasks in health administration [16, 17].
- Information about accidents that occur to residents that occur outside the area where they live.
- Information about the management of deceased patients who are connected to the Dukcapil Office.

2.1. Research Method

The proposed IoT framework integrates healthcare delivery using advanced technologies, including IoT-enabled sensors, cloud computing, and secure data networks. The system architecture connects hospitals, health facilities, and community members via a centralized IoT-enabled application. The framework incorporates:

- Sensors for real-time health data acquisition.
- Data management systems employing cloud computing for scalability and security.
- An integration layer enabling seamless data exchange with existing health information systems.
- A mobile application that facilitates data submission by residents and provides instant alerts to healthcare providers.

The framework emphasizes data privacy and security, adhering to regulations such as the Health Insurance Portability and Accountability Act (HIPAA) standards and Indonesian data protection laws. To achieve this, it incorporates robust encryption methods, access control mechanisms, and secure data transmission protocols. Regular security audits and compliance assessments are conducted to mitigate potential risks and ensure that sensitive health data remains protected. Additionally, the system prioritizes user transparency by providing clear consent mechanisms and allowing individuals to manage their personal health information securely. Through these measures, the framework ensures a reliable and compliant approach to data security in healthcare.

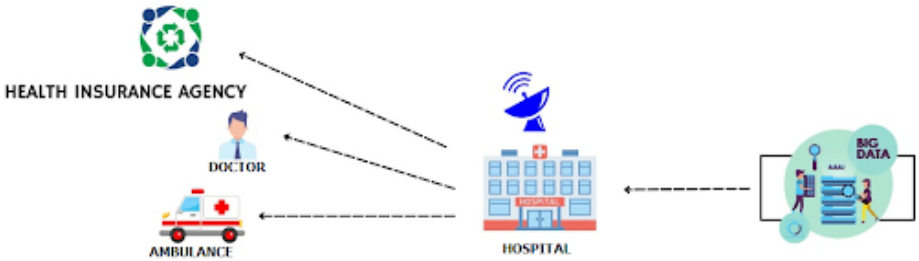

Figure 4. Framework Hospital Action

The diagram in Figure 4 illustrates the framework of hospital actions within a smart healthcare system, showcasing the integration of various entities such as health insurance agencies, doctors, ambulances, and big data systems. The hospital acts as a central hub, receiving input from healthcare providers and insurance agencies while coordinating emergency services like ambulances. Data from these interactions are processed through a big data system to improve decision-making, optimize patient care, and ensure seamless operations. This interconnected framework emphasizes the use of technology to streamline healthcare delivery and enhance service efficiency.

Meanwhile, disaster victims in certain areas, such as victims of floods, earthquakes, fires, and even accidents, have integration with news senders to ensure accurate and timely information dissemination. These services for disaster-affected communities begin with the transmission of data, often in the form of images or videos, using cellular networks to provide real-time updates about the situation. This data is then processed by the community server, where it is analyzed and validated to ensure its reliability before being forwarded to relevant authorities or healthcare providers. Such integration allows for rapid assessment of the number of victims, the extent of damages, and the resources needed for effective response. Additionally, this system enables early alerts and immediate action, ensuring that emergency services such as ambulances or rescue teams can be mobilized efficiently. By leveraging modern technology, this approach strengthens disaster response capabilities while promoting coordinated efforts between communities, healthcare facilities, and disaster management agencies.

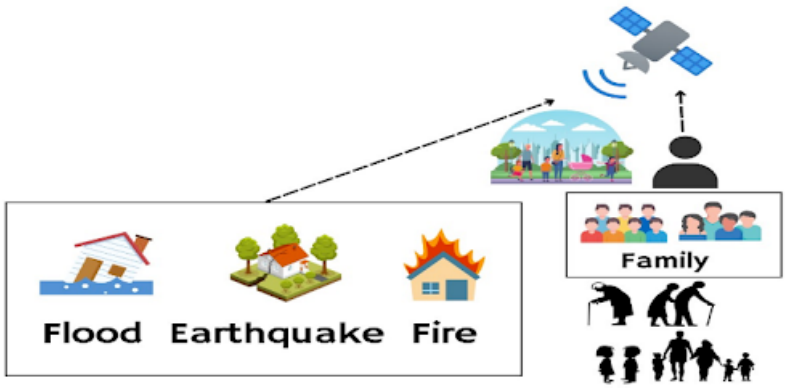

Figure 5. Information from Citizen

Figure 5 illustrates how information from citizens is integrated into a medical network to support disaster response and community health monitoring. The framework highlights the flow of data from families and affected individuals during disasters like floods, earthquakes, and fires, which is transmitted to centralized systems for further action. This network facilitates the collection of real-time data, such as the number of victims, service needs, and drug predictions, enabling disaster management agencies to respond effectively. Additionally, families can send electronic health examination results to the community server, which organizes data by age, service type, and treatment appointments. This interconnected system supports secure communication, authentication, and data management to enhance healthcare delivery and disaster mitigation at the local level [18].

The medical network was built to provide information services in the form of number of victims,

service needs, drug predictions. Meanwhile, disaster management agencies need community information to mitigate disasters such as floods and fires that occur in a neighborhood level [19, 20]. Monitoring the health of residents in areas determined by posyandu within the sub-district scope by creating secure connections between networks, and providing authentication and authorization mechanisms for users. Each family can send electronic-based personal examination results which can then be reported on the community server. Network development in this community allows grouping of data based on age, type of service, consultation and treatment appointments, etc.

2.2. Medical Record

Medical records are files that contain notes and documents regarding patient identity, examinations, treatment, procedures and other services that have been provided to patients and outpatients [21, 22] based on Medical Practice. Meanwhile, the type of medical record data in question can be text (either structured or narrative), digital images (if digital radiology has been applied), sound (such as heartbeat), video or biosignals such as electrocardiogram records. There are 2 (two) important parts of medical records, namely: Patient Records and Management. Medical records are information recorded both in writing and electronically about a patient health condition and illness and Management is the process of processing and compiling a patient health condition and illness so that it becomes useful information for responsibilities in terms of management, finances and the patient health development conditions [7, 23, 24].

2.3. Posyandu

Posyandu is a social institution that accommodates community empowerment in basic social services. The task of this community organization is to provide health promotion assistance to the smallest levels of government as well as provide preventive measures against disease in the community. For example, maintaining maternal and child health, immunization, family planning programs, immunization, nutrition, prevention, and control of diarrhea [25]. Additionally, Posyandu plays a crucial role in collecting and managing health data at the community level, which can be used to identify health trends and inform public health strategies. It also serves as a platform for educating residents about hygiene practices, early detection of illnesses, and the importance of regular health check-ups. These efforts contribute to strengthening the overall health system by bridging the gap between communities and higher-level healthcare services. Tables and Figures are presented center, as shown below and cited in the manuscript.

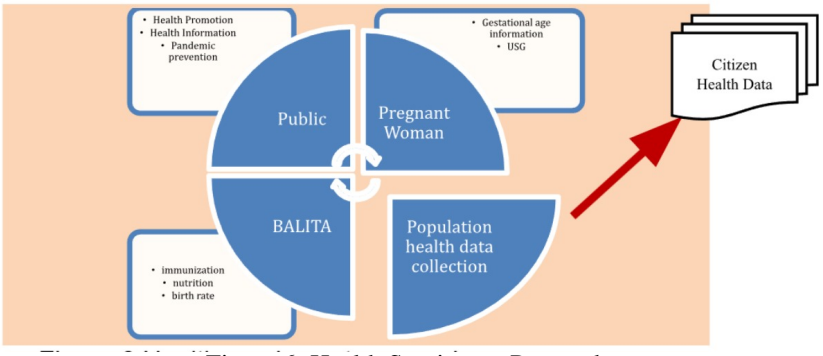

Figure 6. Health Services at Posyandu

The Figure 6 diagram illustrates the integrated flow of citizen health data within a community health framework, focusing on key demographic groups such as the public, pregnant women, and toddlers. It highlights the collection of population health data, which includes critical information like age, immunization records, and nutritional status. This data supports health initiatives such as disease prevention, health education, and medical interventions. The system emphasizes the continuous exchange of information between these groups to ensure comprehensive and targeted healthcare services, ultimately contributing to better health outcomes across the community.

Integration of health services from a smaller level (community services/posyandu) to higher health services such as community health centers, city and provincial hospitals is urgently needed [17]. Smart e-health development will start from early patient data collection in public health services [15]. The medical history of all patients who have been recorded will become an important document that can be shared with

related parties who serve as referrals for services in the city and province. In addition, patient data will be connected to the Health Social Security Administering Agency (BPJS) [25, 26].

Furthermore, health services recorded in medical records do not just record patient registration and services, but must accommodate before and after services as an implementation system. Recording medical records of health services can start from registering pregnant women, registering health service information from toddlers, health services and treatment measures received by patients, then the archives are stored. Data can be used when someone needs it for their purposes or other purposes [15, 27].

3. RESULT AND DISCUSSION

The city government, through the disaster management agency, in carrying out its mission to provide assistance often faces difficulties, mainly due to inaccurate disaster location information, leading to delays in decision-making to send aid. Additionally, the limited number of Search and Rescue (SAR) members does not match the number of flood-affected victims. The disaster management agency, provincial health office, do not have real-time population data and adequate information systems for decision-making in flood disaster management actions.

In a densely populated housing complex there are health service problems that are difficult to resolve. This includes residents suffering from certain diseases, births, and deaths. Furthermore, health services are also needed immediately for residents affected by disasters, floods, fires and earthquakes. Assistance from the government and related agencies such as disaster management agencies, health service officers and other related officers has not been able to resolve this problem due to late information resulting in victims not being helped. The need to handle births and other emergency conditions is the government focus to be able to solve these problems. Limited access also influences the receipt of accurate information. Additionally, access to the Health Insurance Agency (BPJS), specialist doctor services and health facilities are also a package of needs for the community to get guaranteed health services.

3.1. Research Implementation

The development of the proposed IoT-based intelligent community services will produce an enterprise architecture that is implemented by building e-health applications for communities in sub-districts and cities [12, 22] as a supporter of the One Health platform. The network infrastructure will support information received via the e-Health Website which is implemented using open source web-based server programming such as Personal Home Pages (PHP) and using MySQL as the implementation of the data warehouse and database. Furthermore, to mine unstructured data as information on health services and services using social media such as Twitter, Instagram and so on [28]. Information support from various social media will then be filtered to obtain valid information. The website will receive information from community members in the environment which will then provide a category for each information as shown in Figure 6. However, network monitoring and control must be carried out to avoid attacks that cause the website to stop and ensure the website continues to operate. Network control and monitoring must also be carried out to ensure that there are no intruders and data thieves.

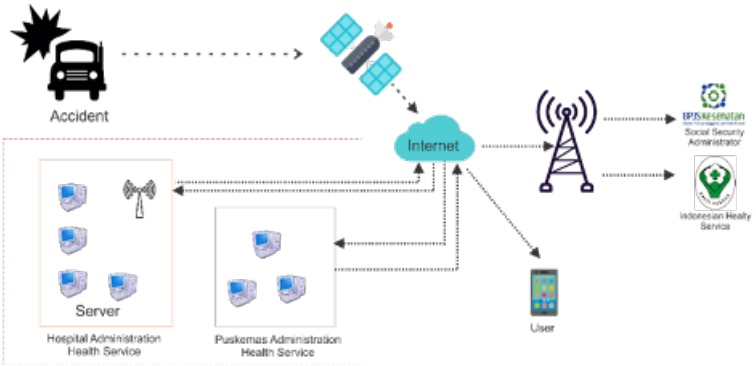

Figure 7. Accident Health Service Integration

The Figure 7 diagram illustrates a smart health system framework for managing accident-related emer-

gencies using IoT technology. When an accident occurs, data is captured and transmitted through satellite and internet networks to central servers handling hospital administration and health services. The system integrates with mobile applications, allowing users to report incidents in real-time. Additionally, it connects with institutional bodies such as health insurance authorities and other related agencies for streamlined coordination and resource allocation. This interconnected system ensures rapid response, efficient management of medical resources, and seamless communication between stakeholders to improve emergency healthcare services [29].

3.2. Family Smart Services

The personal health service assistant model for each family will be built into a smartphone application that can be accessed with a personal cell phone. This health service assistant model will provide personal health care advice to family members based on disease complaints, for example: about activities to be carried out and nutrition needed [25]. Additionally, this application model can provide benefits in the form of duplicating tests and treatment, getting active medical action and useful information to cure them when facing health problems [30]. This health care assistant model is also beneficial for health workers who are helped by the availability of information about patient data and similar medical treatments or symptoms and can provide efficient and appropriate medical therapy to patients [6, 10, 17]. Extracting health information from social media can be applied to find structured information that can be used to provide certain health information based on the user personality. Mining of unstructured data from social media will include news mining and must be under supervision to have valid information and thus unstructured data will be converted into structured data that can be easily maintained and used [4, 16].

3.3. Community Health Services

The proposed Health Network in Figure 5 will receive data and information from residential locations and sub-district level. There are two types of data received, namely medical record data originating from the posyandu or community health center and local hospitals. Meanwhile, data on disaster victims includes data on victims, material and immaterial losses and infrastructure in the affected area the location. Disaster victim data also contains pandemic data that occurred at the location. Data from posyandu will contain information on pregnancy, birth, nutrition, population development and promotion of disease prevention [3, 13, 26]. Community Health Services will provide assistance to accident victims and victims of other disasters that occur around the area after receiving information from information sources via Twitter, WhatsApp and other unstructured media [9], [31]. Community Health Services will send patient data to the nearest hospital for immediate assistance. Network development for community health services can be built at the RW level to facilitate monitoring and data collection on residents.

3.4. Hospital Health Services

Data collection carried out by community services will be sent via the network to the hospital with adequate security [27]. This is to reduce leakage of personal data. Medical records will support disaster victim services in providing decisions for taking appropriate medical action [22]. Hospital Health Services will follow up on reports from community Health services by preparing medical personnel, vehicles and payment facilities. Furthermore, with the existence of IoT-based integrated health services, outpatients and patients in hospitals can be served in accordance with health service standards [7].

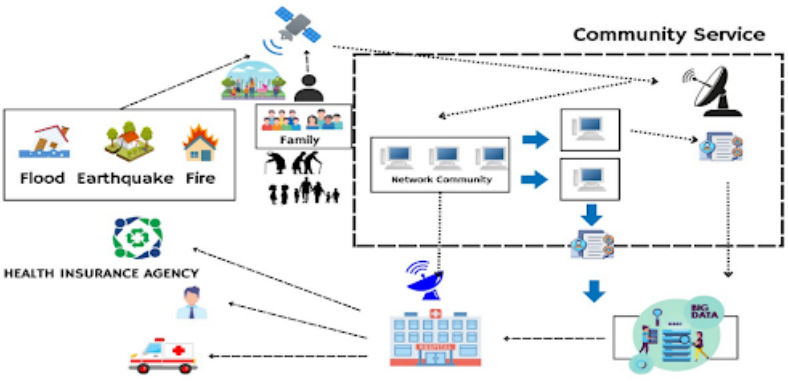

Figure 8. Community Smart Health Service Framework

The diagram in Figure 8 represents a community smart health service framework that integrates various entities to enhance healthcare and disaster response. It highlights the role of community services in managing data from events like floods, earthquakes, and fires, as well as individual family health data. This information is routed through a network community system, which processes and transmits it to relevant stakeholders, including hospitals, health insurance agencies, and big data analytics systems. The framework ensures efficient communication and coordination between community-level data sources, healthcare providers, and administrative systems, enabling rapid responses to emergencies and improved overall healthcare delivery.

The third component is a liaison between hospitals and disaster victims, namely the community as a disseminator of valid news and has a server to create and store medical data. Furthermore, the process of help and health care will start from information submitted by the user which is sent via smartphone on social media or directly. The information will be received by the community server responsible for processing and storing acquired data in the cloud. Community servers will also create a chronology of events and validate information. The success of an IoT system depends on how satisfactory the system is healthcare provider requirements. Since every disease requires complex health activity procedures, namely topology must follow medical rules and steps in diagnosis procedure.

4. CONCLUSION

IoT-based community smart health services represent a transformative approach to health management and emergency response. By integrating IoT technology into community health networks, the proposed model enhances data accuracy, accelerates emergency responses, and reduces healthcare costs. The implementation of this model in Indonesia aligns with SDG 3 and SDG 11, offering policymakers and practitioners a framework to achieve sustainable, efficient, and equitable healthcare delivery. Future work will focus on pilot implementations and scalability assessments. The information provided can be in the form of data, images, heart rate results, blood sugar or blood pressure. Apart from that, smart health services can also provide information about disaster victims who must take immediate action to avoid loss of life.

The implementation of community-based intelligent health services for provinces in Indonesia will bridge health services from community, rural, urban and provincial levels integrated in a health application. In addition, the number of health workers, facilities and medicines can be immediately identified and equipped based on the patient need for treatment. Health services for residents who are patients will be fast, comfortable and of high quality. The benefits of having online access to safeguard personal health and health workers, will provide efficient and effective health services without wrong treatment. Apart from that, valid information from social media will provide great benefits for citizens in terms of securing health services where patients and health workers will be assisted with valid data to combat health problems.

5. DECLARATIONS

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5.2. Author Contributions

Conceptualization: DJ and ZN; Methodology: HP; Software: AI and ZN; Validation: IS and DP; Formal Analysis: DJ and HP; Investigation: AI; Resources: IS; Data Curation: DP and ZN; Writing Original Draft Preparation: YS and HK; Writing Review and Editing: DJ and HP; Visualization: AI; All authors, DJ, HP, AI, IS, DP, and ZN have read and agreed to the published version of the manuscript.

5.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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5.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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