

# Modern Geriatric Home Health Care Architecture

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## Abstract

In the last five years, Indonesia's Gross Domestic Product (GDP) has continued to grow positively and followed by an increase in general healthcare services. Thus, Indonesia has reached a new record of life expectancy rate of more than 70 years old.[1] However, health facilities especially home health care for geriatrics are still very limited. [2] Therefore in this paper, we propose an architecture and a scheme of modern geriatric home health care (GHHC) in order to overcome the disadvantages of the present GHHC such as paper-based transaction, lack of patient activity monitoring, and uncontrolled personal health record (PHR) data. In this research, we collaborated with the Medical Faculty of Universitas Katolik Indonesia Atma Jaya, and using the case of North Jakarta Region. This architecture accommodates four key technologies, namely Data Science, Cloud Computing, Internet of Things (IoT) and Artificial Intelligence (AI).

**Keyword:** Home Health Care, Architecture, Integrated Information System

## 1. INTRODUCTION

Indonesia's life expectancy nowadays has surpassed minimum age of elderly which is 70 years. However, the professional geriatric home health care (GHHC) [3] in the developing countries like Indonesia has still underdeveloped and needs government regulations especially related to information technology (IT). Therefore, government should support the development of GHHC standardized facilities. The existing professional GHHC, though only few, that equipped with paper-based standard operational procedure (SOP), is inadequate for non-professional healthcare of GHHC personnel with basic IT ability. They are only able to use Microsoft Windows with Microsoft Office and certain basic application such as browsers (Mozilla Firefox, Google Chrome or Microsoft Edge), calculator, and notepad.

To promote regulation of formal GHHC services, the Indonesian Ministry of Health (MoH) published a book called "Buku Lansia" (elderly book), [4] which contains of personal health record (PHR) of the elderly. The Government has also issued a campaign for outreach to many places about the importance of health care for the elderly. Nevertheless, the paper-based system cannot cope with today's health demands. There are several problems that occur frequently:

1. Lack discipline: the documentation of PHR and GHHC operational documents are not well maintained. Most of the case, the documents are scattered and some of them are missing.
2. Delay of service: GHHC document is not available timely, for instance in the case when the document is needed as a medical reference to other hospital.
3. Schedule: Patients have difficulty to find appropriate GHHC and getting appointment.
4. Process: Analyzing and build reports from large amount of electronic medical record (EMR) data.
5. Generic: No application as a general platform to become a

standard based to communicate and data sharing between GHHC and others health institution.

## 2. KEY TECHNOLOGIES

There are several technologies that will gradually become the core features in GHHC integrated information system (IIS), the following describes some of the technologies involved in those features.

### A. Cloud Computing [5] [6]

Cloud Computing (CC) is an architectural approach to build a flexible IT infrastructure. People can easily pool of hardware and software resources to meet the requirements of business processes. Its applications can be developed using internet technologies i.e., HTML, CSS, .NET Framework. The access is also easy, fast and only required minimum effort. Because of Indonesia has thousand islands geographically so that CC is very suitable to be implemented with GHHC industry. According to the service, CC is categorized into infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS).

### B. Data Science [7]

Data science (DS) is the practice of using computational methods to derive valuable and actionable insights from raw datasets. Talking about Data Science, it is commonly related with big data as the storage of huge data to be processed. There are many sources of big data in the GHHC, some of which are electronic health records (EHR), personal health records (PHR), and picture archival and communication systems (PACS). Practically, in GHHC, data science provides significant benefits. Some benefits of this technology are detecting diseases at an early stage and thus giving effective prescription, determining the most suitable and effective medicine, and measuring patient activity behavior in order

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to regain health after suffering from illness.

### C. IoT Technology [8][9]

Internet of Things (IoT) is defined as the network of things, with clear element identification, embedded with software intelligence, sensors, and ubiquitous connectivity to the Internet. The most important role of IoT in GHHC is to sense and measure conditions and behaviors of the patient in real time. With this information, the GHHC team can be assisted in applying corrective, preventive, risk-based, and condition-based care to patients.

### D. AI Technology [10]

Artificial Intelligence (AI) is the ability of a machine to perform cognitive tasks that are associate with the human mind, include the possibilities for perception as well as the ability to argue, to learn independently and thus to find solutions to problems independently. AI in GHHC plays a role in helping stakeholders to accomplish their responsibilities easier and faster. Ambient assisted living, smart homes to support dementia patients, Diabetes prediction and monitoring are some practical examples that have applied with AI at present.

### 3. MODERN GERIATRIC HOME HEALTH CARE

In this paper, we propose an architecture of GHHC based on four key technologies in order to overcome some of unique Indonesia conditions and cultures. During our survey in this field on 2019-2020, we found that most of the patient's family relatives prefer to use instant messaging services such as Whatsapp, Line or short message service (SMS) in order to communicate with GHHC support staff rather than any others communication media. Therefore, chatbot will be very suitable to handle this workload. Most of Indonesian people are also very interested to using IT gadget such as closed-circuit television (CCTV), up-to-date smartphone and self-service customer dashboard on the website.

Through the implementation of modern GHHC, people can fast and accurately obtain the relevant service information, thus it can realize definite service, management standardization and scientific decision. At the same time, through the integration and collaboration of application service, it can realize information acquisition, sharing and service to throughout all others health service providers, so as to promote the implementation process in smart service, smart diagnosis, smart decision, smart treatment, and smart management.

### 4. ARCHITECTURE OF MODERN GERIATRIC HOME HEALTH CARE

Modern GHHC architecture proposes patient centered framework which its concept is defined by Institute of Medicine (IOM), USA. This patient may have possibility that they also have other position such as professional healthcare or the family of another patient so that the membership system should have to accommodate the relation between each other. When using Modern GHHC architecture, every GHHC stakeholder will have only one unique account along with his/her own medical information so that the consistency data will be maintained. The health organizations (e.g., hospital, clinic, insurance) may put set their own patient identity number on the reference column of the account information. The applications, that are able to be accessed from miscellaneous devices, provide dashboard with rich User Interface/User Experience (UI/UX) for the stakeholders to interact with the system.

The architecture is defined into eight layers, whilst the other six layers are software-based. The first and second layer are hardware-based. First layer is consisting of devices that users use to access or synchronize data into system, while the second layer is physically group of servers, networking devices and others machine on the datacenter that provide the main hardware structure.

Software	SaaS	<b>GHHC Business Intelligence</b> <small>(Web, Desktop Version)</small>		AI	<b>8</b>
		<b>GHHC Business Solutions</b> <small>(Web, Desktop Version)</small>			<b>7</b>
		<b>GHHC Business Applications</b> <small>(Web, Desktop, Mobile Version)</small>			<b>6</b>
		<b>Web services, Multimedia, eMail</b>			<b>5</b>
Hardware	PaaS	<b>Software Framework (Java, Python, .NET), Storage (DB/File)</b>			<b>4</b>
	IaaS	<b>Computation (VM), Storage (Block)</b>			<b>3</b>
		<b>CPU, Memory, Disk, Bandwidth</b>			<b>2</b>
	<b>IoT Device</b>	<b>Mobile Device</b> <small>(smartphone, tablet)</small>	<b>Computer</b> <small>(notebook, PC, Workstation)</small>	<b>1</b>	

**Figure 1.** Architecture of Modern GHHC

Based on the key technologies that has been discussed, CC technology is applied at the second to the eighth layers (IaaS, PaaS, SaaS) so that it gives an advantage when we need to enhance resources. AI plays a major big role in GHHC. First, AI technology is implemented in IoT devices at the first layer. (e.g., Sleep detection using physiological signals from a

wearable device, telemonitoring devices used in diabetes mellitus, chronic kidney disease, or heart failure, [16]) Second, it is embedded in sixth layer to eighth layer which applications on the business applications layer (e.g., chatbot, scheduling task and predicting waiting times using neural network [17]), business solutions layer and the business

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intelligence layer so that it provides many solutions. Meanwhile, DS helps users to make decisions at the business applications layer and IoT provides indicators and user health data on a regular basis automatically. On layer sixth to eighth, some of them are categorized as business application. Common application such as enterprise resource planning (ERP), human resource information system (HRIS) and payroll are belonging to GHHC Business Applications layer which is to manage daily operational job and produces lots of data (see Figure 2). While on seventh layer, GHHC Business Solutions gives more comprehensive features for analyzing, and research. It will produce detail information and knowledge for strategic decision making. Last, the GHHC Business Intelligence, providing wisdom for strategic decision making. The application presents it with visual and state of the art of UI/UX.

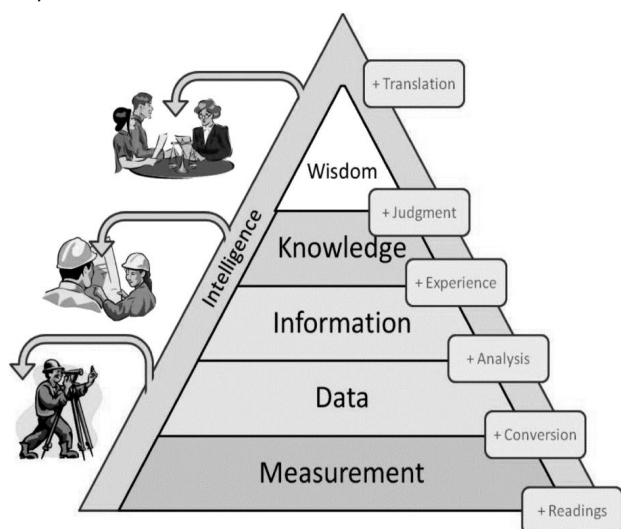


Figure 2. Knowledge Management [11]

### 5. IMPLEMENTATION OF MODERN GERIATRIC HOME HEALTH CARE

The Implementation of Modern Geriatric Home Health Care involves several aspects listed below.

#### A. International Standardization

There is a lot of standardization that systems have to comply in order to be able to communicate and collaborate with other systems. In healthcare, there are at least three international standards, i.e., HL7, ICD, and DICOM to be implemented in GHHC. HL7, [12] developed by Health Level Seven International, is a set of international standards for transfer of clinical and administrative data between software applications used by various healthcare providers. ICD, [13] abbreviation of International Classification of Diseases, is a globally used diagnostic tool for epidemiology, health management and clinical purposes. The ICD is published and maintained by the World Health Organization (WHO) which is a specialized agency of the United Nations (UN) that responsible for international public health. DICOM [14] is Digital Imaging and Communication in Medicine, published by The National Electrical Manufacturers Association (NEMA). The DICOM standardization is for the communication and management of medical imaging information and related data.

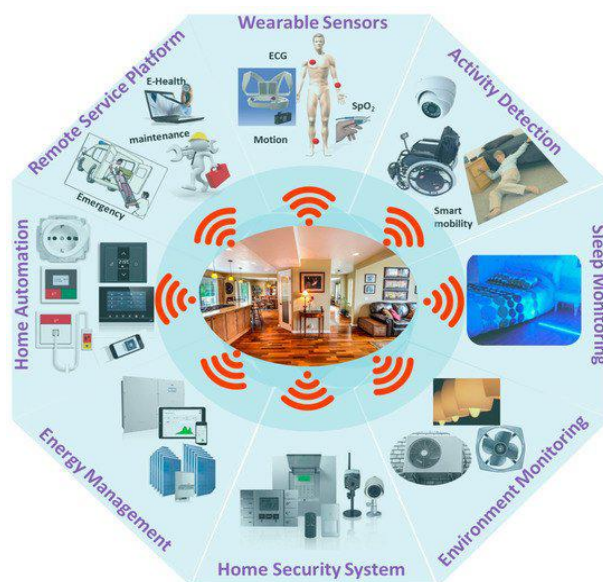
#### B. Construction of IoT Platform

In order to integrate IoT technology into the system, a

platform is needed that become a command center to regulating many IoT products from various providers. There are eight IoT groups that are used at the GHHC place, which is Wearable Sensors, Activity Detection, Sleep Monitoring, Environment Monitoring, Home Security System, Energy Management, Home Automation, Remote Service Platform (see Figure 3). This IoT is essentially a supporting tool for monitoring patients so that they are able to work together and complement each other in order to provide real time patient condition accurately.

Figure 3. IoT Applied Products [15]

#### C. Construction of CC Platform



Being an archipelagic country, most of Indonesian territories have not been covered by a good electricity or internet network, CC platform should be able to do several important things as follows:

- Synchronizes data automatically from the head office with branches automatically when the internet - intranet connection is reconnected after being disconnected for some period of time.
- Create virtualization in a quick auto provisioning as soon as a GHHC provider registers on the system.
- Work adaptively with poor network connectivity conditions which is rely on VSAT as the main channel.

#### D. Construction of Shared Data Platform [18]

The GHHC system also provides general data for consumption by GHHC providers as information support. Generally, this data is obtained from central and local governments. However, it is possible for GHHC providers to complete or add to it. Therefore, a platform is needed to manage the credential. The platform also facilitates data exchange between GHHC providers, especially with regard to medical records so that a specific approval mechanism is required.

### 6. CHALLENGES AND FUTURE WORK

Some challenges may arise in the future, such as security, data management, scalability, user experience, reliability, flexibility, interoperability, and legal standing. Security – There are many cloud providers as well as healthcare organizations become stakeholders of the modern GHHC that manage huge of confidential data. Therefore, proper security mechanism, which is ISO 27001 as the standard internationally, becomes a great challenge to integrity, confidentiality and availability.

Data Management – Obviously, lots of structured and unstructured data will be generated continuously in Modern GHHC. Therefore, replication and backup mechanism should be seamless so that the higher reliability and better access can be achieved. In spite of any hardware or software failure that may occur persistently, the data integrity is a concern.

Scalability – In order to serve the customers in any conditions, the system should be able to scale up by itself seamlessly to meet the requirement, and system also should be able to accommodate the possibility of additional features to provide people with a better service.

User Experience – Lots of people from various cultures and educational backgrounds come from many geographical places will use under the same GHHC system. An implementation scheme such as assisting feature or proper video training will be indispensable.

Reliability – Because of this is a generic architecture that is design to be suitable for any providers that related to health industry, The CC resources and services must be reliable for any adjustment or enhancement. It must be able to perform quick maintenance instantly.

Flexibility - Because the health industry is growing rapidly in Indonesia, not only many new startup healthcare companies were born every day, but also many people become more and more aware about their health, this architecture must have fluent flexibility. Modifying existing services or adding new one should be flexible with minimum effort and cost.

Interoperability - Migrating data, having open protocol, communicating and synchronizing information are some daily activity that must be available for collaborate between modern GHHC and other applications. Health Level Seven International (HL7) is an international standard that becomes a mandatory consensus for all health application to communicate each other.

Legal Standing - There are clear laws and guidelines in Indonesia for using clinical or non-clinical data in business or another context right now. The electronic health record is very confidential which may be use by registered health provider only. All data related to cloud computing must be located in a data center that is geographically located in Indonesia.

In the future, this modern GHHC architecture can be incorporated with other industry domain such as finance, education, and government. There are many theoretical and applied research that can be performed for collaborating and enrich the capabilities of the system.

### 7. CONCLUSION

In this paper, a modern GHHC architecture is proposed that allows many stakeholders to collaborate and develop a healthcare ecosystem. The effective and efficient performance can also be achieved so that patients and their relatives may acquire a quick response and excellent health services from GHHC providers.

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