Web-Based KNHANES System in Cloud Computing

Mi-Yeon Park†, Pil-Sook Park**, Guk-Boh Kim***, Jin-Yong Park****, Gu-Beom Jeong*****

ABSTRACT

Cloud computing is an internet-based technology, providing services to the virtualized IT environment, and allowing users to add or remove resources of hardware or software at their discretion. Since Cloud computing can construct virtually integrated environments out of multiple local computing environments, various information services can be provided by it. In addition, state organizations also strive to build the cloud computing environments due to the benefits of reduced costs to introduce the system and of reduced time to build and provide the IT services. This study suggests a web-based cloud computing system for the computing environments, to be applied for the Korean National Health and Nutrition Examination Survey (KNHANES) by the Ministry of Health and Welfare, Republic of Korea.

Key words: cloud computing, virtualization, information service, KNHANES, web-based system

1. INTRODUCTION

Cloud computing is a computing service that provides the IT resources of virtualized hardware, software, and networks, utilizing the internet technology. It is defined as "a model for enabling convenient, on-demand network access to a shared pool of computing resources like networks, servers,

storage, applications, and services" [1]. It supports scalability in real-time according to the amount of service load, and users only need to pay per use [2]. The application necessary for the Cloud computing environment can be developed by the users themselves for operation, but they can also get services from the infrastructures of Cloud computing. Cloud computing, virtualized by the IT technology, has similar characteristics as a large scale web site with various hardware, software, and networking technologies. It can provide various services according to the users' needs, regardless of their geographical locations.

A web-based system model of Cloud computing environment is suggested by this study, which may support economically and effectively the Korean National Health and Nutrition Examination Survey (KNHANES) that the Korean government is promoting as a national project. KNHANES is to measure Korean national health and nutrition levels supervised by the Korea Centers for Disease Control and Prevention, an affiliated organization of the Ministry of Health & Welfare, of the Republic of Korea. It consists of a Physical Examination Survey, a Health Survey, and a Nutrition Survey, as shown in Table 1 [3].

The Physical Examination Survey and the
Table 1. Contents of KNHANES

<table>
<thead>
<tr>
<th>Classification</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Examination</td>
<td>obesity, hypertension, hyperlipidemia, diabetes, anemia, liver function,</td>
</tr>
<tr>
<td>Survey</td>
<td>pulmonary function &amp; pulmonary disease, kidney function, stomatopathy,</td>
</tr>
<tr>
<td></td>
<td>eye disease, osteoporosis, ENT disease, heavy metal poisoning</td>
</tr>
<tr>
<td>Health Survey</td>
<td>contraction of a disease, damage(accident &amp; poisoning), activity restriction &amp;</td>
</tr>
<tr>
<td></td>
<td>quality of life, medical utilize, smoking, drinking, obesity, physical activity,</td>
</tr>
<tr>
<td></td>
<td>emotional health, oral health, physical examination, safety consciousness,</td>
</tr>
<tr>
<td></td>
<td>household Survey, education &amp; economic activity</td>
</tr>
<tr>
<td>Nutrition Survey</td>
<td>intake situation of food &amp; nutrient, dietary life behavior, dietary supplements, nutrition knowledge, food stability, nursing situation, ablation supplements, intake frequency</td>
</tr>
</tbody>
</table>

Health Survey are done by the mobile physical examination centers in the areas. The Nutrition Survey is done by the surveyors visiting the local families directly. Questionnaires on educational and economic status, contraction of diseases, and medical utilization in the Health Survey are done by interviewing, as well as those in the Nutrition Survey. Items in the lifestyle area, such as smoking and drinking, are examined by self-filling out of the questionnaires. The methods of direct measurement, observance, and sample analysis are utilized for the Physical Examination Survey. The examination and survey data are recorded by using the check list, and later it is put into the computer for statistics.

2. RELATED STUDY

2.1 Cloud Computing

The concept of cloud computing is depicted as a cloud. By that we mean the cloud as a hidden, complex infrastructure. Although users may not know the complexity of the cloud computing infrastructure, they can use various computing services provided by the cloud network [4].

In a cloud computing system, computer hardware and software are controlled by a large scale web data center. In operating a local system, the cloud computing provides various computing services, using virtualization and software technologies. Storage virtualization is a technology that uses software with a virtualization function and specific devices. It integrates physically heterogeneous storage devices into one logical virtualization storage pool. Depending on users’ needs, any of these virtualized storages may be allocated or released [5].

Since the storage virtualization technology enhances efficiency, scalability and usability of the storage resources, the overall cost for using it may be reduced. Fig. 1 shows storage virtualization technology in the Storage Networking Industry Association(SNIA), where ‘What is created’ shows the virtualization object, ‘Where it is done,’ the virtualization location, and ‘How it is implemented’ shows the virtualization technique [5].

Cloud computing provides various software services online. With the same function as the software installed in the local computers, it provides the infrastructure and application for CPU and storage, the platform for various utilities and

![Fig. 1. SNIA Storage Virtualization Taxonomy](image-url)
middleware, as well as software for the user-supportive services. In addition, cloud computing platforms provide easy access to a company's high-performance computing and storage infrastructure through web services. It also reduces the costs of purchasing, operating, and managing the hardware and software [6-9]. Due to these advantages, the governments of countries such as the USA, UK, Japan, and also Korea, give efforts to build the e-Government Service Platform utilizing the cloud computing environment [10-12].

The architecture of cloud computing for these services consists mainly of three different levels: IaaS (Infrastructure as a Service) for the hardware as well as the servers, PaaS (Platform as a Service) for the software development environment, and SaaS (Software as a Service) for the applications:

- SaaS: This layer refers to API or application services provided for the users, which are through public network connections such as internet. Users can order and receive their peculiar types of software application services online from the SaaS providers to meet their actual needs. Ideally, this layer provides services that are the same as local services such as E-mail, CRM, Word Processor, etc. The services run on the providers' infrastructures and are accessed through the internet [13-16].

- PaaS: This layer provides web application frameworks, web hosting services, various software development environment, and supports for the operating systems. Some commercially available services are Google App Engine, Microsoft Azure, and Force.com. PaaS providers try to produce a platform similar to software developers by utilizing common languages like C, Java, and PHP [17-18].

- IaaS: This layer refers to the provision of infrastructural resources on demand. It serves as servers, storage, and connectivity. When users need the services, they can use them as if it is their own infrastructure. It does not manage or control the underlying cloud infrastructure, but has control over operating systems, storage, and deployed applications [19-20].

2.2 Korean National Health and Nutrition Examination Survey

The KNHANES is a consolidation of the National Nutrition Examination Survey since 1969 and the National Health and Sense of Health Survey since 1962. The current survey was first conducted in 1998, based on the Law of National Health Development article 16 [21]. It is launched every 3 years in order to obtain statistics regarding Koreans' health and nutritional status. The results of the survey are used as the basic data necessary for evaluating and setting the standard for Korea's health development, and creating efficient health-promoting programs. The results also provide statistics that can be used to compare Korea with other OECD-member countries.

This survey is the biggest among health-related surveys in Korea, and its purposes are as shown below [21-22]:

- The interim evaluation of the General Plan for Korean Health Promotion and modification of the standards.

- Analyzing the interrelationship between the causes of health hazards such as smoking, drinking, nutrition, and major diseases.

- Grasping the prevalence rate of major chronic diseases and management indicators (recognition rate, treatment rate, control rate, etc.).

- Establishing a situation of using Health Care services according to the kinds and status of disease and disability.

- Producing comparable health indicators between nations.

This Korean health and nutrition survey is performed following the procedure in Fig. 2 [21].

Surveyors visit the local families and check their diseases, health, and nutritional condition. The re-
results are documented in paper and later-on, filed into the computer system. The data on diseases are examined and confirmed by the doctors in their specialties. The data on nutritional status are analyzed by using a nutrition analysis program. The KNHANES statistics, analyzed by SAS (Statistical Analysis System) or SPSS (Statistical Package for Social Science), are being utilized by many research papers, and applied as the nutrition and health indicators of the Korean people [23-28].

3. WEB-BASED KNHANES SYSTEM ON CLOUD COMPUTING

The KNHANES is now being conducted nationwide. It is an important tool for gaining statistical data about the causes of health risks and the prevalence of major chronic diseases. This data is used for setting the national health policy and developing health-promoting programs. This national enterprise began its first stage in 1998 and went through its fourth stage in 2007-2009. The fifth stage started in 2010. During its fourth stage, the survey expanded greatly in scope and breadth. Although the quality and depth of the survey has increased, it is still lacking much in its IT aspect, as explicated below.

- The cost of inputting data into the computer has increased under the present system: the paperwork is done first and manually entered into the database.
- The nutrition analysis program now being used for the KNHANES is not web-based, so it doesn’t show the analyzed result immediately and therefore it is difficult to check the survey and health questionnaire with the database immediately.
- As this enterprise expands, so is the cost of maintaining a growing number of computer systems.

In order to solve these problems, we propose web-based KNHANES System using Cloud Computing as below.

3.1 Constructing Cloud Computing for Web-Based KNHANES System

Since cloud computing infrastructure provides excellent scalability, it can provide expanded services to the users as much as they need. Such scalability can be applicable to both cloud developers and users. Cloud application developers can expand their service capability as much as they want. Fig. 3 shows an example of cloud Computing infrastructure that operates the web-based KNHANES system.

The KNHANES center in the public cloud has the computing domain that processes the data surveyed in different areas. The center uses a web-based KNHANES storage connected with VPN in the Cloud Computing Service Center. The storage can be expanded or released depending on users’ demands. This Infrastructure is the IaaS layer as shown in Fig. 4.

The web-based KNHANES System users consist of employees of Korea Centers for Disease Control and Prevention in the Korea Ministry of

![Fig. 2. The Diagram of KNHANES Data Processing Flow.](image)

![Fig. 3. Example of Cloud Computing Infrastructure for Web-based KNHANES System.](image)
KNHANES is done in papers. The data are entered into the computer later on. In this manner, it takes as much time as the survey itself. There is also the high risk of making mistakes when surveyors and data entry clerks are not the same. Hence, it is more efficient to have internet connection at the spot of checking and surveying, and the input of data right after the survey is conducted using web-based KNHANES.

3.3 Application Structure for Web-Based KNHANES System

In the PaaS layer, programmers develop web-based applications to manage KNHANES data. Once the data is collected, a statistic report on the concerned parts can be generated, using a statistic package in the SaaS layer. Applications are mainly composed of a health questionnaire and nutrition survey components. The Data flow management of each component is shown in Fig. 5. Users can be served with Statistic data and can also check a Health questionnaire, raw data of the Nutrition survey, and all kinds of result data, using web-based KNHANES application.

4. IMPLEMENTATION

As seen in Fig. 5, the Web-based KNHANES system consists of a Health Interview Component,
a Health Behavior & Examination Survey Component, and a Nutrition Survey Component.

- **Survey procedure**

The Health Interview Survey has three different types of health questionnaires for different age groups, one for adults over 19, another for adolescents between the ages of 12 and 19, and the last for infants and young children under 12. The trained interviewers check the subjects of the survey: whether they currently suffer a disease; their health behaviors: whether they have had an obesity; their history of medical check-up previously: the level of physical activities: quality of life; history of using clinics and pharmacies: their educational and economic level: mental health condition: their drinking and smoking habits, and more.

The Health Behavior & Examination Survey has two parts: the Health Behavior Survey and the Health Examination Survey. The former measures subjects physically and their arterial blood pressure, and collects their blood. The latter includes an oral cavity test, an eye test, an ENT test, a chest X-Ray, a bone density test and an osteoarthritis test. Based on the results of the two surveys, doctors diagnose the subjects' health condition.

The Nutrition Survey consists of four sub-surveys: Dietary Survey, Infant Dietary Survey, Food Intake Survey, and Food Intake Frequency Survey. The Dietary Survey examines eating habits of subjects concerned, their use of dietary supplements (vitamins etc.), nutrition knowledge, and others. The Infant Dietary Survey of babies aged between 12 and 48 months, asks their height and weight at birth, and questions about breast feeding practices and period, and baby food. The Food Intake Survey, using the 24 hour recall method, examines subjects' daily food intake and makes an analysis of it by nutrients. The Food Intake Frequency Survey examines how frequently respondents aged over 12 eat grain, meat, fish, and other foods in a year.

- **IaaS layer**

The result data of the three major surveys are all stored in a database for each component through the input programs of the Web-based KNHANES System. The database of the Web-based KNHANES System is made using MS-SQL. This database is managed in the storages of the IaaS.

The Health Interview Component consists of a health interview survey database including a database for the history of using pharmacies and clinics. The Health Behavior and Examination Component consists of an oral cavity test database, an eye test database, an ENT test database, a chest x-ray database, a bone density test database, and an osteoarthritis test database, as well as the health behaviour survey database.

In order to analyze the food consumed by subjects, by each nutrient, the database for the Nutrition Survey consists of two databases, a stuff code and a food code. In addition, there are the food intake survey database and the food intake frequency database. The sample of Database of Web-based KNHANES System is shown in Fig. 6.

- **PaaS layer**

The application program for the Web-based

![Fig. 6. Database of Web-based KNHANES System.](image-url)
KNHANES system is developed using HTML and ASP and written in Korean. Fig. 7 shows the sequence diagram of the web-based KNHANES system. The application program for the Health Interview Component first enters the result data of the health questionnaires into the Health Interview Database and checks whether they are coincident with disease data stored in the database for the Health Behavior & Examination Survey. When the application program for the Health Behavior & Examination Component records survey data in its database, it orders a relevant doctor to make an assessment of the health conditions of each subject. The dietary life survey application program for the Nutrition Survey Component stores each subject’s daily food intake data, obtained through the 24 hour recall method, in a database by each ingredient. The diet & nutrition analysis application program looks up food and its code using the stuff code database and food code database and analyzes its energy and nutrients such as carbohydrate, protein and fat. The analyzed data are stored in the food intake database.

The Application program for the Infant Dietary Survey and Food Intake Frequency Survey, processes data in a similar way as the application program for the Dietary life survey does. The sample source of the Web-based KNHANES System is shown in Fig. 8.

- SaaS layer

The Web-based KNHANES System users have access to the application of each component through Windows Internet Explorer. Each application program in the system has a function to look up all databases created for each survey component. The Nutrition Survey application program searches its nutrition database to provide information such as nutritional analysis of subjects’ food intake and nutrition assessment. It is shown in Fig. 9.

Statistics applications such as SAS or SPSS perform statistical processing on data in the database and deliver the results to users, as shown in Fig. 10.

5. CONCLUSIONS

In this paper, the model of the web-based KNHANES System is proposed, which uses an efficiently virtualized storage of cloud computing.
Cloud computing is a profitable technology in economic respect, in which users can allocate and release computing environment on their demand.

Because of virtualization and supporting software technology, users will be served with various computing services from an internet-based cloud computing through user interface, and they can raise the operational rate of the computers. Users can also use many kinds of IT devices, such as personal computers or smartphones as their terminal units of cloud computing, which establishes flexible user environment. Moreover, users can be served by cloud computing even though they do not have any professional knowledge about infrastructure of cloud computing. Hence, virtualized, integrated environment is established through the network of cloud computing with many local computers, and it is considered profitable to establish the web-based KNHANES System to support the nation-wide health and nutrition survey performed all over Korea.

The characteristics of the web-based KNHANES System based on Cloud Computing are as follows:

- Since the cloud computing environment is established as a model project promoted by the Korean government, users can easily estimate the economic efficiency and the easiness to build and extend the system.

- Users can use the resource of the system as much as they need according to the increasing survey data in the IaaS layer of the cloud computing, and easily return the system at the completion of the project. This will enable the operational bureau to optimize the cost to purchase and expand hardware.

- Since applications of KNHANES through PaaS and SaaS layers are developed and maintained by the Cloud Computing service company, users can enhance the usage and maintenance of the system, and easily meet their needs to change the specifications.

- By establishing a web-based integrated database for data of the Physical Examination Survey, the Health Survey, and the Nutrition Survey, users can easily do real-time data inputting and effective analysis in the SaaS layer, and easily interlock between databases.

The model of the web-based KNHANES System, proposed in this paper, is constructed to provide efficient and economic server and storage
service of Cloud Computing as an Infrastructure of the web-based KNHANES System. The model is structured for users to be served with a web-based KNHANES application in the SaaS layer, which is developed in the PaaS layer.

REFERENCES


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