Research Article – Vol. 01, Issue 02, No. 03

Advanced in Engineering and Intelligence Systems

Journal Web Page: https://aeis.bilijipub.com

HSSCIoT: An Optimal Framework based on Internet of Things-Cloud Computing for Healthcare Services Selection in Smart Hospitals

Oanh Nguyen[1,*]

[1] *Department of Computer Science, Saigon University, Ho Chi Minh City 700000, Vietnam*

Highlights

- Proposing a new Healthcare Services Selection based Internet of Things-Cloud
- using LSTM-ASPP deep learning technique for data processing
- Synchronous of proposed method with high performance in terms of low false alarm with good treatment
- Application of HSSCIoT for HIS in smart hospital

Article Info

Received:24 May 2022
Received in revised:26 June 2022
Accepted:26 June 2022
Available online:03 July 2022

Keywords

Internet of Things (IoT),
Cloud Computing,
Hospital Information System (HIS),
DEMATEL,
Healthcare Services Selection,
Deep Learning

Abstract

The combination of Internet of Things (IoT) and cloud computing has been used in many fields which make global customized interest. Recently, this technology has been considered in medical and healthcare industry. Understanding the challenges and opportunities of using IoT-cloud in modern healthcare system needs more knowledge and strategies. This trend can implement in smart hospitals with Hospital Information System (HIS) to provide a success structure for better management in new era (especially in coronavirus pandemic). Proposing a new schema for HIS based on IoT-cloud as an assumption with formulating some advanced models for three components notification, database and data processing provided in DEMATEL protocol. In general, this article proposes a new framework of Healthcare Services Selection based Internet of Things-Cloud (HSSCIoT) in HIS for smart hospitals which use deep learning technique to process any data. The combination of Recurrent Neural Network (RNN) means Long Term Short Memory (LSTM) and new kinds of Convolutional Neural Network (CNN) means Atrous Spatial Pyramid Pooling (ASPP) deep learning methods consider for HSSCIoT.

1. Introduction

In recent years, companies and organizations have been strongly focused on developing the quality of products and services which is justified by the increasing consumer demand and fierce competition between companies. Competition is very prominent in this field that can be considered between companies and organizations in relation to product introduction. It is often observed that a large number of companies are reluctant to take innovative risks or adopt cutting-edge technologies which are generally called strategies. Strategic innovations are more costly than other innovations which leads to related research that may even take a long time. Risks can be facilitated by using collaboration strategies. However, Collaboration can also be an obstacle, especially when companies and organizations are looking to work with technology partners who want to communicate seriously. Technology innovations may face another shortcoming which is the inherent risk with science-based innovations and often difficult to define and measure.

Organizations may face significant financial losses and opportunities ahead if the development or implementation of new products and their supply in an organization is shut down. Research in the field of knowledge-based networks focuses mainly on concepts, mechanisms and components. Knowledge-based networks are grouped as follows:

- ✓ Macro levels which refer to the increase activities at the national level.

* Corresponding Author: Oanh Nguyen
Email: nguyenoanh@sg.edu.vn

- ✓ Typical level that works with companies' business activities based on knowledge flow.
- ✓ Low level that includes activities between application fields.

The idea behind knowledge-based networks can be similarly tracked by normal supply chain management. In other words, the usual knowledge chain with the aim of adapting resources to customer demand, such as product supply chains. As a general rule, knowledge-based networks can be used in a variety of sectors, including universities, institutes, hospitals, manufacturers, retailers, customers, and more. The knowledge-based network includes all the processes of acquiring, creating or transforming knowledge. Although knowledge is considered in the form of data or information, the flow unit can be considered as potential value that is added to companies which in turn creates or concentrates activity. In general, knowledge is intended to improve overall performance by turning knowledge into available products by expanding the shared vision of companies that focus on physical, information or financial chains. Knowledge refers to specific information in universities, companies, organizations, hospitals and other departments to create a product or process innovation [1]

We first refer to the dynamic criteria that lead to the innovation process to explain how the innovation process leads to impact by several criteria. This compulsion can be from existing demand, technological advances, government initiatives, and so on. In addition, the success of the innovation process depends on the range of support functions such as the environmental system, the market system and the presence of technology in the field. The present study examines the challenges and barriers of hospital information systems management to select health services [2], so knowledge-based networks can be implemented in this field. Therefore, the present study presents a new solution based on knowledge-based networks to solve the choice of health services. On the other hand, knowledge-based networks need intelligent systems to solve the problem of e-health selection services based on the Internet of Things in cloud computing environment. Considering some IoT challenges is an issue which studied in [3]

Cloud computing is a new delivery model for IT services and typically involves the provision of dynamic scalable and often virtual resources over the Internet [4]. However, cloud computing has concerns about how cloud service providers, user organizations, and governments should deal with such information and interactions. Personal health records show a patient-centered pattern for the exchange of health information, which they undertake to store by third parties, such as cloud providers. Using these records, each patient needs to encrypt their personal health information before uploading it to the cloud servers. Current encryption techniques rely primarily on conventional cryptographic approaches. However, key management issues have not been largely resolved with these encryption techniques. Of course, the purposes of this research are not focus on security and cryptography and refers to the health services selection in the cloud and Internet of Things. The advent of cloud computing has led to new developments for a wide range of applications. This is especially true of the extremely important health care that exists in today's society, so it is worthwhile to examine the value from relevant perspectives and insights. Cloud computing is gaining more attention and today represents one of the most important research topics in science computing and information systems. Cloud computing refers to both applications provided as services through the Internet and the hardware and software systems in the data centers that provide these services. The cloud is now seen as a viable strategy, and specific applications based on these technologies have been developed. Healthcare, like any other service operation, has been influenced by the cloud computing phenomenon with the reported literature on the benefits and challenges of cloud computing in this area. However, the evolving nature of science and technology creates new scenarios that must be explored using interdisciplinary and holistic issues [5].

With the expansion and development of infrastructure and important centers, attracting manpower to provide better services is undeniable. Human resources in each rank and position have responsibilities that are controlled and evaluated by their managers. Many service and research centers that require experienced and specialized personnel have a lower risk of human error. These centers include hospitals, pharmacy, nuclei, document registration, etc. The Internet of Things as a technology capable of providing human services can significantly reduce human error in these centers and maintain and improve the quality of services and satisfaction of evaluation managers results [6].

In each hospital, patients are transferred to the care units after the admission process and the necessary instructions by the nurses and will be under the supervision and control of the doctor and the nurses of the nursing station [7]. It is the duty of nurses to take care of the condition of patients, including examining their health conditions and symptoms or the physical condition of patients, coordination of how to visit patients and environmental health control and their pharmaceutical services. In normal and non-emergency cases, these services are performed completely and with quality and will not cause any problems for patients and their families, except for the difficulty of the treatment period. Increasing demand for health care in the event of unforeseen events such as wars or natural disasters or dangerous contagious diseases or road chain accidents that can affect the usual conditions of admission, care and patient care. However, new methods and up-to-date technologies and smart hospitals can provide suitable solutions in the field of healthcare.

The main contributions of this paper are proposing a new Healthcare Services Selection based Internet of Things-Cloud (HSSCIoT) for HIS in smart hospital and also using LSTM-ASPP deep learning technique for data processing in application layer for better performance in real-time and synchronous mode. The rest of this paper is organized as in part two, some recent models and algorithms disused and reviewed as literature review. Then a new model and schema proposed for HSSCIoT in IoT-cloud environment and also modeling LSTM-ASPP. At the end, a conclusion represents the main key parts of this paper and some observation and perspective provide for next researches following this article to create a new application. Also, the main advantages of HSSCIoT in comparison to recent methods and algorithms with will be describe in literature review section from references [8–10] is that our model is real-time and synchronous with high performance in terms of low false alarm with good treatment and advice which services selection is aware of nurses as main operator.

2. Literature Review

Many researchers studied about e-health services via cloud and IoT. As one of the main studies, industry 4.0 uses big data in cloud-IoT environment to provide new kinds of services in hospitals [10]. Big data processing in IoT for e-health services need more settings which in [11], 5G technology used. Using IoT or cloud in some other layers such as fog computing can propose new kinds of e-health systems to optimizing quality of services such as throughput and latency which discussed in [12]. Remote systems as home e-health system via IoT in fog level-based cloud proposed in [13] where doctors and nurses can monitor patients to recover and also send some treatment and advice. IoT Wideband and narrowband can use in smart hospitals for providing e-health services and selection that can connect everything to internet as mentioned in [14] as NB-IoT.

Another smart e-health system proposed in [15] to monitoring soldiers health in distributed IoT platform based on fuzzy classification. A new marketing e-health model via IoT proposed in [16] in Vietnam as reliable system. This article introduces some process for e-health start up and some processing challenges especially big data in IoT for e-health systems.

Data privacy for patients in e-health services based on IoT is another issue that in [17] a new model of user's data privacy-aware of energy proposed. securing e-health services is an issue in smart hospitals which in [18], a new model based on lightweight protocol proposed for patients by using sensors in body area based IoT to provide more security level and also checking quality of services. A new scheme of e-health services based on motion-based hospital and emergencies via IoT with Unmanned Aerial Vehicle (UAV) in Block Chain platform proposed in [19]. Defining security level and performance measured in this article. Privacy-policy controlling in e-health surveyed in [20] with some constrained resources via IoT for better services. Using fog computing in IoT-based healthcare system proposed in [21] by considering privacy policy with Organization for Economic Cooperation and Development (OECD). Public Verifiability is another issue in e-health services for smart hospitals via IoT which in [22] proposed a method for solving this issue entitle Escrow-Free Identity-based Aggregate Sign-Cryption (EF-IDASC).

Some other researchers proposed IoT-based e-health for predicting diseases as main services. For example, in [23], a new smart diabetes prediction for urine provided. This approach uses combination of Recurrent Neural Network (RNN) and Self-Organized Map (SOM) neural network for prediction. Another article [24] proposed a deep learning model in IoT-based e-health for predicting gallstones. This method provided a new and effective model of big data processing. In [25], proposed a prediction model based on Back-Propagation (BP) neural network for outpatients in clinic via IoT to provide fast services. Also, in [26], a new feature extraction and classification model based on Recurrent Neural Network (RNN) and Harmony Search Algorithm (HSA) proposed for ovarian cancer detection in IoT e-health system.

Some review provided in terms of e-health for hospital services selections in IoT and cloud environment. For example, [27] provided a deep survey about enabling some technologies in e-health. In [28], end-user opinions and perspectives surveyed for using IoT in e-health services by considering high performance. Personalizing e-health services with IoT surveyed in [29]. A survey of using edge and fog computing in IoT in e-health case study provided in [30] which considering an industrial protocol. In [31], investigated IoT in hospital for services selection to aware nurses as main operator. In [32] surveyed about patient's condition monitoring via IoT with some challenges ahead.

Also, a clinical perspective performed in [33] for surveying challenges of IoT healthcare which noted to challenges, impacts and some open issues in this area. In [34], surveyed about big data processing technology in IoT e-health systems to develop the detection and prediction rate for better life. Also, in [35], a comprehensive survey of IoT e-health in smart hospitals by considering some open issue and challenges provided. Review a series of uncertainty when using IoT in e-health systems provided in [36]. Some uncertainty considered in this article are big data, complex condition to put up IoT deployment, dynamic systems communications with specific features and dimensions in different structures and behaviors. IoT layers and its deployment for e-health systems discussed in [37] with many challenges in short survey such as barriers, privacy and security, control, big data and processing, data storage and remuneration. Some IoT trends for solving e-health problem in smart hospitals for providing fast and efficient services surveyed in [38]. This article focused on artificial intelligence algorithm migration to edge computing in IoT.

Also, we use deep learning which is based on [39] and also [40]. But there are many others article which proposed some healthcare systems and frameworks connected to Internet. For example, in [41] proposed a tele-health frame works and accomplished in Netherlands hospitals as well. This program represented successful progress in healthcare systems project which can extend the quality of healthcare. Also, in [42]spoke about how government can improve e-health system in terms of using in hospital and its performance. In [43] proposed a model for drug reactions detection with an application of healthcare system. This program worked based on data collection processing. As one of the best review articles in healthcare system based on Internet, reference [44] described a full topic with details for using some intelligence technology such as 5G communication with IoT in smart hospitals.

The main challenging part is DEMATEL (Decision Making Trial and Evaluation Laboratory) which described in [45] as systematic review. It described the models and mathematic formulation, some application and findings and any combination with other methods. Also, Fuzzy and Grey DEMATEL described and ten bibliometric analyses explained.

3. Proposed Model

It should be noted that this model is formulated as a hypothesis for proposing healthcare system in smart hospital which used in HIS based on IoT-cloud. Here it is assumed that a series of main parameters are as follows:

- ✓ C_j is implementation cost which consider two main parts and some subsets:
  - o Cost of access to resources C_s such as:
    - ▪ Cost of acquiring data sources (C_{sd} in second)
    - ▪ Cost of access to processing resources (C_{sp} in second)
  - o C_r is Cost of running such as:
    - ▪ Time costs (C_{rt} in seconde)
    - ▪ Processing costs (C_{rp} in second/Watt)
    - ▪ Memory cost (C_{rm} in second/byte)
    - ▪ Cost of energy consumption (C_{rc} in second/Watt)
- ✓ Accuracy (A_c) ccontain two sets $F_i = \{x_1, x_2, \dots, x_n\}$ and $D_i = \{o_1, o_2, \dots, o_m\}$ and also o_i^k, $T_{m,p}$, t_i

All of these sets are as $\widetilde{N}$ and define (l, m, u) in the form of a triple state as Fig. 1.

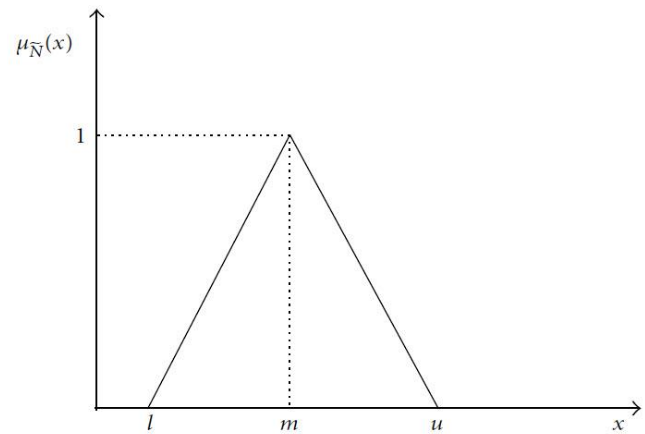

Fig. 1. Cost and accuracy sets

Cost and accuracy set as $\mu_{\widetilde{N}}(x)$ calculated as Eq (1) that$l$, m and u are real numbers and$l \le m \le u$.

$$\mu_{\widetilde{N}}(x) = \begin{cases} 0, & x < l \\ \dfrac{(x-l)}{(m-l)}, & l \le x \le m \\ \dfrac{(u-x)}{(u-m)}, & m \le x \le u \\ 0, & x > u \end{cases} \tag{1}$$

The approach that is initially considered to solve the problem of choosing health services called DEMATEL, which is a laboratory for evaluation and decision making. The DEMATEL method is based on differential and can separate promising criteria for both cause and effect groups. Differentials can be assembled from DEMATEL which is interpreted as graphs that allows users to know about the connections between subsystems. Here we can point out that identifying the connections between infrastructure and subsystems in the HIS can be interesting using DEMATEL. In other words, a differential can be thought of as a communication network or a conversion relationship between criteria. In addition, DEMATEL is used to reveal the importance of given criteria and to determine how specific criteria affect another. A significant advantage of the DEMATEL method is the modification of the studied criteria. The end product of this method is a visual design that makes the overall decision and method. The DEMATEL implementation steps are generally described below:

1- Finding a pair of comparison matrix: In the first step, the decision-making system determines the range for a particular criterion that affects another. In other words, the pair of comparison matrix by the decision-making system with the array a_{ij} shows how the criterion i affects the criterion j. All comparisons are based on a score in the range of 0 to 4. Scores include "no impact" for zero, "very low impact" for one, "low impact" for two, "high impact" for three, and "very high impact" for four. A $n \times n$ matrix is created and developed as $A = [a_{ij}]_{n\times n}$ which is created at the time of comparison. However, the given matrix should be developed to an average value in the presence of a group of specialists. Eq (2) represents an average matrix in which H refers to the number of specialists.

$$[a_{ij}]_{n\times n} = \frac{1}{H}\sum_{k=1}^{H}[X_{ij}^{K}]_{n\times n} \tag{2}$$

Without losing generality, the HIS is chosen as the initial direct relationship matrix. This represents the initial direct effect that an element is sent to the last recipient user in the HIS by another element. In addition, the cause of the effect between the pairs of standard pairs as a mapping is enumerated by the development of the effect mapping. The effective mapping grid is shown in Fig. 2. The letters of the alphabet in the circles and the lines of communication between them indicate the criteria included in the HIS between users in a hospital and their effects on each other. For example, the line from b to c shows the effect of b on c and the number 3 shows the power mode which has a "high" effect.

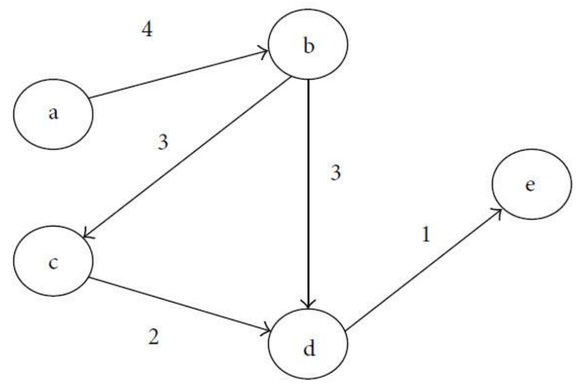

Fig. 2. An impact mapping in HIS healthcare services selection

2. Calculation of the normalized primary dependent direct matrix: The normalized primary dependent direct matrix or M is added by Eq (3) which is directly related to the A matrix. It should be noted that all diagonal elements are equal to zero.

$$M = k.A$$
$$k = \frac{1}{max\sum_{j=1}^{n}|a_{ij}|};\ \forall i = 1,2,\dots,n \tag{3}$$

2- Calculation of all dependent matrices: Total dependent matrices S will be able to be calculated when all normalized dependent matrices are collected. S Is derived through Eq (4) where I is matrix identifier.

$$S = M + M^2 + M^3 + \cdots + M^{\infty}$$
$$= \sum_{i=1}^{\infty} M^i = M(1-M)^{-1} \tag{4}$$

3- Calculating the values of the transmitted and received groups information for selecting health services: The groups transmitted and received selecting the health services can be done by identifying the values of $D - R$ and $D + R$ which R is the sum of the columns and D is the sum of the matrix rows matrix S. Eq (5) defines an influential level to other levels of health service selection and a level related to others. $D - R$ Shows how one metric affects others. The criterion with a positive value is called the transmitted data. On the other hand, the criterion with a negative value is called the received data. The degree of correlation between one data criterion and others is identified as D + R. The criterion with the highest value is to show the greater volume of communication between other information departments of the hospital when there are lower values of these communication rates with other communication departments in the health service selection system.

$$S = [s_{i,j}]_{n\times n}; i,j \in \{1,2,\dots,n\},$$
$$D = \sum_{j=1}^{n} s_{i,j}\,, \quad (5)$$
$$R = \sum_{i=1}^{n} s_{i,j}$$

5- Setting a threshold value and collecting diagram impact maps: The decision-making system is required to select a threshold value for the impact level with the aim of collecting diagram impact maps. Elements that exceed the set threshold values become a mapping. Threshold values are selected in the presence of a decision-making system or expert who can provide data set mapping$(D+R, D-R)$. $D+R$ And $D-R$ are reflected by vertical or horizontal vectors and transmitted data to select health services.

This research proposes an intelligent system in order to address the current limitations of health service selection systems in HIS based on IoT-cloud. The proposed health service selection system uses the capabilities of a modern Android smartphone and thus reduces the overall cost, as no special hardware is required. All processing is done in the cloud and data collected from IoT devices. The proposed health services selection system architecture is a layered mechanism shown in Fig. 3

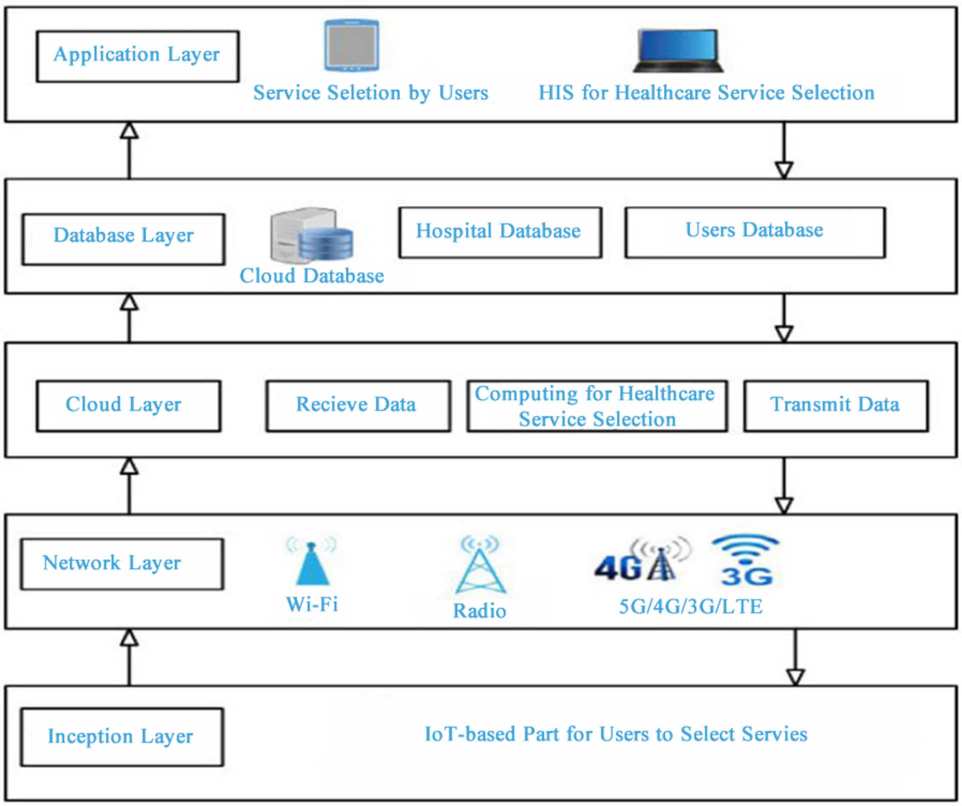

Fig. 3. Proposed health services selection system architecture

The architecture of the proposed health services selection system consists of five different layers, namely application layer, database layer, cloud layer, network layer and perception layer. In the proposed architecture, the perception layer is responsible for interacting with smartphone sensors. The main purpose of the perceptual layer in the proposed health service selection system architecture is to collect data from IoT-dependent sensors. This information is about users in the hospital and their information and the position of their data in databases. All of this is taken from the sensors on the smartphone. This data is then transferred to the network layer for further processing. The network layer is responsible for creating a connection between the perception layers and the cloud. This layer receives data from smartphone sensors, location and driver information from sensors in the perception layer. The network layer uses WiFi cellular communications or 3G/4G/5G technologies to transfer data to the cloud layer. The cloud layer holds the algorithm for detecting health service selection and specifies a health service selection based on threshold analysis. If any health service is identified, it notifies the nearest hospital about that service. The processing layer transfers data to the database layer. Finally, the database layer is responsible for storing data related to the type of health service, hospital information, user and user information. All information is transferred to the application layer which includes the smartphone application interface for the driver and the web-based system interface for the hospital.

Fig. 4 shows the proposed system for a better understanding how system works. A user downloads the application from the Google Play Store and installs it on their smartphone. After installation, the user registers the program and provides the necessary information. After registration, the user can use the program freely. Each time a user starts a health service, it activates the tracking process. The smartphone starts reading IoT-dependent sensor data and transfer it to the cloud. This information is then processed with the aim of identifying any choice of health services in the cloud. If health services are selected, a nearby hospital will be notified and provide details on how to choose health services.

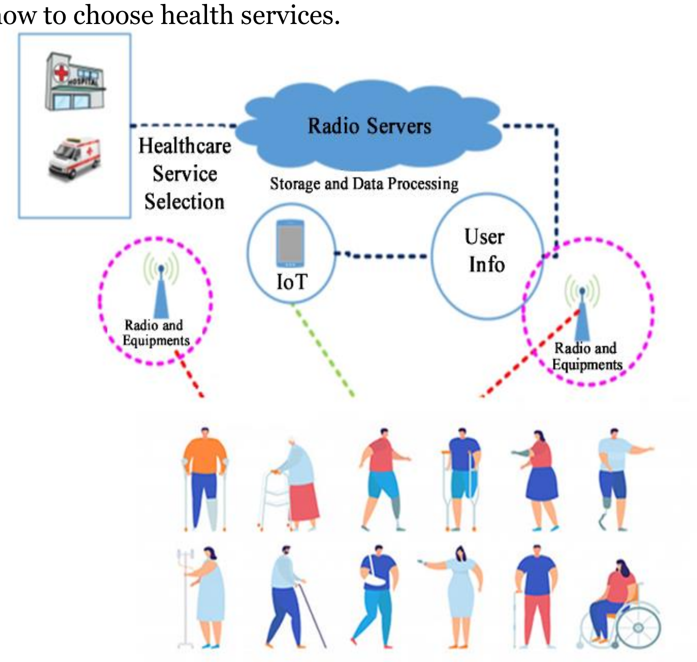

Fig. 4. Overview of proposed healthcare services selection

This system assumes that each hospital is connected to a smartphone. Each smartphone is equipped with four types of sensors: a user identification sensor, a user disease type sensor, a disease type sensor and a sensor for selecting health services. The phone constantly sends data to the cloud which processes the data and looks for a status to choose from health services. The cloud processes the data and checks to see if an accident has occurred. Threshold values are defined, and if the values collected from the sensors, it creates a value higher than the threshold value and it indicates an accident has occurred. When this condition is reached, an alarm is generated and sent to the user. If the user cancels the alarm, the hospital will not be notified to prevent incorrect reporting. If the user does not respond within 10 seconds, the IoT-cloud service will send the notification to the nearest hospital. The IoT-cloud platform contains a database consist of users and hospitals. The hospital sends a health service to users to perform the operation. Hospitals also have information about diseases. The main purpose of this architecture is to increase the accuracy in choosing health services. This system consists of two stages: the 1st stage) the stage of selecting health services, 2nd stage) information stage. These steps are further discussed in the following sections.

The main purpose of the proposed system is to provide an architecture that can do 5 things: 1) allows direct user communication to the infrastructure, 2) automatic exchange of information about the disease, 3) communication of the second case to increase accuracy in service selection 4) reduce the number of false reports and 5) create a cost-effective system. The most important variables of this research include multi-smartphone sensors for selecting health services. Also, reviewing the 5 operations of the proposed approach, including the possibility of direct user connection to the infrastructure, automatic exchange of information about the disease, increasing accuracy in choosing health services, reducing the number of false reports and creating a cost-effective system, can be considered as variables. The main research should also be enumerated. A new approach needs to be presented in several different sections. The first part deals with the components of crash detection.

3.1. *Components of healthcare services selection detection*

Identifying the healthcare services selection is used to prevent any accidents that lead to damage or injury, and thus reduces mortality from disease. Fig. 4 represent the main components used in the diagnosis phase of healthcare service selection. These components help to healthcare services selection.

3.2. *Notification Phase*

Healthcare services selection is a major issue and effective information and delivery is also important. Information about healthcare services selection should be sent immediately to the hospital nurses or doctors. The system receives the user's GPS location from the GPS of the smartphone by identifying a health service. Smartphone cellular connection such as 3G/4G/5G and also LTE data connection is used to transfer user information to the cloud. The cloud has a database of hospitals and determines the nearest hospital using the mapping service, which is the Google Maps API by default, to select health services. A location details along with owner information will be sent to the hospital. The collected data is stored in an existing database of cloud.

3.3. Database

There are two kinds of databases, user database and HIS database. Users database include total information of registered users. This information is ID, name, address, telephone number, any disease background which stored in cloud database. Also, HIS database contains any information for transmit some advice to users and communicate between users and doctors/nurses.

3.4. Data Processing

The patient is often presented in the smart healthcare services selection system as a sequence of care visits. These include first aid visits, outpatient intensive care, and emergency care and hospital admissions. Information per referral can be broadly divided into demographics (care provider) and patient's clinical condition. Demographic characteristics include the patient's age, gender, location, type of visit, and more. Clinical status in the smart healthcare services selection system is provided as a list of clinical codes and values related to diagnoses, methods, laboratory results, animals or drugs recorded in that visit. Mode can be represented numerically as a scale intensity score, or a feature vector. These features are the same smart healthcare services selection that patient users choose and are trained through the deep learning method which this approach, use LSTM-ASPP.

Deep learning is the development of artificial neural networks. Deep learning allows machines to solve complex problems even when using a very diverse, unstructured and interconnected data set. Deeper algorithm obtains the better performance. In practice, deep learning is just a subset of machine learning. In fact, deep learning is technically a machine learning which works in a similar way. However, its capabilities are different. While the basic models of machine learning are gradually getting better as they get better, they still need guidance. If an artificial intelligence algorithm returns a false prediction, then an engineer must step in and make adjustments. With the deep learning algorithm, an algorithm can alone determine whether the prediction is correct or not through its neural network [39].

A deep learning model is designed to continuously analyze data with a logical structure similar to how a human concludes. To achieve this goal, deep learning programs use a layered structure of algorithms called artificial neural networks. The design of an artificial neural network is inspired by the biological neural network of the human brain and leads to a learning process that is far more powerful than standard machine learning models. This is to ensure that a deep learning model does not yield the wrong result - like other examples of artificial intelligence, it requires a lot of training to streamline learning processes. But when it works as intended, deep functional learning is often perceived as a scientific wonder that many see as the backbone of real artificial intelligence [40].

The LSTM-ASPP architecture represent in Fig. 5. LSTM-ASPP depends on the previous stage mode and the new input visit. Remarkably, at each stage, there is a LSTM-ASPP block that transfers its state to the next dense layers. This LSTM-ASPP configuration is usually a sequence for sequence prediction. This means that at each time step, there is an input and output for the network. It should be noted that any layer has weights W and in layer2, RNN mode means LSTM works, and in unfolded RNN in another services T_p and behind the training layers, ASPP as CNN run

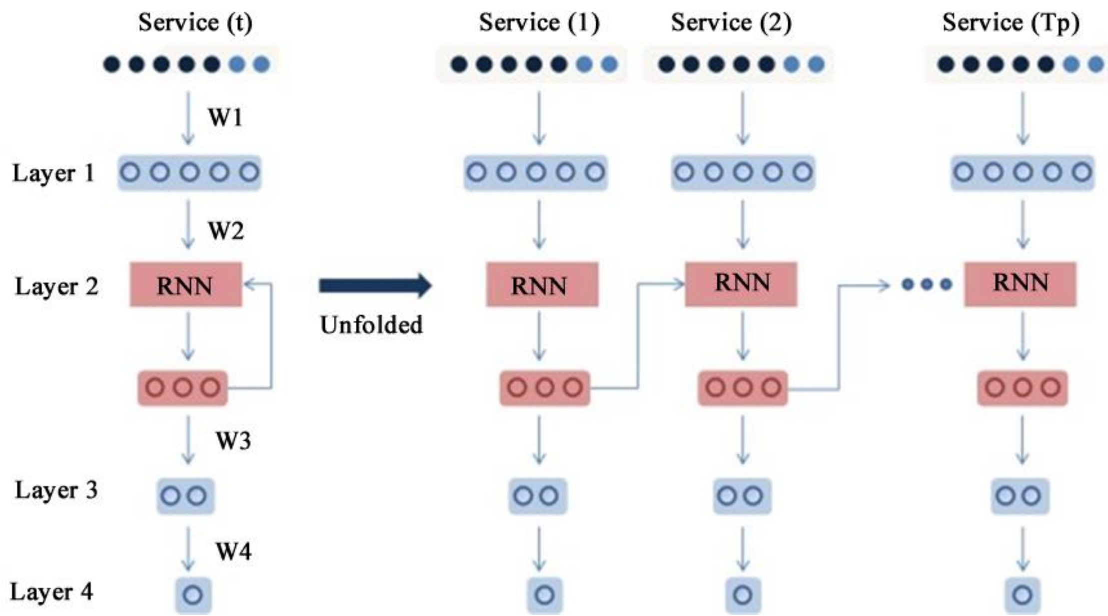

Fig. 5. Proposed LSTM-ASPP deep learning technique for HSSCIoT

A typical LSTM network is made up of different blocks of memory called cells. In fact, these blocks are the same rectangles that can be seen in the Fig. 6 as LSTM architecture. There are two modes that are transferred to the next cell. The state of the cell and the hidden state of the memory blocks are responsible for remembering things, and the manipulation of this memory is done through three main mechanisms called gates. One of these gates is the forget gate. A forget gate is responsible for removing information from the cell status. Information that is no longer needed by the LSTM is removed by multiplying a filter to understand things or information that is less important. This is required to optimize LSTM network performance. This gate has two inputs h_{t-1} and x_t that h_{t-1} is the hidden state of the previous cell or the output of the previous cell, and x_t is the input at that particular time point. The given inputs are multiplied by weight matrices and bias is added. The sigmoid function is then applied to this value as transitional function. The sigmoid function represents a vector with values from 0 to 1 corresponding to each number in the cell state. Basically, the sigmoid function is responsible for making decisions to preserve and delete values. If a value of zero is generated for a certain value in cell state, it means that the gateway forgets that cell state can completely forget that part of the information. Similarly, a "1" means that the gateway forgets to remember all the information. This vector is multiplied by the sigmoid function in the cell state.

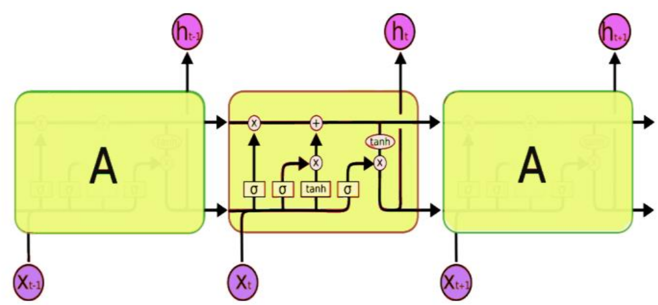

Fig. 6. LSTM architecture

The next gate is the entrance gate. The gateway is responsible for adding information to the cell state. This cell is responsible for regulating the values that must be added to the cell state using a sigmoid function with three process levels:

- ✓ It is basically very similar to the forget gate and acts as a filter for all h_{t-1} and x_t information.
- ✓ Create a vector containing all possible values that can be added. As understood from h_{t-1} andx_t. This is done using the tangent function, which converts the values from -1 to +1.
- ✓ Multiply the amount of regulator filter (sigmoid gate) created on the vector and then add this useful information to the cell state.

The next gate is the exit gate. The operation of an exit gate can again be divided into three stages:

- ✓ Creating a vector after applying the tangent function in the cellular state and thus changing the values in the range of -1 and +1.
- ✓ Build the filter using the values h_{t-1} andx_t, so that it can adjust the values required for the output from the generated vector. This filter uses the sigmoid function again.
- ✓ Multiply the value of this regulator filter by the vector created in the first step and send it as an output as well as to the hidden state of the next cell.

Overall, LSTMs are a very promising solution to sequence and time series problems. However, one of the disadvantages of LSTM is the difficulty in training them. High capacity of system time and resources are fully utilized in training parts of LSTM even in a simple training model. But this is just a hardware limitation associated with LSTM problems. But in terms of efficiency, it has a much higher application than other methods of deep learning. To overcome the training problems in LSTM, a convolution-based method called ASPP is used. ASPP improves resilience at various scales. ASPP explores the field of effective views or Effective Fields-of-Views (FOV) and the convolution feature layer with a filter at multiple sampling rates and then captures the resilience at different scales. The overall LSTM-ASPP hybrid architecture is shown in Fig. 7. It contains 5 pooling layer and then 4 convolve layers with 3x3 windowing and rate 6, 12, 18, 24, respectively in any convolve layer with Atrous (blue points). Also, combination model use 8 fully connected (FC) layer in 1x1 windowing to fit sum-fusion in data processing parts of HSSCIoT.

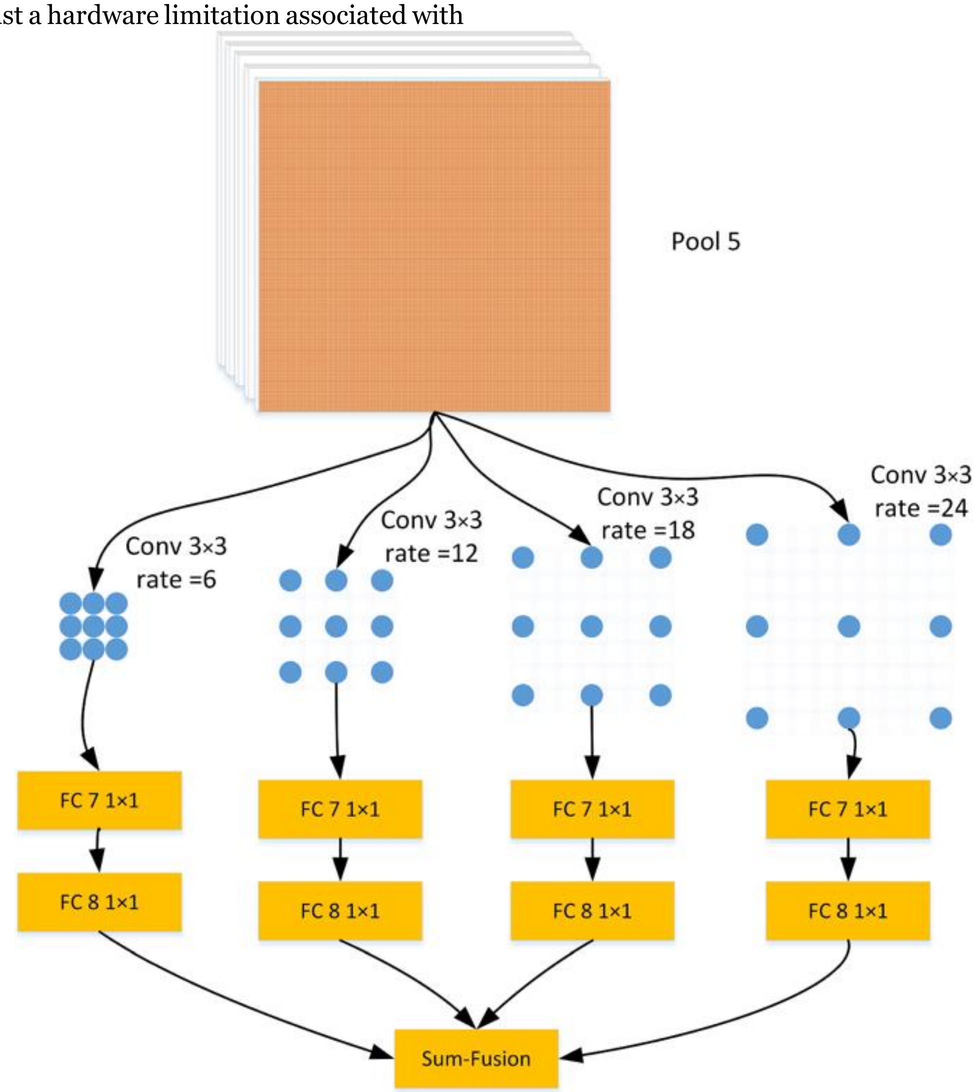

Fig. 7. LSTM-ASPP architecture

4. Conclusion

This article proposes a novel schema for healthcare or e-health service selection in HIS for smart hospital via IoT-cloud environment. This schema is an innovation model which uses facilities of DEMATEL protocol in HIS which consist of three components such as notification, database and data processing. It is a big assumption to create a novel model for smart hospitals-based HIS to provide some services for end-users which gain some advice from online doctors and nurses to prevent disease grow. This study an impalement in any smart hospital around the world which have some infrastructure for deploying IoT-cloud equipment. By considering some challenges and issues from recent literature, this article proposes a new model in five-layer, application layer, database layer, cloud layer, network layer and inception layer. IoT and services deploy in lowest layer, inception. Then network layer considers connection types by radio, Wi-Fi and cellular 3G/4G/5G/LTE. Then cloud layer with its database deploys and has direct communication with database layer. In application layer, user can sleet any services and in real-time and synchronous mode, some data transmit to database and stored in it via cloud and then transmit a new information for user. This framework can implement physically as iOS or Android or even web application. This schema is new generation of HIS in smart hospital named Healthcare Services Selection based Internet of Things-Cloud (HSSCIoT). Another contribution of this paper is using a combinational technique of deep learning from RNN means LSTM and also CNN means ASPP which used in data processing level at application layer.

REFERENCES

[1] Yu J, Liu G. RETRACTED: Knowledge-based deep belief network for machining roughness prediction and knowledge discovery 2020.

[2] Setyonugroho W, Puspitarini AD, Kirana YC, Ardiansyah M. The complexity of the hospital information system (HIS) and obstacles in implementation: A mini-review. Enfermería Clínica 2020; 30:233–5.

[3] Stoyanova M, Nikoloudakis Y, Panagiotakis S, Pallis E, Markakis EK. A survey on the internet of things (IoT) forensics: challenges, approaches, and open issues. IEEE Communications Surveys & Tutorials 2020; 22:1191–221.

[4] Casola V, Castiglione A, Choo K-KR, Esposito C. Healthcare-related data in the cloud: Challenges and opportunities. IEEE Cloud Computing 2016; 3:10–4.

[5] Din IU, Almogren A, Guizani M, Zuair M. A decade of Internet of Things: Analysis in the light of healthcare applications. Ieee Access 2019; 7:89967–79.

[6] Sunhare P, Chowdhary RR, Chattopadhyay MK. Internet of things and data mining: An application-oriented survey. Journal of King Saud University-Computer and Information Sciences 2020.

[7] Gholami M, Damanabi S, Hachesu PR, Ghyassi FS. Evaluation of Nursing Information Systems Using the HIS-Monitor Instrument: Nurses Perspectives. Frontiers in Health Informatics 2019; 8:9.

[8] TESHNIZI SH, Alipour J, Highlight MHH. Usability evaluation of hospital information system: A cross-sectional study. Applied Medical Informatics 2020; 42:118–25.

[9] Khalifa M, Alswailem O. Hospital information systems (HIS) acceptance and satisfaction: a case study of a tertiary care hospital. Procedia Computer Science 2015; 63:198–204.

[10] Aceto G, Persico V, Pescapé A. Industry 4.0 and health: Internet of things, big data, and cloud computing for healthcare 4.0. J Ind Inf Integr 2020; 18:100129.

[11] Zhan K. Sports and health big data system based on 5G network and Internet of Things system. Microprocessors and Microsystems 2021; 80:103363.

[12] Tiwari K, Kumar S, Tiwari RK. FOG assisted healthcare architecture for pre-operative support to reduce latency. Procedia Computer Science 2020; 167:1312–24.

[13] Hassen H ben, Ayari N, Hamdi B. A home hospitalization system based on the Internet of things, Fog computing and cloud computing. Informatics in Medicine Unlocked 2020; 20:100368.

[14] Zhang H, Li J, Wen B, Xun Y, Liu J. Connecting intelligent things in smart hospitals using NB-IoT. IEEE Internet of Things Journal 2018; 5:1550–60.

[15] Bandopadhaya S, Dey R, Suhag A. Integrated healthcare monitoring solutions for soldier using the internet of things with distributed computing. Sustainable Computing: Informatics and Systems 2020; 26:100378.

[16] Tuan MND, Thanh NN, le Tuan L. Applying a mindfulness-based reliability strategy to the Internet of Things in healthcare–A business model in the Vietnamese market. Technological Forecasting and Social Change 2019; 140:54–68.

[17] Saba T, Haseeb K, Ahmed I, Rehman A. Secure and energy-efficient framework using Internet of Medical Things for e-healthcare. Journal of Infection and Public Health 2020; 13:1567–75.

[18] Esmaeili S, Tabbakh SRK, Shakeri H. A priority-aware lightweight secure sensing model for body area networks with clinical healthcare applications in Internet of Things. Pervasive and Mobile Computing 2020; 69:101265.

[19] Islam A, Shin SY. A blockchain-based secure healthcare scheme with the assistance of unmanned aerial vehicle in Internet of Things. Computers &

Electrical Engineering 2020; 84:106627.
[20] Pal S, Hitchens M, Varadharajan V, Rabehaja T. Policy-based access control for constrained healthcare resources in the context of the Internet of Things. Journal of Network and Computer Applications 2019; 139:57–74.
[21] Elmisery AM, Rho S, Botvich D. A fog-based middleware for automated compliance with OECD privacy principles in internet of healthcare things. IEEE Access 2016; 4:8418–41.
[22] Kumar M, Chand S. A secure and efficient cloud-centric internet-of-medical-things-enabled smart healthcare system with public verifiability. IEEE Internet of Things Journal 2020; 7:10650–9.
[23] Bhatia M, Kaur S, Sood SK, Behal V. Internet of things-inspired healthcare system for urine-based diabetes prediction. Artificial Intelligence in Medicine 2020; 107:101913.
[24] Yao C, Wu S, Liu Z, Li P. A deep learning model for predicting chemical composition of gallstones with big data in medical Internet of Things. Future Generation Computer Systems 2019; 94:140–7.
[25] Jin Y, Yu H, Zhang Y, Pan N, Guizani M. Predictive analysis in outpatients assisted by the internet of medical things. Future Generation Computer Systems 2019; 98:219–26.
[26] Elhoseny M, Bian G-B, Lakshmanaprabu SK, Shankar K, Singh AK, Wu W. Effective features to classify ovarian cancer data in internet of medical things. Computer Networks 2019; 159:147–56.
[27] Dhanvijay MM, Patil SC. Internet of Things: A survey of enabling technologies in healthcare and its applications. Computer Networks 2019; 153:113–31.
[28] Martínez-Caro E, Cegarra-Navarro JG, García-Pérez A, Fait M. Healthcare service evolution towards the Internet of Things: An end-user perspective. Technological Forecasting and Social Change 2018; 136:268–76.
[29] Qi J, Yang P, Min G, Amft O, Dong F, Xu L. Advanced internet of things for personalised healthcare systems: A survey. Pervasive and Mobile Computing 2017; 41:132–49.
[30] Ray PP, Dash D, De D. Edge computing for Internet of Things: A survey, e-healthcare case study and future direction. Journal of Network and Computer Applications 2019; 140:1–22.
[31] Kang S, Baek H, Jung E, Hwang H, Yoo S. Survey on the demand for adoption of Internet of Things (IoT)-based services in hospitals: Investigation of nurses' perception in a tertiary university hospital. Applied Nursing Research 2019; 47:18–23.
[32] Kadhim KT, Alsahlany AM, Wadi SM, Kadhum HT. An overview of patient's health status monitoring system based on Internet of Things (IoT). Wireless Personal Communications 2020; 114:2235–62.
[33] Habibzadeh H, Dinesh K, Shishvan OR, Boggio-Dandry A, Sharma G, Soyata T. A survey of healthcare Internet of Things (HIoT): A clinical perspective. IEEE Internet of Things Journal 2019; 7:53–71.
[34] Kim M, Man KL, Helil N. Advanced internet of things and big data Technology for Smart Human-Care Services. Journal of Sensors 2019;2019.
[35] Islam SMR, Kwak D, Kabir MDH, Hossain M, Kwak K-S. The internet of things for health care: a comprehensive survey. IEEE Access 2015; 3:678–708.
[36] Tissaoui A, Saidi M. Uncertainty in IoT for smart healthcare: Challenges, and opportunities. International Conference on Smart Homes and Health Telematics, Springer; 2020, p. 232–9.
[37] Kelly JT, Campbell KL, Gong E, Scuffham P. The Internet of Things: Impact and implications for health care delivery. J Med Internet Res 2020;22: e20135.
[38] Greco L, Percannella G, Ritrovato P, Tortorella F, Vento M. Trends in IoT based solutions for health care: Moving AI to the edge. Pattern Recognit Lett 2020; 135:346–53.
[39] Alom MZ, Taha TM, Yakopcic C, Westberg S, Sidike P, Nasrin MS, et al. A state-of-the-art survey on deep learning theory and architectures. Electronics (Basel) 2019; 8:292.
[40] Yu Y, Si X, Hu C, Zhang J. A review of recurrent neural networks: LSTM cells and network architectures. Neural Comput 2019; 31:1235–70.
[41] Rauwerdink A, Kasteleyn MJ, Chavannes NH, Schijven MP. The successes and lessons of a Dutch University Hospitals' eHealth program: an evaluation study protocol. Clinical EHealth 2021; 4:30–6.
[42] Wu J-H, Lin L-M, Rai A, Chen Y-C. How health care delivery organizations can exploit eHealth innovations: An integrated absorptive capacity and IT governance explanation. International Journal of Information Management 2022; 65:102508.
[43] de Pretis F, van Gils M, Forsberg MM. A smart hospital-driven approach to precision pharmacovigilance. Trends in Pharmacological Sciences 2022.
[44] Kumar A, Dhanagopal R, Albreem MA, Le D-N. A comprehensive study on the role of advanced technologies in 5G based smart hospital. Alexandria Engineering Journal 2021; 60:5527–36.
[45] Si S-L, You X-Y, Liu H-C, Zhang P. DEMATEL technique: A systematic review of the state-of-the-art literature on methodologies and applications. Mathematical Problems in Engineering 2018;2018.