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Managing Cloud Intelligent Systems over Digital Ecosystems: Revealing Emerging App Technology in the Time of the COVID19 Pandemic

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Abstract: The COVID19 pandemic has indirectly changed the landscape of the business environment system through cloud intelligence within the digital ecosystem that has as a goal increasing the access, efficiency, effectiveness, equity and quality of business processes through cloud intelligent systems. Cloud intelligent systems are becoming revolutionary in today's world pandemic causing a complete and drastic change to a variety of industries, including, security, transportation, business, logistics and manufacturing. The main purpose of cloud intelligence systems is to facilitate the ease of access from any location and the management of practical computing resources. One of the challenges faced by cloud technology today is scheduling. The role of scheduling algorithms is very important, since tasks are executed by orders that may need more attention. Here, scheduling algorithms intended to minimize monetary cost and minimize makespan time to execute the workflow are presented. This study proposes cloud intelligent systems apps through an approach to cloud computing scheduling that may lead to great benefits and efficiency. The result is very promising. It showed that there are numerous applications of intelligent systems due to the more advanced hardware being built nowadays, plus business processes advancing to become smarter and more efficient in growing profitably over a destructive digital ecosystem during the COVID19 pandemic. The results indicate that intelligent systems over the cloud play a big role not just for interacting with the world helping businesses grow, but as well as in the advancement for a better tomorrow.

Keywords: cloud computing; clustering; monetary cost; makespan; data transfer; cloud intelligent systems; digital ecosystem

1. Introduction

To anticipate the increasingly massive impact of the spread of the coronavirus or COVID19 virus pandemic, business ecosystems have improved their processes broadly covered by work from home (WFH) policies. Unfortunately, not all employees can use this policy due to lack of suitable technology,

especially in the aspects of software, business handling models and infrastructure. For1 this reason, cloud computing technology is very useful for implementing work-from-home models. The cloud can help in a variety of ways, from storing and managing employee databases, names, cellphone numbers and e-mail contacts. Here, work-from-home systems automatically minimize direct meetings and it appears employees can still work productively, even though not in the office. Cloud computing has become an adoptable technology for many of the businesses with its dynamic usage of virtualized business resources as a service through the Internet. In other words, the term "cloud computing" has been an important term in the world of information technology (IT). Cloud computing is a kind of computing which is highly scalable and use virtualized resources that can be shared by the users [1]. It is an emerging application platform and aims to share, store and process data, calculations and services among users under IT.

The function of cloud computing is to store, manage and process data. Unlike local servers or personal computers, cloud technology is able to manage data in greater amounts. Cloud computing includes servers, database archives, networking, software, analysis and intelligence to help industries achieve faster innovation and increase business processes. Cloud computing is primarily a new business paradigm, as opposed a new technical paradigm including a cloud supplier-provided hardware and software infrastructure, or an application as a service to its customers [2]. Thus, the cloud can help employees work remotely because of its ability to store and manage data on one central server. With the implementation of work-from-home, face-to-face meetings will certainly be reduced and may even disappear altogether. For industries, the main problem faced when implementing work-from-home is related to task assignment since it is very difficult to use the old model in assigning employees which may cause an employee productivity freefall. In recent times, several interested parties in the private and public sectors world have realized how cloud intelligent systems are very important to apply to today's work environment. Cloud intelligent systems are a new business model related to the management of computing resources, both storage, communication networks and computing power using the pay-as-you-go paradigm where users only pay according to the resources they use. Pay-as-you-go offers computing facilities on a large scale without having to own hardware so users do not pay for investment in information and communication technology (ICT) infrastructure [3–7]. However, during the COVID19 pandemic the communication and marketing patterns will be more through digital canal. Today, digital communication media and social media are an effective and efficient choice for communicating with the community.

A survey conducted by Facebook shows that with the appearance COVID19 in Indonesia, almost 80% of Indonesian citizen respondents are afraid of contracting COVID19, related to the absence of a vaccine to overcome COVID19 worldwide (Figure 1). In Indonesia, along with business-from-home (BFH), work-from-home (WFH) and school-from-home (SFH) have shown an increase in cloud intelligent technology accessed through digital media platforms such as Facebook or Instagram where more than 30% visited Facebook and 36% visited Instagram more often than usual. (idcloudhost.com, June 2020).

Figure 1. Coronavirus impact (Survey by Facebook).

This research reveals business processes through cloud intelligent systems during the COVID19 pandemic. The result is interesting, as there are many options to access cloud intelligent systems. Moreover for efficient cloud access, this study implemented a scheduling approach through workflow optimization. Workflows are commonly used to model data flow and commands for each application deployed in the cloud. The workflow consists of tasks and data control between tasks. Ordinary workflows are described by a directed acyclic graph (DAC) that consists of tasks and controls, represented by nodes and edges, respectively. Users pay for cloud services based on executed workflows, where workflow execution must be in accordance with any time limits and quality of service agreed upon between users and cloud service providers. On the other hand, cloud service providers try to minimize the cost and execution time of workflows to obtain greater profits. Here, a scheduling algorithm which requires minimizing costs but not reducing the level of satisfaction of cloud user services was the main challenge [8]. Cloud computing can provide the opportunity to continue to take advantage of new developments in IT technologies at affordable costs [9]. Moreover, cloud intelligent system use for digital ecosystem general purpose activity, learning, school-from-home, work-from-home, and making a start-up business in relation to the pandemic situation is increasing. There are many uses of cloud intelligent system which have been addressed in this study. Digital ecosystems connect people across the globe where they are able to stay in contact and share their experiences. The various cloud intelligent system platforms have different features that are available for use by their subscribers. Cloud intelligent systems have also made easier for people to do business, due to the fact they open up the global market and make it cheaper to advertise.

This paper is structured as follows: Firstly, in the literature review section the details for each of the terms used and the benefits of cloud intelligent systems, especially during the pandemic, are illustrated. Secondly, the methods used in the proposed the cloud apps intelligent system scheduling methods, gathering the data and what are the limitations are discussed. Thirdly, the key differences and similarities between the uses of the terms are shown and discussed with support from findings in the literature that is related to research in the cloud intelligent system area. In addition, the different views of the use of cloud intelligent systems are introduced using real-life examples since it is the foundation for understanding these terms. Finally, the results of the different views are discussed in the conclusions part where some recommendations are also given.

2. Literature Review

Previous studies are related to scheduling algorithms to minimize monetary costs and execution time in the cloud, multiple VMs and different price models to get the lowest cost and faster workflow execution times. In line with this research, particle swarm optimization (PSO) algorithms including non-dominated sort PSO (NSPSO) and ε-fuzzy PSO were developed. NSPSO is a development of PSO to improve the selection of each particle so that non-domination comparisons are more effective. ε-Fuzzy PSO combines a fuzzy mechanism and PSO to find the best agreed on solution [10–12].

Durillo and Prodan [13] developed the heterogeneous earliest-finish-time (MOHEFT) multi-objective method and applied it for scheduling on Amazon EC2. MOHEFT is a development of HEFT, where HEFT is intended for a single object solution and MOHEFT develops it further so that it can be a solution for multiple objects. SPEA2 is an improvement of NSGAII and SPEA2 achieved by improving the NSGAII and SPEA2 evolutionary algorithms [14]. However, none of the mentioned algorithms can be directly applied to the cloud environment because they are mostly designed for traditional computing environments. Zhou et al. [15] designed fuzzy dominance sort heterogeneous earliest finish (FDHEFT) method which is a development of HEFT in order to reduce the cost and execution time of workflows simultaneously. FDHEFT is divided into two phases, namely the task prioritizing phase and the instance selection phase. The task prioritizing phase will determine the priority of each task and the instance selection phase will determine the best task to execute. Compared to MOHEFT, FDHEFT has a better execution time and gets a better solution with fuzzy dominance sort [3,13–18].

Intelligent systems are very useful in this modern world and important for business as an aid to improve the business processes strength as well as reduce weaknesses to become a leader in the industry. Intelligent systems over the internet are also known as the Internet of Things. This is due to devices such as mobile phones, refrigerators, watches and others being able to connect to the internet to collecting data and analyze it and thus provide convenience to the user. The devices can help users to perform better and improve productivity, help decision making and it has become a trend for the intelligent systems to operate within digital ecosystems [19–21]. One example intelligent systems over the internet to boot business processes are the so-called Smart Retail Systems. These smart retail systems help businesses by collecting data from customers when they enter the door with the help of a device such as a camera. The camera is connected to the cloud and starts facial recognition, collecting data, analyzing and predicting customer behavior. As a result, businesses can identify which of the product or services that most customers need and want, what product is suitable for this type of gender or businesses can eventually advertise trending products or services from the result thus successfully increasing the profitability of the business [5,22–24].

The next benefit or good circumstances that intelligent systems over the internet can provide is traffic monitoring systems. This system is the combination of both software and devices as well as connections to the cloud. Traffic lights are connected to the cloud and collect data, analyze it and make decisions for it on how many seconds or minutes should the traffic go to green, yellow and red. If accidents happen or a traffic jam has occurred, the monitoring systems will automatically reanalyze the data and make new decisions for that. There are also some cons for this system, like when there is a power failure, the system will be shut down and there will eventually be traffic problems. When the power is back on, the traffic monitoring systems need to be reset in order for it to run normally and collect data again, reanalyze and make its own decisions which takes a while. Another problem is hacking. Hacking can be done by irresponsible people which can damage the system as well as the real-life traffic. The operator must take control of the system as the intelligent system cannot do it by itself and this may take a while [25–29].

Another circumstance are Smart Environmental Sensors systems, which could benefit businesses and organizations. These sensors can detect the presence of people and cars. For businesses, employers may install these systems to detect the presence of their employees whether they are around in the building or area of working or not. They also can be used to check attendance, and the systems can detect at what time they come to and leave the office, etc. Smart Environmental sensors systems also help some organizations/businesses to tell their customers where to find available parking in their area. The system will analyze and calculate this and then give a result. If the parking is not full, the system will tell the customer with a green light with how many parking spaces are available and when it is full, the system will tell the customer this with a red light [6,23].

From the cloud intelligent systems technical point of view, this study implemented a combination between the kigh-possibilistic c-means (HOPCM) clustering algorithm and the scheduling FDHEFT algorithm, introduced by [15], to find the optimal solution in minimizing monetary cost and execution time (Figure 2).

Figure 2. Cloud intelligent system scheduling processes.

To analyzed the workflow load and activity, Zhou et al., implemented a workflow structure modeled with a direct acyclic graph (DAG) G = (T, D), where T = {T1, T2, ..., Tn} is the set of tasks and

D = {(Ti, Tj)|Ti, Tj ∈ T} is the data dependencies. The tasks may involve predecesors (Pre), succesors (Succ), without predecessor (Tentry), and without succesor (Texit) that is expressed by:

$$\text{Pre (Ti)} = \{\text{Tj}|(\text{Tj, Ti}) \in \text{D}\} \quad (1)$$

$$\text{Succ (Ti)} = \{\text{Tj}|(\text{Ti, Tj}) \in \text{D}\} \quad (2)$$

$$\text{Pre (Tentry)} = 0 \quad (3)$$

$$\text{Succ (Texit)} = 0 \quad (4)$$

Here, T1 is (Pre) of T2, T3, and T4, and those three tasks, T2, T3, T4, are (Pre) of T5, T6, and T7, vice-versa as successor. On the other hand, T1 is (Tentry), and T7 is (Texit), within the overall scheduling task (Figure 3).

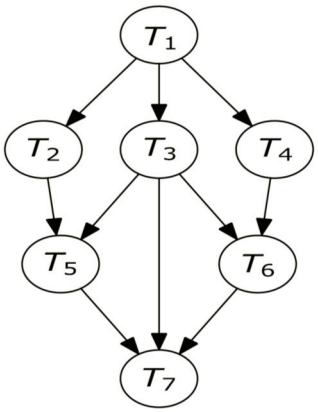

Figure 3. Example of application workflow.

In other hand, [20] created a scheduling algorithm to minimize monetary cost and workflow execution time in the cloud environment with two objectives called a multi-objective optimization problem (MOP). This MOP main function minimizes conflicts between tasks. Here, "X" is stated as the solution space, $F_r(x)$ is r^{th}; here the main focus is MOP where the monetary cost and execution time contradict each other. The approach is state by the following equation:

$$\text{F(x)} = (F_1(x),\ F_2(x),\ F_3(x), \ldots F_r(x))^T, \text{ where } x \in X \quad (5)$$

3. Results and Discussion

3.1. Cloud Connectivity Scheduling

Clustering is one technique that is widely used in analyzing data; its use is widely applied in the fields of computer science, statistics, biology and big data. Moreover, clustering refers to a group of datasets that are divided into different classes in the same cluster. Here, datasets are differentiated by their level of similiarity, such as high level degree and minimal level degree of similarity. Clustering is the process of partitioning a set of data objects into subsets called clusters, where the clustering process is accomplished through applying a computer algorithm. According to Han [10], the conditions and challenges that must be met by a clustering algorithm are: Scalability, Ability to Analyze Various Forms of Data, Find Clusters with Unexpected Shapes, Ability to Handle Noise, Sensitivity to input changes, Ability to do clustering for high dimensionality data, and Ability to do clustering for high dimensional data Interpretation and usability.

This study refers to the implementation of the high-possibilistic c-means (HOPCM) algorithm approach for clustering a set of data. The HOPCM algorithm was developed to strengthen a previous clustering algorithm namely the possibilistic c-means (PCM) algorithm, to cover the issues of big data

clustering with heterogeneous data. HOPCM can work well for clustering heterogeneous data that has many data attributes, a large number of data samples and diverse data sources. Zhang et al. [30] developed HOPCM algorithm by defining the Objective Function as follows:

$$J_m(U,V) = \sum_{i=0}^{c} \cdot \sum_{j=1}^{n} U_{ij}^{m} \sum_{i_1 \ldots i_N}^{l_1 \ldots l_N} \left(x_{ji_1 \ldots i_N} - V_{ii_1 \ldots i_N} \right)^2 + \sum_{i=1}^{c} \eta_i \sum_{j=1}^{n} \left(1 - U_{ij}\right)^2 \quad (6)$$

where $V = \{V1, V2, \ldots, Vc\}$ are a set of cluster centers and u_{ij} is membership value. By simplifying the objective function above, two equations will be produced, namely the membership matrix function and clustering center functions, represented by the following equations:

$$U_{ij} = \frac{1}{\left(1 + \left(\frac{d^2_{(T)ij}}{\eta_i}\right)^{1/(m-1)}\right)} \quad (7)$$

$$V_{ii_1 i_2 \ldots \ldots i_N} = \frac{\sum_{j=1}^{n} U_{ij}^{m} X_{ji_1 i_2 \ldots i_N}}{\sum_{j=1}^{n} U_{ij}^{m}} \quad (8)$$

where $d^2_{(T)ij}$ is the distance between X_j and V_i given by the following equation:

$$d^2_{(T)ij} = \sum_{i_1 \ldots i_N}^{l_1 \ldots l_N} \left(x_{ji_1 \ldots i_N} - V_{ii_1 \ldots i_N} \right)^2 \quad (9)$$

The result of a joint test of the HOPCM clustering algorithm with scheduling FDHEFT as tested by Zhou et al. [15] is shown in Tables 1 and 2 for five series. It is very promising to be implemented within cloud applications in the time of COVID19. After a while, the results were compared with other schematic algorithms, namely ε-fuzzy PSO, NSPSO, SPEA2*, and MOHEFT related to monetary cost and workflow execution time. The result is a combination of the HOPCM clustering algorithm with FDHEFT scheduling algorithm that produces the best performance related to the reduction of monetary cost and time of excess workflow in the cloud environment compared with: (1) ε-fuzzy PSO algorithm [18], (2) NSPSO [17], (3) SPEA2* [14], and (4) MOHEFT [13].

Table 1. Workflow comparative studies of existed algorithms.

Cloud Workflow	Algorithms				
	Series (1)	**Series (2)**	**Series (3)**	**Series (4)**	**Series (5)**
i	0.615	0.954	0.905	0.945	0.961
ii	0.917	0.932	0.876	0.929	0.954
iii	0.822	0.863	0.871	0.935	0.949
iv	0.716	0.365	0.762	0.787	0.847
v	0.408	0.652	0.634	0.785	0.846
vi	0.269	0.2	0.502	0.697	0.782
vii	0.944	0.945	0.915	0.947	0.96
viii	0.721	0.637	0.916	0.966	0.978
ix	0.429	0.928	0.813	0.934	0.961
x	0.126	0.398	0.117	0.519	0.519
xi	0.2	0.595	0.391	0.722	0.762
xii	0.279	0.2	0.347	0.82	0.837

Table 2. Runtime comparative studies of existed algorithms.

Cloud Runtime	Algorithms				
	Series (1)	**Series (2)**	**Series (3)**	**Series (4)**	**Series (5)**
i	13.96	13.13	5.12	9.55	0.13
ii	36.99	35.31	5.69	43.51	0.34
iii	143.12	138.12	7.46	555.31	1.51
iv	13.06	12.38	5.93	11.93	0.54
v	36.9	34.2	5.5	50.56	0.5
vi	139.05	134.09	7.02	622.71	1.19
vii	10	8.93	5.15	5.6	0.11
viii	36.05	34.21	5.32	46.3	0.33
ix	140	135.37	6.52	552.32	1.74
x	12.74	11.94	7.97	10.52	0.12
xi	48.57	45.66	8.62	74.72	0.4
xii	133.23	130.15	7.16	518.55	0.94

Table 1 and Figure 4 show five series of workflow cloud comparison studies, where the series-5 algorithm attracts attention through providing the best performance, higher than other four series as a workflow approach for a cloud apps environment.

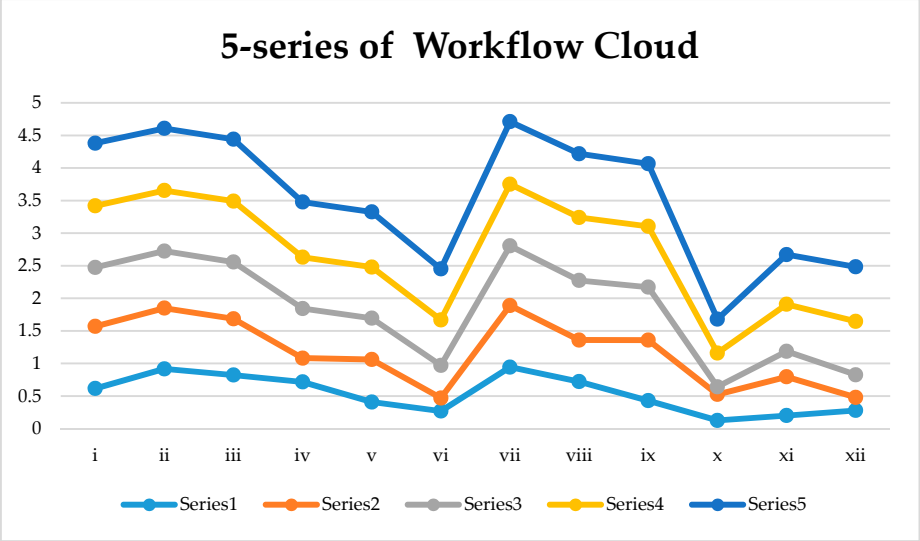

Figure 4. 5-series of workflow comparative studies of existed algorithms.

On other hand, the series-5 also gives a promising result as seen through the best speed of runtime for cloud workflows (Table 2 and Figure 5), with the respective datasets of: (i) cybershake-30, (ii) cybershake-50, (iii) cybershake-100, (iv) inspiral-30, (v) inspiral-50, (vi) inspiral-100, (vii) montage-25, (viii) montage-50, (ix) montage-100, (x) sipht-30, (xi) sipht-60, (xii) sipht-100.

Technology is evolving from day to day. As mentioned by the Results section, this research found that the HOPCM clustering algorithm with the FDHEFT scheduling algorithm produces the best performance of cloud intelligence connectivity. The use of intelligent systems is becoming ubiquitous nowadays, especially in the private and public sector. The capability and capacity of a digital computer-controlled system to perform tasks which are commonly associated with intelligence could be considered artificial intelligence (AI). The use of AI is technically to perform complex tasks that humans were unable to accomplish. The ability to understand the user's behaviors and be able to suggest a particular activity to users such as to visit a website based on the patterns and trends of the users. The following sections discuss how the HOPCM clustering algorithm with the FDHEFT scheduling algorithm produce the best performance of cloud intelligence connectivity, to implement

such application connected to cloud intelligent technology related to the surveillance and monitoring of COVID19 spread.

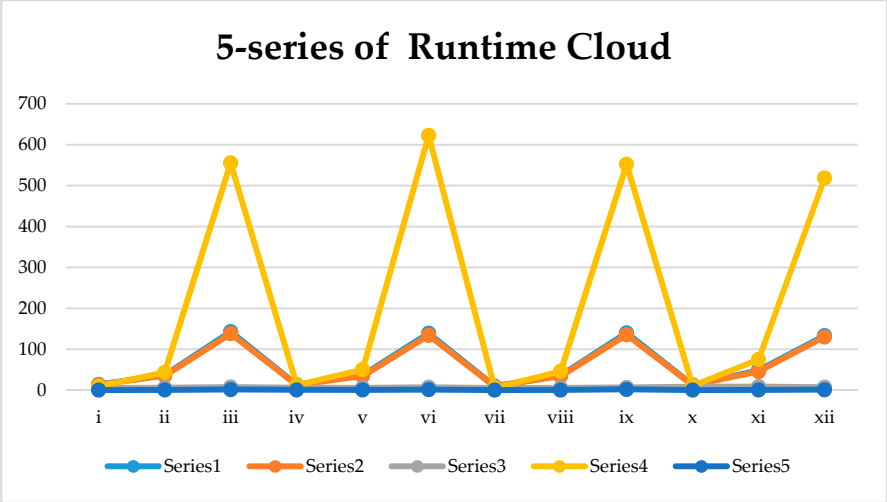

Figure 5. 5-series of runtime comparative studies of existed algorithms.

3.2. Implementing Cloud Apps Intelligent Systems

3.2.1. Importance of the Intelligent Systems for Enterprises

Nowadays within the digital ecosystem era, data is very valuable to the private and public sectors as it gives the opportunity to improve business processes as well as reducing weaknesses. The more data they get, such as customer data, sales data, customer satisfaction, business opportunities, and employee improvement, businesses can improve their market share performance. Moreover usability helps improve business processes, as follows:

- *Improve Product Time to Market*: The systems help businesses roll out their products to customers much faster. The system will eventually gather data and analyze the best development cycle for the business and reach out to the potential customers in the market. The system will automatically advertise the product in the market, hence making the company more recognized and profitable. This will create more profits for the business as the smart system picks/predicts the next best thing for the business.
- *Improve Business Revenue*: With this system, businesses can improve their revenue based on previous data and analysis, serve current customers and find new potential customers.
- *Improve Manufacturing Processes*: The system may enhance the existing processes making them more efficient and productive. It also can produce new smarter processes which can control, monitor and predict what the best process is and produce products and at the same time it will improve the time and increase productivity.
- *Build Company Loyalty*: The system collect data and show results for what should be improved from the customer experience viewpoint. This allows the businesses to improve the products or services that customers need.
- *Improve the Supply Chain*: The system allows the businesses to track and assess the quality and volume of the supply chain and also monitor everything regarding the supply chain and the quality of products.

3.2.2. Cloud Intelligent Trend

Today, in time of pandemic COVID19, where every private and public sectors relay on cloud services and connectivity through intelligent systems scheduling to efficient and effectiveness of cloud

delivery cost. In other hand, intelligent systems are important for the business to improve the business strengthen its core as well as reduce weaknesses and become the market leader. Intelligent systems over the internet is also known as the Internet of Things, due to the devices such as the mobile phone, refrigerator, watches and others, being able to connect to the internet collecting data and analyze it and then give convenience to the user. The devices can help users or businesses to perform better and improve/ increase performance and productivity and help to make decision making. It has become a trend for the intelligent systems to operate in this modern era. It has been evolved and operates from application to software and eventually to the internet. Everyone has been using it for its own purpose and to make things easier.

The next benefit that intelligent systems over the internet can give is the traffic Monitoring Systems. This system is the combination of both software and devices as well as connected to the internet. The traffic light is connected to the internet and it collects data and analyzes and makes decisions for it on how many seconds or minutes should the traffic go to green, yellow and red. And if accidents happen or traffic has occurred, the monitoring systems will automatically reanalyze and make new decisions for that. There are also some cons for this system. When there is power failure, the system will be shut down and there will eventually be traffic. When the power is back on, the traffic monitoring systems need to be reset in order for it to run normally and take data, reanalyze and make its own decision which takes a while. Another problem is hacking. Although most ICT systems are designed to have a considerable amount of strength in order to sustain and assist private and public sectors in protecting information from security threats, they are not completely immune from the threats. Private and public sectors pay increasing attention to information protection as the impact of information security breaches today have a more tangible effect.

In other hand, the Smart Environmental Sensors systems, which could benefit the private and public. These sensors can detect the presence of people and cars. For the businesses, employers may install these systems to detect the presence of their employee whether they are around in the building or area of working or not. It also can be used as the attendance, and the systems can detect at what time they come to the office and etc. Smart Environmental sensors systems also help some organizations/businesses to tell their customers regarding the available parking in their area. The system will analyze and calculate then give a result. If the parking is not full, the system will tell the customer with green light with how many parking spaces are available, while if it is full, the system will tell the customer with a red light and it's full.

3.2.3. Business Processes: Pandemic COVID19 Issues

COVID19 is a new type of virus that has affected all sides of human activity. Moreover, the private and public sector have been affected by the COVID19 pandemic, with ups and downs depending on the type of business. Booming businesses during the COVID19 include YouTube, Netflix, mask companies, cleaning services, delivery services, drones and video conferencing, whereas businesses that are struggling to make profits include hair salons or barber shops, movie theaters, oil companies, and even the tourism industry as travel bans are imposed all around the world. As a result of work-from-home and learn-from-home infrastructure and cloud connectivity may lead to everyone using devices to connect to relevant software to fulfil their needs. Importantly, video communications are heavily relied upon for conferencing therefore the likes of Zoom, Skype, Microsoft Teams are the ones being used and thus, the popularity and profits of these businesses is increasing. With COVID19 continuing to spread worldwide, movie theaters are closed, thus people get to enjoy online entertainment services from home for their leisure because of quarantine and lockdowns. Streaming services such as Netflix have implemented a drastic increase in their subscription rates—with almost 16 million new subscribers since lockdowns began (Netflix boom, https://www.channelnewsasia.com/news/commentary/netflix-television-coronavirus-COVID19-19-quarantine-lockdown-tv-12714118). The high usage of Netflix streaming services may be temporary as the boom did not begin until the lockdown happened, but the company will still be able to survive as they have enough original content in store for the next few

months to come. Many manufacturing industries that have large numbers of employees, must cut down their number of employees, MSME's will be have the largest impact from this pandemic. As each nation's government are trying to stimulate the economies to ensure the stability and be able to help their unfortunate peoples and businesses. Below are some brief explanations of how each nation that has had positive cases of pandemic COVID19 has been affected either in terms of government, the economy, communities and people:

- Economic recession affecting businesses especially micro, small, medium enterprises (MSMEs).
- Unemployment will be a major contributor to economic recession as lots of people may lose their jobs due to the current situation and government orders.
- Governments may have to implement economic injection initiatives to boost and stabilize the economy. This can affect the GDP of the nation as when economic activities are not doing great and government must use initiatives to ensure the GDP of the nation will not be badly affected. Examples of economic injection are to give incentives to MSMEs so that they still can do business, give allowances to people which were badly affected so their purchasing power is still viable, network infrastructure must be upgraded due to home and work learning initiatives implemented by the government and private sectors, and any other method that will use by the government to stimulate their economy.
- Lots of business must shut down – during lockdown or due to economic recession. This is what are currently happening throughout the globe. Because of lockdowns or impacted by the economy, a numbers of businesses, especially MSMEs, must shut down as business was not going well and their sources of revenue were affected.
- All economic activities were suspended during lockdown to ensure the outbreak can be minimized and to encourage people to stay at home.
- Most projects will be put on hold. Major projects such as government projects either in terms of infrastructure or others, might have to be suspended for a period of time. The affects the government schedule, return on investment and GDP.

In terms of entertainment, as COVID19 forces people to stay at home, they are bound to stream videos on the Internet during their leisure time. Video accounts for about 70 percent of network traffic which puts the heaviest strain on the Internet. Simply watching 4 K videos on Netflix uses up to 11.25 GB of data per hour. Therefore, it has reached a point where Netflix has been asked by the European Union (EU) Commissioner Thierry Breton to reduce their streaming quality (Reducing Netflix streaming qualities, https://www.businessinsider.com/eu-netflix-hd-video-internet-strain-coronavirus-outbreak-2020-3), meaning it will to no longer offer 4k streaming as it takes four to five times the bandwidth of regular high definition quality. This is done in order to reduce Internet traffic so everyone can still have secure Internet access. As a result, YouTube has also followed the same steps as Netflix, reducing YouTube's streaming rates to a minimum to lessen Internet traffic.

Since the majority of people in the world are normalizing the work-from-home infrastructure, Internet load balancing is at its highest peak, because the usage of the Internet is required as part of the crucial process. Whenever and wherever a person is at, working from home and with other family members also performing their own daily things, all of them are using devices to connect to the Internet which uses a lot of bandwidth. The impact or more specifically, the reality of the Internet of Things (IoT) during COVID19 pandemic is that it has significantly provided numerous means for a more flexible and automated process of operations for industries all over the world.

Robots as doctors. Robots have been a big game changer for the world ever since the COVID19 pandemic appeared. Currently in Wuhan, hospitals are being built and robots put to work controlled by humans powered by a powerful 5G infrastructure. The major positive feature is that medical practitioners (doctors) can protect themselves with robots avoiding human contact which increases safety when treating people.

Patrol robots. A company from Guangzhou that manufactures smart city products and services, namely the Guangzhou Gosuncn Robot Company has developed a 5G-powered police patrol robot that is capable of assisting frontline police officers in carrying out disease prevention inspections such as scanning the temperature of up to 10 people all in one go within a 5 m radius. These patrol robots are installed with high-resolution cameras and thermal imaging cameras, thus if an absence of a mask or a high body temperature is detected, the robots alert to the relevant authorities as all the data can easily and quickly be transmitted to a centralized control center for the process of real-time situation response and decision making activities.

Delivery robots. To battle the COVID19 pandemic, in some areas of China, Beijing has been ensuring the usage of robots for deliveries of items such as groceries, medicines and food purchases. All people need to access to an online e-commerce platform where they can buy their groceries online. Next, the robot will go to the relevant company warehouse and then it will travel to find the designated or desired area of the customer for delivery.

If countries with lesser resources were to implement robots controlled in real-time, the main challenge would be implementing the 5G itself. China in general has implemented the 5G infrastructure thanks to their drastic advancement of technologies and excellent profit gains from businesses overseas. Countries with lesser resources compared to China will hardly be capable of implementing the way China functions with robots. The reason is the expensive cost, such as installation of underground network cables, cell towers or new power lines.

3.2.4. Smart Health Surveillance Software and Apps

AI smart health surveillance software applications are surveillance programs that are focused on contain the outbreak of the COVID19 pandemic. The purpose of this software is to minimize the outbreak and to cut the chain of COVID19 transmission. These are systems where the functions are to detect, alert and give information and alert particular government agencies involved in fighting this pandemic and the community such as the users of the application through cloud intelligent connectivity (Figure 6).

Evolving technology with the HOPCM clustering algorithm and FDHEFT scheduling algorithm produces the best cloud intelligent system connectivity performance. Here, the basic processes of this software and application are as follows: first and foremost, there will be a server, host and AI functionality will be implemented in the software for the usage of the software and application users (users, hosting team and government agency). The server will be the mainframe of data storage, analyze data and give alert notification to all users based on their roles and functions. For applications that are used via a smartphone, it must have three functions that will be available for users' advantage. The first function is the data that users input to the application will be stored on the server for future detection and analysis of potential positive COVID19 patients. The second function is as a tracking device for patients that are under quarantine at that time.it easier for authorities to track down their movement. Finally, a function that will have to use Bluetooth to work is focused on the people around the users. When everyone has the application and Bluetooth is on and they are near each other, the application can retrieve the data from others' smartphone. The purpose of this, when an AI smart surveillance camera detects that a particular user is a potential COVID19 patient, is to make it easier for the AI server to analyze, detect and filter users for contact tracing and make it easier for governments to find patients (Figure 7).

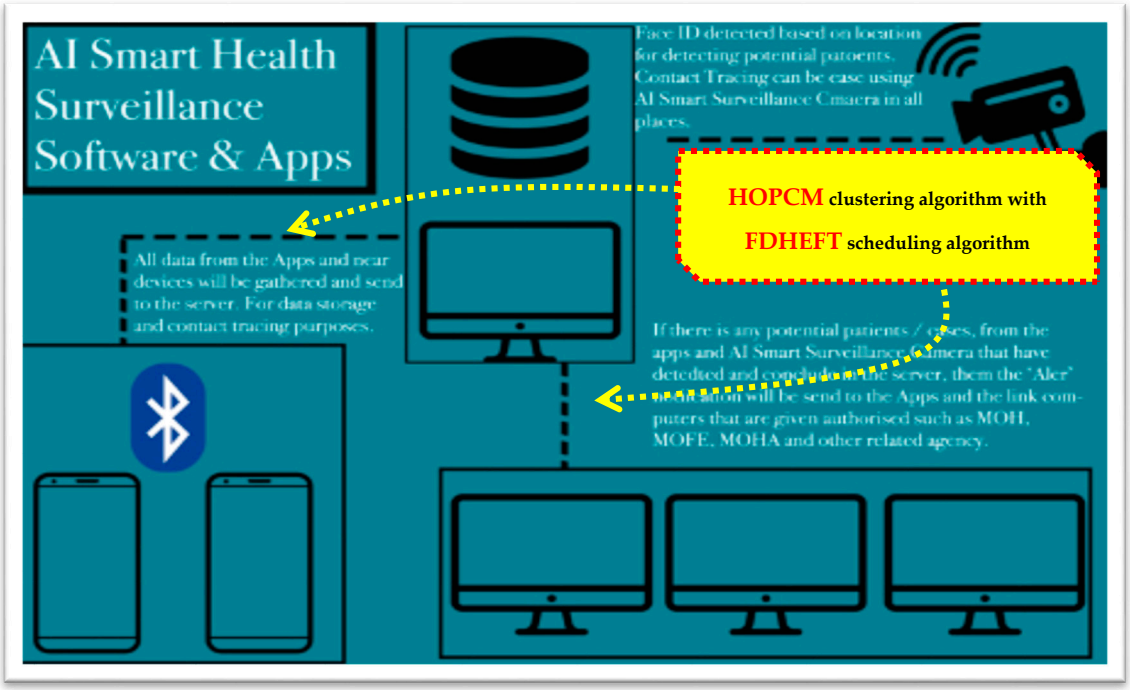

Figure 6. Architecture of cloud based smart health.

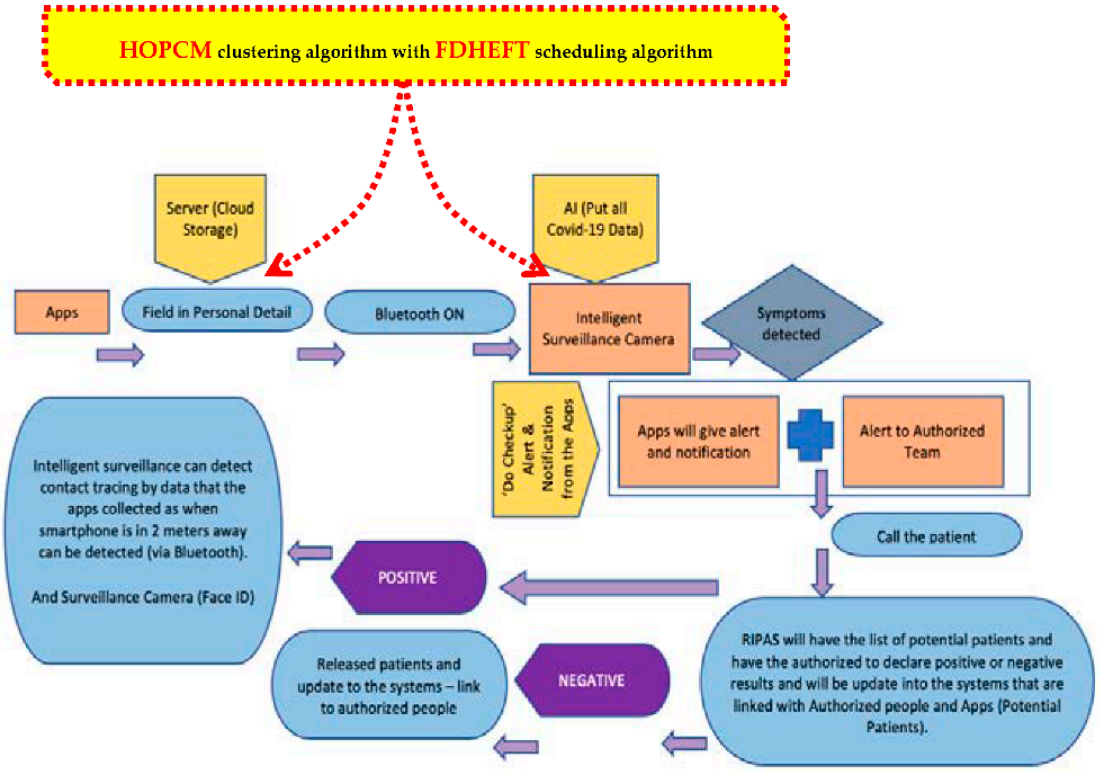

Figure 7. Processes flow of cloud-based smart health.

As for the smart surveillance camera, this camera will have functions of facial ID, detecting persons that have COVID19 symptoms (that will be input as data to the server and AI) and have a thermal scanner for the body temperature of each person who is detected by the smart surveillance camera. The picture from the AI smart surveillance camera will assign a "Green" detection result to the facial ID of people showing as negative for potential COVID19 contagion and a "Red" detection to

the facial ID of people showing a positive potential COVID19 result. Those who receive a Red facial ID detection result will be given an alert notification on their apps and then the alert updated list will be send to appropriate particular authority for further action. Lastly, for computers or devices on which the software will be installed at several particular government agencies where all relevant data are analyzed by the server and host computer, if an updated alert of a potential COVID19 patient is received, the server and host computer will give a notification and update the "COVID19 Alert List" will be send to computer government agencies for further action. The government agencies that will be have such authority can be:

- Prime Minister Office—PMO
- Ministry of Health—MOH
- Hospital and National Quarantine Center—HNQC
- Ministry of Finance and Economy—MOFE
- Ministry of Home Affairs—MOHE
- National Disaster Management Centre—NDMC

Here, the listed agencies have their own roles as they have the authority to declare a status of positive, negative, quarantine and other status to be updated. Once updated, related agencies will also receive the updated list and status, then automatically be connected to the cloud intelligent server-host for further storage and data analysis. Having this cloud intelligent system surveillance camera will provide benefits to the private and public sector to improve their business processes revealing COVID19 pandemic outbreaks. The cloud intelligent system apps may lead to benefits for business processes such as:

- The ability of agencies to check the movement of quarantined patients to ensure all patients are obeying the regulations that have been set by the government as there were issues before with cases where quarantined patients tried to escape from quarantine centers.
- The ability to transfer data from app to app so that it is able to gather data when contact tracing. When a smartphone users meets another smartphone user within a specific range, data will be interchanged.
- An efficient way for agencies to do "contact tracing" when a positive case is found, as the current method to contact tracing consumes lots of time, energy and workforce.
- Convenience of use for all users as all the data has been stored on a cloud server and can be analyzed, so there will be no need to use the internal storage capacity of phones.
- The ability of the AI function to analyze the symptoms and other factors in order to detect potential patients. This can be helpful for governments to detect potential COVID19 patients.
- The camera has the function of Face ID detection making it easier for governments to recognize people when doing search activities. Furthermore, the smart surveillance camera has a thermal mode to detect body temperatures.
- When AI Smart Health Surveillance systems are installed throughout the nation, it will make it easier for governments to detect patients and perform contact tracing.
- Agencies can lift a few lockdown restrictions so the economy will still function in the country. This can be done when the pandemic is effectively contained.
- Business can use this software and application as a precaution for their businesses and their workers. It can be help agencies when there is a need for contact tracing if potential COVID19 patients are detected on their premises.
- To ensure the national health systems graphs will be stable, as having this will make sure COVID19 is contained.
- Ability to help MSMEs during this pandemic. When the pandemic is contained, business activity can be resumed like normal.

- Ability to understand the lifestyle patterns, how the outbreak will affect communities and how this pandemic can spread and how it can be encountered.

3.2.5. Intelligence Gate System

This system is one of the ideas to prevent COVID19 from spreading through people in one place. An automated gate system can be placed in front of a building such as a workplace, school, mosque etc, and the person who wants to enter the building must get scanned through the CCTV face recognition and a thermal check to ensure the person is clear from any COVID19 sickness. The gate will only open if there is no record of the person and he/she is in good health. The purpose of an intelligent gate system is to help the government prevent the spread of the COVID19 virus in workplaces, schools, mosques, marketplaces and any other place. This also help the Ministry of Health (MOH) identify and recognize patient clusters, potential infected persons and record as well as to know the current place that they are visiting. The thermal CCTV will also help to understand the temperature of a person whether they are in a normal temperature range or not. The gate will prevent infected and unwell persons from going into the building and premises with the help of CCTV. The gate will remain closed and will not open and there will be a screen informing the person that they are unwell or infected and the MOH and nearby police officer will be informed automatically (Figure 6).

From the early stages of the COVID19 pandemic private and public sectors have already been trying their best to stop this virus from spreading nationwide by closing all borders where no one can go out and go into the country, quarantining potential patients and also implementing social distancing for all citizens where they must distance themselves from each other at least 1 m and they must not attend any gatherings. There are some cases where infected persons don't have any symptoms yet they are infected with COVID19.

The implementation of this app is part of the prevention plan, which consists of four stages, where the first stage is the face recognition by the CCTV, the data will then be sent to the cloud server through intelligent accessed scheduling, then the agencies gather data and analyze the person to ensure that the person is not from a COVID19 cluster and a potential person to get infected. The second stage is sending the data to the main cloud server for further analysis by AI. The mechanism is that the AI system will immediately trigger a notification to the nearest authority to act at that place to notify and inform the premises that the person is infected and maintain distancing from other people. On the other hand, the mechanism works if there is no record regarding a cluster-infected person, in good health with a normal temperature, then the AI system will send information to the gate to open and the person has passed the first checkpoint (Figure 8).

The third stage for the intelligent gate system is the thermal scanning. This scanning is to identify the person's temperature. The temperature data will eventually be sent to the cloud server to make a decision whether the calculated temperature is allowable or not and the main server will send data to the gate. If the temperature of the person is high, the data center will tell the gate not to open and if the temperature of the person is normal, the system will tell the gate to open. The ideal temperature is set from 36 degrees Celsius to 37.9 degrees Celsius in the system for the gate to open. If the temperature is high, the gate will not open and it will notify the person to cool down for a while. If the temperature is still high even after resting a while, that means he/she is not in a good health and recommended to have get checked at a nearby hospital. The gate will open if the person's temperature is based on the set calculation on the system (between 36 to 37.9 degrees Celsius). The last stage of this system is the disinfection booth. After the person has passed checkpoint 1 and checkpoint 2, he/she must go to the disinfection booth to remove all bacteria and possible COVID19 infection on the body. The person just must go into the booth, which will release and spray the whole body with a disinfection liquid. The spray will go on for at least 10 s. After that, the person may proceed and enter the building or premises. The size of the gate and the disinfection booth will depend on the place/building and the number of people expected. There are two types, single door gates and double door gates. The size of a single door gate will be 30" to 48" width and the length is up to 7.9 feet. The single door gate can

only be used by a single person at a time. For a double door gate, the size is from 60" to 96" width and the length will be same as the single door gate, which is 7.9 feet. Double door gates can be accessed and entered by two people at the same time (Figure 9).

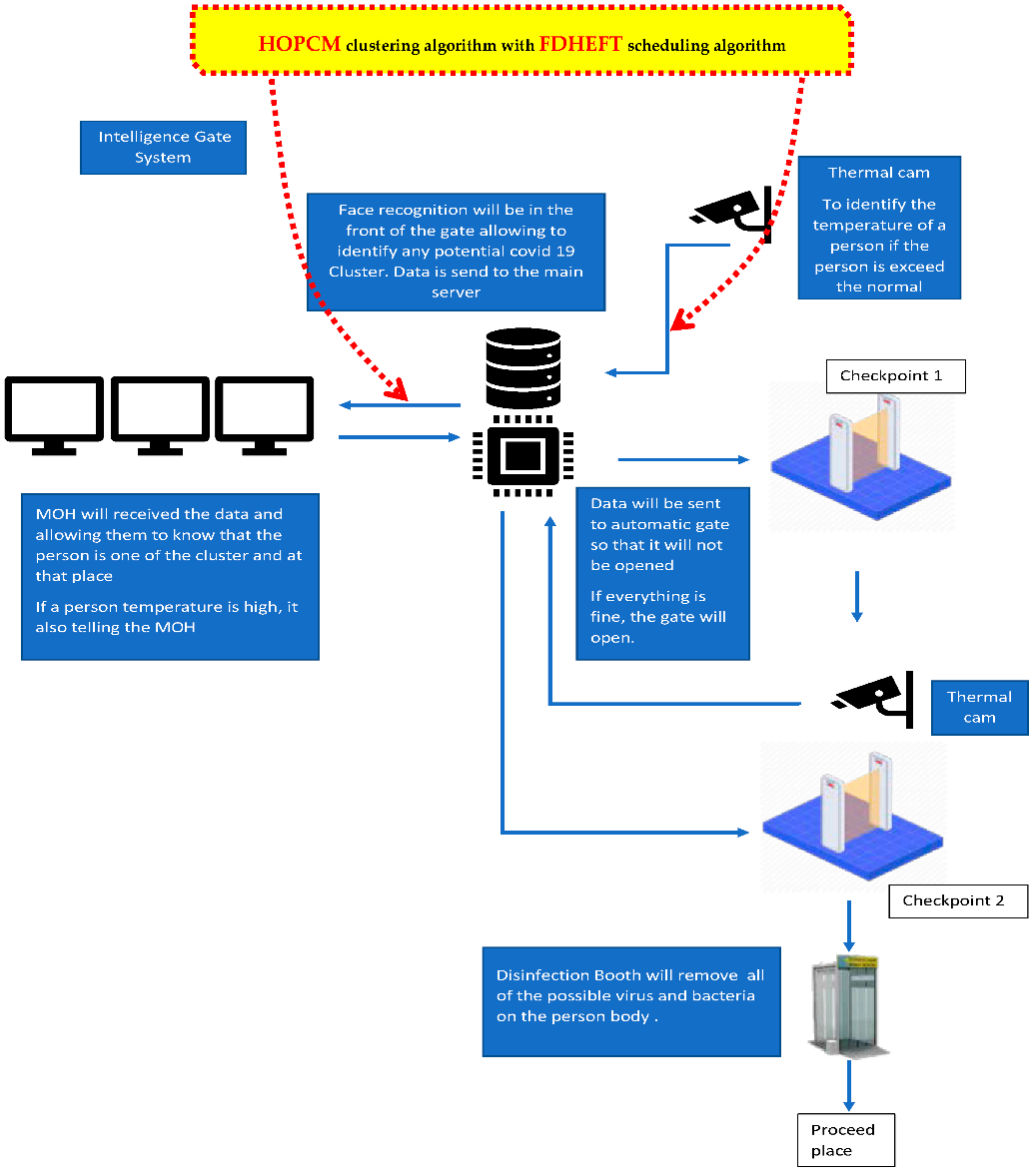

Figure 8. Cloud intelligent gate system.

This intelligent gate system has its own benefits that make it very useful to the private and public sectors to prevent the virus from spreading. This system can also be used for the other types of viruses, if needed. The benefits include:

- *Government Accessibility*: This system is accessible to specific ministries and organizations such as the Ministry of Health, Prime Minister's Office, Ministry of Finance and Economy, Ministry of Home Affairs and lastly the Disaster Management Center. This is due to the fact the data provided by the CCTV and system is confidential and needs privacy protection. The data also can be collected from the CCTV and the information delivered to a cloud server, thus, all the above ministries and organizations can access and see what new data have been collected.
- *No Human Intervention is Needed*: Everything is controlled by the artificial intelligence (AI) system through the internet. Everything from facial recognition, analyzing the data, thermal scanning,

gate opening as well as the disinfection booth operations are handled by the AI. There is no human interference unless needed, such as showing potentially infected people detetcted where the quarantine zone place is, maintenance etc. Other than that, it is fully automatic.

- *Ability to Know Location*: This system will help determine the location of a person's whereabouts. For example, if the person is infected with COVID19, he won't be able to go into the building or leave the area and must stay in the quarantine zone provided. He will be monitored in the quarantine area. Thus, the location where a patient was detected is the place or the location where the necessary frontline activity must occur.
- *Trigger Notification to the Nearest Frontline*: This system will also help to directly inform the MOH and relevant organizations if the system detects an infected person with COVID19 or a potential cluster/infected person or the government is looking for that person. A frontline person such as a medic, nurse and doctor and also police officers will be informed immediately by the system.
- *Prevent Spread in Buildings*: With this system, only a person who is in very good health and does not have any problems with the current COVID19 as established by the agencies, have any relations with clusters and so on will be able to proceed and enter the building. Thus, this will help prevent the people who are inside the building from getting the COVID19 virus. On the other hand, if symptoms are detected outside the building, people who are already inside the building do not have to worry anymore because they are safe, but those who are outside will need to wait for the frontline worker to come and tighten the checking before entering the building, as they are queuing up to enter the building, they probably have been contacted without distancing from each other.

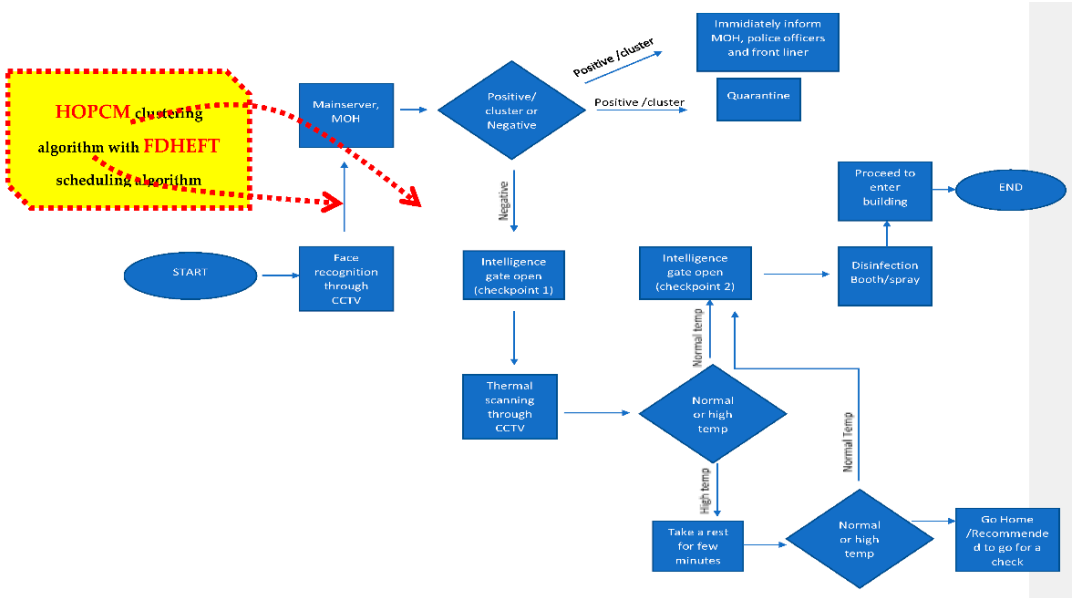

Figure 9. Processes flow of cloud-based smart health.

4. Conclusions

Intelligent systems over the cloud have reached a peak where they are considered to be a major key for having a better tomorrow, especially in regards to aspects of the private and public sectors, industries such as operations, safety and healthcare, business and security, whereas another is for reducing latency and enabling real-time video analytics via intelligent surveillance systems. For our analysis in regards to the business and issues that have arisen during the COVID19 pandemic, this paper contributes with three main ideas as a solution to cope with and enhance the efforts to prevent and stop the virus and furthermore to help businesses run again as this can help the nation's economy. However, to have effective and efficient cloud access, cloud intelligent scheduling access is applied.

Here, the combination of the HOPCM clustering algorithm with the FDHEFT scheduling algorithm produces the best performance related to the reduction of monetary cost and workflow execution time in the cloud environment compared with alternstives like the ε-fuzzy PSO algorithm, NSPSO, SPEA2* and MOHEFT. By using this scheduling algorithm model, an organization can achieve its goal in a cost-efficient way by using cloud computing. In other words, organizations can obtain many advantages from cloud services. The personnel of the organization have the opportunity to quickly and economically access various application cloud service platforms and resources online or through web pages to meet their work demands. Therefore, organizational cloud computing automatically reduce the cost of company expenses and offers companies more powerful functional capabilities.

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