Healthcare Logistics System Planning for Facility Location of Aging Society

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Abstracts: Healthcare facility location management is essential to the public infrastructure, particularly as it relates to access to the healthcare system. Therefore, the locations of primary healthcare centers (PHCs) must be sufficient to accommodate the size of the elderly population in the future. Thailand is entering an aging society. Most of research studied to improve service quality of healthcare more than consider amount of location of PHCs. So, the purpose of this study was to applied a geographic information system (GIS) to study coverage area of accessing to health facility location under condition of increasing elderly population. It analyzed by using the Dijkstra Algorithm and concept of last mile delivery center. For the elderly population, this research applied auto regression to forecast elderly population. The study found the population of elderly people will increase in every district by 2025, with the highest increase being in Khlong Sam Wa. The original locations point of PHCs in Bangkok included 145 locations, which can accommodate an area for the elderly to access a PHC. Health services need to be easily accessible by walking in 5-15 minutes [1]. Thus, the problem is the current locations of PHCs are insufficient to support a future aging society. This research applied the location of Covid-19 vaccine distribution model (CVDM) to support the positioning of healthcare services. The CVDM comprised 191 pharmacies/clinics then analysis the service coverage area. The point of location CVDM and PHCs which showed health services coverage by comparing walking times. This modal can increase service covering of walking in 5 minutes, 10 minutes, and 15 minutes of 4.34%, 11.78% and 20.35%, respectively. The efficiency of service cover-age for primary and secondary medical care for elder can be improved if the location of health service centers is increased.

Keywords: Healthcare, Service Area, Aging Society, Auto Regression, Geographic Information Systems.

1. INTRODUCTION

Healthcare Logistics Management is a science that is applied to business management with the aim of reducing costs and increasing competitiveness. Nowadays, this science has a role in the healthcare industry, which has different goals from other businesses. The healthcare business must consider the safety of the services. The National Development Strategy is one of the national economic and social development plans that allows the public and private sectors to implement logistics management systems. Most of health business management is employed to improve the stock of pharmaceuticals, standardization of medicines and medical supplies, procurement, issuance of orders warehouse management, product distribution and transportation. Thus, users are treated safely and have access to better-quality healthcare services [2]. Moreover, the first revision of the 20-year National Strategic Plan for Public Health in 2018 (2017-2036), important issues concerning public health were raised by the Constitution of the Kingdom of Thailand 2017 and the Thailand 4.0 policy. In addition, the National Economic and Social Development Plan and the 12th National Health Development Plan focus on public health to organize plans and guidelines that support the aging society based on changes in the environment and geography, as well as morbidity and birthrate. Moreover, the health service facilities also pay attention to hospitals, nursing homes, health centers and local hospitals. There must be considerations made in order to enable people to have comprehensive access to services, including the health workforce [3]. Health logistics has been applied to prepare a plan to accommodate increased health services to accommodate the aging society in Thailand. Since 2016, the aging society has increased rapidly by 16.5 percent, which is predicted to increase by 32.2 percent in the next 15 years. The percentage of the elderly who live alone must be taken into account. The likelihood of depression has increased by 8.7 percent, so access to the primary healthcare system is necessary due to the growing number of older people and those seeking health recovery. However, traveling long distances to a medical facility makes traveling inconvenient for Thai people to receive health services [4].

Bangkok is a modern health service area consisting of government hospitals and private hospitals. These hospitals serve not only patients in Bangkok, but also people living out-side the area. Nowadays, these hospitals tend to encounter overcrowding. This problem described which occurs in the city because the patients come from many areas and do not accept treatment in the medical unit close to home [5]. The reason is that urban areas do not have enough PHC coverage. In addition, the arrival of patients from many areas results in insufficient medical personnel, and sometimes treatment is only a follow-up. Bangkok has an increasing population of the elderly, which further reinforces the idea that access to health care is very important in the future [6]. Notably, approximately 84.2 per-cent of the elderly travel from home for treatment. It shows that most of the elderly travel to see a doctor, which is considered the main activity, and that traveling to nursing homes for the elderly will increase according to the size of the elderly population.

If location of healthcare in logistics perspective have been applied, it can prepare the medical facility near the community area for primary service. Healthcare is important to properly support the aging society in the future. The gap of research is most of research considered health service more than number of location of facility by observing in service area, therefore causing the concentration of people to use the service. The number of medical facilities location near the community needs to be considered to enable access conveniently, quickly, and satisfactorily, including medical equipment and ordering. Geography Information Systems (GIS) is the efficiency tools to visualize planning for government. It shows overview of service area from health care positions for beneficial to governor decision making. Moreover, PHCs should prepare enough personnel to meet the needs of patients should consider the location of the service center. Thus, patients can receive treatment conveniently. The Asia Pacific Observatory on [4] for community center hospitals is an important consideration and planning to implement public access to primary and secondary healthcare services.

Bangkok faces the problem of needing to increase the number of primary care facilities in the future that support services for the aging society. Healthcare Optimization Logistics can be regarded as playing an important role in setting guidelines for increasing the number of public service centers. The plan aims to accommodate and provide comprehensive services in all areas of Bangkok for the increasing elderly population. Normally, elderly people have access to PHCs and follow-ups because some PHCs face difficulties and congestion in access to hospitals. The data collecting is limited of number of elder in future. Therefore, this research aims to study the forecast of the future aging population using the Autoregressive Integrated Moving Average Model (ARIMA) then applied Geo-graphic information systems (GIS) to employed position of PHCs with elder population forecasted and compared with new model of position for access services conveniently.

2. MATERIEL AND METHODS

2.1. Logistics Management in the Health Industry

As noted, logistics refers to the process of managing the product movement system that leads to the storage process in the form of raw materials [2]. The characteristics of the products depend on the production process as well as the products that are finished and delivered to consumers efficiently. The main logistics operations are based on the 7Rs including the right product, the right place, the right time, the right quantity, the right quality, the right price, and the right conditions.

The healthcare business is a form of business that does not focus on profit, but rather on patient safety as a priority, with cost reduction being a secondary goal. Nowadays, the health business plays an important role in the society of many countries around the world. Not only does logistics help to manage the import-export of business to reduce costs, but also must take into account logistics management in the health business, which helps to manage the cost of medicines, medical supplies, medical devices, or raw materials, as well as comprehensive medical services. The scope of the health business consists of 5 main activities, namely purchasing, storage, distribution, and recall management, as shown in Figure 1.

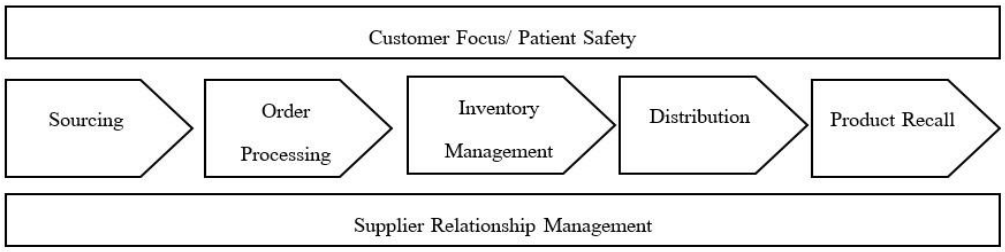


Figure 1. The logistics process in the health industry. [2]

The system for health infrastructures should include logistics to increase efficiency, especially in the distribution of medical supplies and equipment so that people can receive health services thoroughly [7]. Population growth has had more diverse impacts on urban living compared to rural areas. Particularly in public health management, it was found that there was still inadequate access to quality health services. As a result, government agencies have become concerned and prepared a response plan to accelerate the development of the health system, which is an important component of the health service system for effectively responding to and preparing for the future [8]. Toward this goal, certain aspects should be considered including: 1) Urban communities in various areas are required to have accessible healthcare services because they are densely populated and have a population of more than 10,000 people; 2) The health system is related to health service provision [8], meaning it must focus on accessibility, coverage, and quality of safety for service users. The management must be effective in protecting both social and financial risks. It also responds to the expectations of the people, including the provision of health services, health personnel, health information medical products, vaccines and technology, health finance leadership and governance; 3) Healthcare systems refers to the provision of health services to the public, consisting of activities for health promotion, disease prevention, medical treatment and health rehabilitation.

2.2. Thailand's Urban Health Service System

Globalization and socio-economic changes have affected the movements and life-styles of the Thai population, directly and indirectly affecting the health system of the Thai people as a result. The main factor affecting Thai people and their health is the urban health service system, which must be efficient and able to support the needs of the people. It must provide basic care in three main areas, comprised of 1) improving the health of the people under its care, 2) responding to people's expectations, and 3) providing financial protection against the costs of illness. An efficient health service system can respond to urban health problems. The expansion of urban communities increases the role of urban primary care systems. The current problem of the urban health service system has changed because of the healthcare behavior of the population [9]. Moreover, the adoption of an eating culture such as eating ready-made meals, and eating fewer fruits and vegetables, brings its own health problems. These problems and behaviors result in urban dwellers experiencing health problems. In addition, accessible and comprehensive health services are important to the health service system in urban areas, such as redundancies in the health service system between public and private providers, lack of integration in planning, and the network connection of health service units with limitations in terms of a less efficient referral system.

The distribution of health service units in urban areas is not covered, causing people in some areas to be unable to access health promotion and disease prevention services. Further, health services do not cover the latent population or migrant workers. This results in a lack of confidence in the quality of primary care services. Patients must travel to receive health services at city hospitals or major hospitals, causing congestion in these facilities. As a result, secondary and tertiary services lose opportunities to improve quality and efficiency, as well as the budget for the provision of health services. Therefore, all parties related to the urban health service system should work together to formulate a strategic plan and development guidelines, as well as a mechanism to drive the urban health service system to provide health services that can effectively meet the needs of the people [10].

2.3. Changes in the Aging Society in Bangkok

Bangkok has a total of 50 districts covering an area of 1,568.7 square kilometers. At present, just over 10 million people live in Bangkok, 5,666,264 of which are Bangkok residents and more than 4,263,359 are a latent population. In 2018, Bangkok had an average population density of 3,614 people per km2 when comparing the population to the area. This makes Bangkok the 37th most densely populated city in the world and the city with the highest population density in Thailand [11]. The number of elderly people in Bangkok tends to increase every year. In December 2018, it was found that Bangkok became an aged society with 1,020,917 elderly people out of the total population of 5,480,469 people, representing 18.63%, comprised of 596,009 females and 424,908 males. Most of the districts have more female elderly population than males. In addition, some areas in Bangkok have begun to become an aged society in all 3 levels, namely Aged society, Completes-aged society, and Super-aged society, which has increased in number compared to 2018. At that time, it comprised 1 area with a super-aged society, 25 areas with completely aging societies, and 24 areas with aging societies [12]. This shows that Bangkok has entered into an aging society, with some districts having completely entered into an aging society. Therefore, health service agencies must pay attention to access to health services for elderly people, especially in Bangkok, where the elderly population is the highest in Thailand [13]. Evidence shows that developing a comprehensive healthcare plan and approach to prepare for an effective aging society is essential. Both primary and secondary care units in the area play a very important role in Bangkok, with the affiliation of medical facilities providing services such as hospitals, branch health service centers accounting for 0.1%, public health service centers accounting for 2.8%, and community health centers of hospitals representing 0.1 % and private clinics representing 97 %. This shows that government agencies at the level of primary care services are inadequate [14].

2.4. Method

The research began with collecting data on the number of elderly people in Bangkok and collecting data on primary care centers, such as dots and lines. The spatial data were then analyzed by network analysis. The forecast and prediction of the future number of elderly people were analyzed by the ARIMA model, and then the data were analyzed for comprehensive services by the Dijkstra Algorithm using the geographic information sys-tem, as shown in Figure 2.

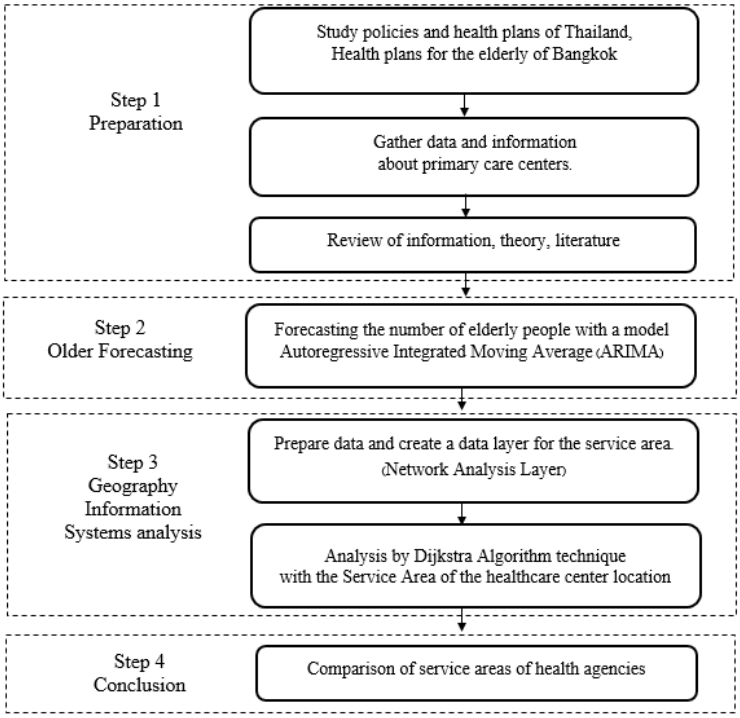


Figure 2. The research framework.

2.4.1. Autoregressive Integrated Moving Average Model (ARIMA)

The Autoregressive Integrated Moving Average Model (ARIMA) is a method for using time series data to find the most suitable model to predict the desired data by analyzing components and testing the model to obtain the most appropriate representation. The use of time series data for forecasting with the ARIMA model consists of 2 components: the analysis of historical data called the AR (Autoregressive) model, which uses 1 historical data to be used in forecasting. The second concept is the MA (Moving average) model, which is the use of past erratic values for forecasting. Both models have different concepts. When the two concepts are combined, an ARIMA model is used with data values in the past and the tolerance of past data to forecast future data [15]. Forecasting using the ARIMA method is based on the behavior of past data. It can be used to determine current patterns and be able to explain future trends or phenomena of the data itself [16]. The ARIMA model process can be divided into 3 main steps: 1) Modeling involves time series data used in the analysis that must have stationary properties with mean and variance; the nature of the union itself remains constant over time. If the data has an unstable variance, it must first be adjusted to have stabilization properties by finding the differences and comparing the characteristics of the correlation function for the Auto-correlation Function (ACF) and Partial Auto-correlation Function (PACF; 2) Model parameter estimation is the procedure for estimating the value of the ARIMA model to obtain the smallest discrepancy; 3) Model verification aims to verify that the characteristics are consistent with the accuracy of the assumptions. If not consistent, the model must be adjusted [17]. Therefore, ARIMA does ex-plain the values of data better than regression. Most of regression is used explain only data not value of it.

The equation can be written as follows:

$y_t=\delta+\emptyset_1 y_{(t-1)}+\cdots+\emptyset_p y_{(t-p)}+\varepsilon_t-\theta_1 \varepsilon_{(t-1)}-...-\theta_q \varepsilon_{(t-q)}$

by y_t is an observation of a time series at time t.

δ is a constant in the model.

ε_t is the random error at time t assuming that ε_t is an independent random variable.

The mean is 0 and the variance is constant. $\emptyset_i$ (i=1,…,p) and $\emptyset_j$ (j=1,…,q) are parameters in the model, whereas p and q are integers representing the rank of the model. If q=0, the AR(p) but if p = 0 then the MA(q) model is applied. The model is applied to forecast the labor force using the labor force survey data to estimate labor demand. ARIMA is suitable for using a single set of historical data for analysis and forecasting. In addition, the Time Series Forecasting by Tell-Jenkins Method (Box-Jenkins) applied with no fixed model in the analysis [18]. The model can be represented in the ARIMA model without seasonal influence.

This model consists of 3 parts including Auto-Regressive $AR: (p)$, Integrated (I) and Moving Average $MA: (q)$, which can be models for $ARIMA\ (p,d,q)$. The combination of these three components each has a unique predictive ability. For $AR(p)$, the model shows that the y_t observation depends on the value of the previous observations. $y_{(t-1)},...,y_{(t-p)}$. $MA(q)$ is a form that represents the y_t observation that depends on the error $\varepsilon_{(t-1)},...,\varepsilon_{(t-p)}$. Integrated (I) is the difference of time series because ARIMA requires time series data with fixed properties (Stationary) only. If the time series data used has nonstationary properties, how-ever, it must first convert the data to stable properties by finding the difference of time series data, called a natural logarithm.

$AR\ (p)$ is $Y_t=\theta_0+\varphi_1 Y_{(t-1)}+\cdots+\varphi_p Y_{(t-p)}+\varepsilon_t$ (1)

$MA\ (q)$is $Y_t=\theta_0+\varepsilon_t+\theta_1 \varepsilon_t-...-\theta_q \varepsilon_{(t-q)}$ (2)

$ARMA\ (p, d)$ is $Y_t=\theta_0+\varphi_1 Y_{(t-1)}+\cdots+\varphi_p Y_{(t-p)}+\varepsilon_t-\theta_1 \varepsilon_{(t-1)}-\theta_q \varepsilon_{(t-q)}$ (3)

$ARIMA\ (p,d,q)$ is $(\Delta^d Y)_t=\theta_0+\varphi_1 \Delta^d Y_{(t-1)}+\cdots+\varphi_p \Delta^d Y_{(t-p)}+\varepsilon_t-\theta_1 \varepsilon_{(t-1)}-\theta_q\ \varepsilon_{(t-q)}$ (4)

Equation (1) refers to a form showing that the observation Y_t depends on the value $Y_{(t-1)}$, $Y_{(t-2)}$,...,$Y_{(t-p)}$, or the observation preceding p. Equation (2) refers to the form showing that the observation Y_t depends on the tolerance $\varepsilon_{(t-1)}$ $\varepsilon_{(t-2)}$,...,$\varepsilon_{(t-3)}$, while Equation (3) is a combination of AR and MA that takes the time series data based on the values of past data and the values of past and present discrepancies. This model corresponds to the stochastic movement, in which time data changes according to the law of probability. The nature of the data used must also be stationary. Equation (4) is a combination of individual models in $ARIMA\ (p, d, q)$ suitable for past time series data into the past and present tolerances, the data properties of the applied time series must be stationary. It determined what p, d, and q values of the model should be considered from ACF and PACF by looking at a correlogram of ACF PACF, as shown in Table 3.1. Other important statistics must be considered as well [19].

Table 1. Model considerations with ACF and PACF considerations [19]

Model	ACF considerations	PACF considerations
AR(p)	curves towards the axis	only one apparent p occurs and then disappears.
MA(q)	only one apparent p occurs and then disappears.	curves towards the axis
ARMA (p,q)	curves towards the axis	curves towards the axis

To measure the accuracy of forecasting, it measured the accuracy of what can predict the data, which must be considered from MAD, MSE and MAPE values to consider whether these values are minimal [20]. It will show that the error of the forecast is low, indicating that the model used to forecast and the predicted value are reliable.

2.4.2. Geographic Information System (Geo-Information System: GIS)

Geographic Information Systems (GIS) involve a process for working with spatial data using a computer system to define data and information related to the spatial location, such as the address, house number, relative distance to a location on the map, and the latitude and longitude; this system can analyze the relationship of spatial data in many forms [21]–[23]. For example, a Geographic Information System (GIS) is a systematic approach to data collection and analysis in terms of changing times, such as the spread of epidemics, immigration, changes in the use of space, etc [21] [24]. The work process aims to store, pre-sent and analyze geographic data through a computer system. The geographic-related data consists of 1) Spatial Data with latitude and longitude coordinates by referring to the Earth, which can be either a point, a line, or an enclosed area, and 2) Attributes with data that de-scribe which buildings or objects are located in that area, including other information such as school points and the number of students, lines of roads and the number of runways, building closures and building types [25].

Data analysis for geographic information systems is different from other programs [26] because GIS will bring details of spatial data and non-spatial data for use in the analysis. Data analysis can be divided into 3 main forms: 1. Analysis of the Spatial Data requires data with geographic coordinate systems such as latitude-longitude or UTM scale to be converted into a geographic coordinate system. The analysis of this spatial data re-quires map projections with different properties depending on the purpose of use. Most maps of Thailand use Universal Transverse Mercator Projection (UTM) contours. There are many methods of analysis such as overlay techniques, mosaic, edge-matching, area, circumference, and distance calculations. Network Analysis is used to analyze spatial net-work data and best route analysis, including distance and time optimization analysis, service area, best route analysis, close facility analysis, origin-destination cost matrix analysis, vehicle routing problem analysis, and location-allocation analysis [26].

The GIS refer to an actual location on Earth. Geocodes can refer to positions either directly or indirectly, which directly reference the Earth's surface and refers to information that has coordinates or real positions in the world or on a map, such as the location of buildings and roads, which indirectly refers to information on the earth. A geographic feature can be in the form of a natural environment or a man-made environment. These are shown on the map with symbols such as point, line, area or polygon and text, which must describe the appearance with colors, symbols, and annotations [27]. There are studies on the application of geographic information systems to the

development of an aging society, such as finding the location of an elderly health center in Uttaradit Province by using quantitative and qualitative factors as data for analysis such as environmental, air and noise factors. Calculation of the distance is achieved from specified factors such as transportation routes and appropriate land use to determine the appropriate size of the number of health centers with geographic information systems to analyze the appropriate location from the actual area [28]. Moreover, the Health Center Maximum Covering Location Problem (MCLP) is used to determine the number of health centers in Malaysia and find ways to plan service coverage for the population. The study found that the existing number of health centers could provide significant coverage for the population of the country [29]. Emergency medical service areas for hospitals and volunteer rescue foundations in Chanthaburi Province carried out a network analysis on a Geographic Information System to receive medical services within 10 minutes.

In addition, an analysis is made to find alternative areas to expand the new emergency medical operation unit to cover as much as possible of the current service area. The study found that the best alternative area to increase the services can be used as a guideline for the development of the emergency medical service system, as well as a guideline for expanding the service area for emergency medical operations in the future [30]. Tools are al-so used to study the future changes in the city that will step into an aging society that re-quires access to public spaces. Infrastructure is necessary to be sufficient to support the growing population. Qualitative and quantitative tools have been applied to analyze data from elderly people aged 60 years and over living in Bangkok. A questionnaire based on the logistic regression model was used to determine the key factors that affected the mobility of the elderly. It was found that 84.2 percent of the elderly traveled to the hospital alone, without an accompanying person, using the public infrastructure [6]. In India, access to healthcare centers has to adapt to the changing dynamics of an aging society in order to reduce the stress of urbanization and support adequate medical facilities. This research aimed to maximize the healthcare coverage that takes into account the limited availability of healthcare facilities. The results show that the case study needs to add another 13 public hospitals to be able to increase to 90.05% [31]. It also shows that GIS has the ability to analyze the relationship between geographic location and access to healthcare services in terms of accessibility and proximity. GIS is a popular and efficient tool that increases the accuracy of considering or making decisions about providing services and service location-allocation effectively in existing areas [21].

2.4.3. Service Coverage Area Analysis

Network analysis is a point-to-point analysis of a point-to-point network that is characterized by a spatial network under conditions of road, distance, and duration [32]. The service area analysis technique is used to calculate the service radius from the point of interest in a specified radius according to the time or distance conditions to find the service area [30]. The analysis of this service network is based on Dijkstra's Algorithm, which is in-tended to find the edge connections of the network to be analyzed in the form of the shortest distance or the least amount of time. This service area analysis can be expressed in the form of lines and areas surrounding the object being analyzed, and thus to determine the level of the service area [33]. The new service facilities are a key to concern in ensuring healthcare accessibility. Euclidean distance is generating service coverages in the application of location problems by using GIS [34]. Service of healthcare are the most important to society. The location should be located on suitable position. The map of service area is pre-sent the hospital service area about 1500 m., so it was excluding the service area. Therefore, the new hospitals need to select the suitable locations for constructing [35].

The Dijkstra Algorithm is a fundamental mathematical approach that applies graph theory and graph mapping, using nodes and arcs instead of connected roads to determine the distance between points as a number on a weight graph [36]. The formula is as follows: Lattice $G= \{V, E\}$ where $V(G)$ is the set of nodes in G, $E(G)$ is the set of arcs in G, and d_uv is the length of the line $(u,v) \in E$, which the algorithm of [36], [37]. It is applied to an uninterrupted line that specifies the direction by the weight of every line must be at least 0, that is, $w(u,v) > 0$ for every (u,v) and define $E(G)$ and set S to be a set of vertex. Defaults to the empty set, d_v is the value of the distance from the origin to the vertex v. Q is the set of vertices that have not entered the loop, initialized to V(G). The selection of the point u to be iterated is chosen from the point in Q which has the lowest d_u value. Once selected, it removes this point from Q and puts its value in S instead by checking every point v that has a line from u to point v. If $d\_v > d\_u / w(u,v)$,

then must be replaced $d\_v = d\_u + w(u,v)$ then solve the pointer that the vertex v must come from point u iterate until Q is an empty set to get the desired shortest path [38].

3. RESULTS AND DISCUSSIONS

3.1. An Analysis of the Size of the Aging Population and Advance Toward an Aging Society

The 12th National Economic and Social Development Plan and the 20-year National Strategy focus on national reform to solve Thailand's fundamental problems, including the social aspect that the nation is entering an aging society. Thailand's health system is undergoing a transition from a rural society to an urban one. Being an aging society under the change of technological advancement, Thailand has to prepare health service quality, especially the health service system, so that people can have better health and quality of life [27]. According to a survey of the elderly population in 77 provinces throughout Thailand, it was found that Bangkok had the highest increase in the elderly population, followed by Nakhon Ratchasima Province, Chiang Mai Province, Khon Kaen Province, and Ubon Ratchathani Province, respectively [39]. From statistics by the National Statistical Office 2007-2017, it was found that the size of the elderly population had increased in all districts of Bangkok. This shows that the rate of increase in the elderly population is a warning signal to government agencies that should plan to accommodate this change, such as pre-paring service centers near service users to cover all areas, which would enable coverage for the increase in the elderly population in the future.

This research applies the ARIMA model to predict the future population of the elderly in Bangkok. Bangkok has changed the model for an aging society according to the definition by the United Nations so that it can be used to prepare plans for future support. This fore-cast uses the elderly population from 2007-2017 as a forecasting database to employ the ARIMA model to forecast the elderly population over the next 8 years. As shown in Figure 3, it can be concluded that the existing database for the elderly population can be applied to forecasting according to the current ARIMA model.

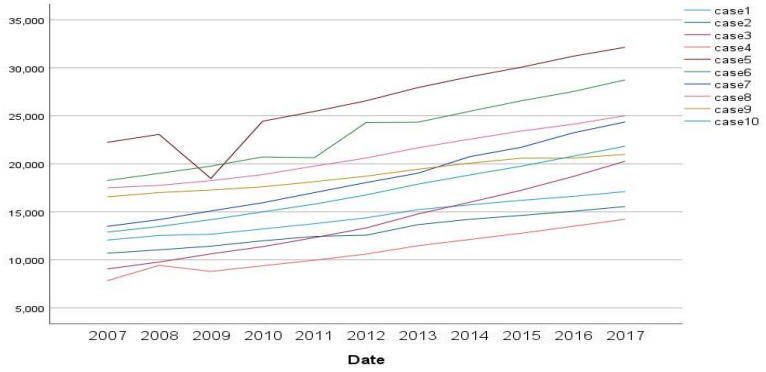


Figure 3. Examination of the characteristics of the sample data in 10 fields
Source: Researcher

A model was established from stationary time series data, with the mean, variance, and self-correlation constant over time. If the data used has a tendency or variance that is not stable, it must first be adjusted to qualify for stabilization by finding differentiations. Most of the elderly population data need to find differences of differencing values, but some data areas have stabilization properties and therefore do not need adjustment of the stabilization values. In addition, the data that can be used must compare the characteristics of the Auto-correlation Function (ACF) and Partial Function Auto-correlation Function (PACF), which can then be used to define a forecasting model. The prepared data can be used for forecasting according to the ARIMA model and then check for the model discrepancy. The parameters of the model must be used to estimate the value of the forecast model obtained from the ARIMA model to view the forecast model, and the forecast value of each field must have the least error from observing the R-squared value. Table 2 shows that the ARIMA model has a small error and an R square value that is close to 1.00. This indicates that the model is consistent in predicting the size of the elderly population close to

the actual size and the appropriate MAPE value.

Table 2. Verification of model tolerance.

Fit Statistic	Mean	Minimum	Maximum	Percentile						
				5	10	25	50	75	90	95
Stationary R-squared	.465	.465	.465	.465	.465	.465	.465	.465	.465	.465
R-squared	.994	.994	.994	.994	.994	.994	.994	.994	.994	.994
RMSE	195.812	195.812	195.812	195.812	195.812	195.812	195.812	195.812	195.812	195.812
MAPE	.530	.530	.530	.530	.530	.530	.530	.530	.530	.530
MaxAPE	2.800	2.800	2.800	2.800	2.800	2.800	2.800	2.800	2.800	2.800
MAE	73.241	73.241	73.241	73.241	73.241	73.241	73.241	73.241	73.241	73.241
MaxAE	354.751	354.751	354.751	354.751	354.751	354.751	354.751	354.751	354.751	354.751
Normalized BIC	11.936	11.936	11.936	11.936	11.936	11.936	11.936	11.936	11.936	11.936

Source: Researcher

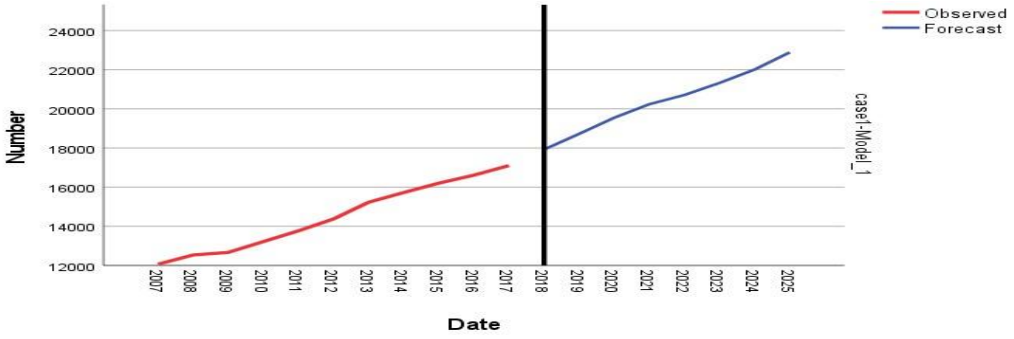


Figure 4. Forecast of the elderly population from 2018-2025
Source: Researcher

From Figure 4., it was found that the model values defined by ARIMA can be used to predict the number of elderly people in the future; when compared to the pre-prediction value, it was found that the trend of the elderly population was consistent and the error was minimal. Therefore, the forecasting data for the elderly population derived from this ARIMA model could be used to analyze the potential increase in the elderly population.

Table 3. ARIMA (p,d,q) models for forecasting the elderly population

District	ARIMA			R-squared	RMSE	MAPE	MAE
	p	d	q				
1.Khlong Toei	4	1	0	0.994	195.812	0.530	73.241
2 Khlong San	4	1	1	0.988	305.147	0.929	118.938
3 Khlong Sam Wa	3	1	0	0.999	114.332	0.516	70.608
4 Khan Na Yao	5	1	0	0.926	887.267	3.123	309.921
5 Chatuchak	3	1	2	0.767	3471.64	5.200	1167.77
6 Jomthong	5	1	2	0.964	1960.17	1.769	386.032
7 Don Mueang	1	1	1	0.998	187.374	0.548	110.25
8 Din Daeng	3	1	0	0.998	142.673	0.391	78.78
9 Dusit	5	0	1	0.995	198.038	0.485	92.102
10 Talingchan	4	1	0	1.000	85.299	0.253	40.397
11 Taweewattana	3	1	0	1.000	44.725	0.221	21.958
12 Thung Khru	2	1	0	1.000	65.19	0.308	40.808

13 Thonburi	4	1	0	0.997	164.625	0.438	83.531
14 Bangkoknoi	3	1	0	0.998	142.046	0.347	73.049
15 Bangkok Yai	5	1	1	0.998	146.702	0.426	51.476
16 Bangkapi	4	1	0	0.999	163.344	0.426	79.08
17 Bang Khun Thian	5	1	0	0.999	211.179	0.680	105.849
18 Bangkhen	4	1	0	0.999	184.774	0.373	84.234
19 Bang Kho Laem	2	1	1	0.991	253.818	0.846	118.412
20 Bang Khae	2	1	2	0.998	278.134	0.352	86.234
21 Bang Sue	5	1	2	0.986	874.087	0.939	213.794
22 Bangna	1	1	0	1.000	3177.57	11.592	161.848
23 Bangbon	2	1	0	0.998	128.464	0.652	69.923
24 Bang Phlat	5	1	0	0.998	167.926	0.411	72.946
25 Bang Rak	5	1	0	1.000	2642.54	11.857	916.201
26 Bueng Kum	5	1	0	0.999	176.162	0.465	81.164
27 Pathumwan	5	1	0	0.991	139.308	0.705	53.878
28 Prawet	2	1	0	0.999	155.226	0.464	84.57
29 Pom Prap Sattru Phai	4	1	0	0.998	80.524	0.477	43.135
30 Phayathai	2	1	0	0.996	90.783	0.562	60.329
31 Phra Khanong	3	1	0	0.996	174.98	0.604	89.767
32 Phra Nakhon	6	1	0	0.997	137.395	0.402	40.987
33 Phasi Charoen	1	1	0	0.996	202.665	0.647	127.548
34 Minburi	2	1	0	0.999	111.865	0.557	69.639
35 Yannawa	4	1	0	0.997	145.773	0.510	59.837
36 Ratchathewi	4	1	3	0.981	452.221	0.925	96.648
37 Ratburana	4	1	0	0.996	159.246	0.723	84.437
38 Ladkrabang	2	1	0	0.997	213.792	0.667	101.862
39 Ladprao	1	1	0	0.999	130.106	0.473	83.607
40 Wangthonglang	5	1	0	0.999	147.318	0.402	59.671
41 Wattana	5	1	1	0.997	177.479	0.451	63.005
42 Suanluang	5	0	0	0.999	160.655	0.452	62.713
43 Saphan Sung	5	0	0	0.998	168.146	0.686	58.738
44 Samphanthawong	1	0	2	0.924	232.21	2.282	118.054
45 Sathorn	1	0	2	0.962	608.778	2.413	293.725
46 Saimai	5	0	0	0.998	294.081	0.702	127.231
47 Nong Khaem	5	0	0	0.999	190.76	0.51	70.315
48 Nong Chok	5	0	0	0.997	264.083	0.988	121.568
49 Laksi	4	0	0	0.999	123.336	0.382	60.372
50 Huai Khwang	7	0	0	0.994	314.779	0.767	78.142

Source: Researcher

Table 3 shows the ARIMA model used to forecast the size of the elderly population in 50 districts of Bangkok. There are 10 areas where the data are stationary without making a difference, namely Dusit, Suan Luang, Sapan Sung, Samphanthawong, Sathorn, Sai Mai, Nong Khaem, Nong Chok, Lak Si, and Huay Kwang, and the data

consistency of R-square values. At a level close to 1.000, it indicates that the predicted value is close to the actual data.

Table 4. Comparison of the size of the elderly population forecasted by the ARIMA model

District	Number of elderly from ARIMA		Difference elderly population	Times
	2018	2025		
1 Khlong Toei	31,847	45,877	14,030	1.4
2 Khlong San	26,192	38,865	12,673	1.5
3 Khlong Sam Wa	52,691	115,541	62,850	2.2
4 Khan Na Yao	28,850	54,964	26,114	1.9
5 Chatuchak	55,880	75,564	19,684	1.4
6 Jomthong	52,886	80,734	27,848	1.5
7 Don Mueang	51,771	95,001	43,230	1.8
8 Din Daeng	44,453	63,389	18,936	1.4
9 Dusit	34,960	38,046	3,086	1.1
10 Talingchan	39,785	69,271	29,486	1.7
11 Taweewattana	28,621	57,180	28,559	2.0
12 Thung Khru	38,219	72,693	34,474	1.9
13 Thonburi	40,509	54,748	14,239	1.4
14 Bangkoknoi	43,055	60,424	17,369	1.4
15 Bangkok Yai	25,502	35,369	9,867	1.4
16 Bangkapi	47,577	80,386	32,809	1.7
17 Bang Khun Thian	51,088	105,440	54,352	2.1
18 Bangkhen	62,923	107,020	44,097	1.7
19 Bang Kho Laem	31,630	47,066	15,436	1.5
20 Bang Khae	66,994	120,250	53,256	1.8
21 Bang Sue	48,032	70,664	22,632	1.5
22 Bangna	31,037	47,716	16,679	1.5
23 Bangbon	31,959	57,055	25,096	1.8
24 Bang Phlat	36,559	52,102	15,543	1.4
25 Bang Rak	15,529	21,271	5,742	1.4
26 Bueng Kum	48,065	80,856	32,791	1.7
27 Pathumwan	15,987	20,063	4,076	1.3
28 Prawet	50,103	97,758	47,655	2.0
29 Pom Prap Sattru Phai	18,250	20,663	2,413	1.1
30 Phayathai	22,536	30,792	8,256	1.4
31 Phra Khanong	32,352	47,018	14,666	1.5
32 Phra Nakhon	19,766	22,169	2,403	1.1
33 Phasi Charoen	44,196	72,551	28,355	1.6
34 Minburi	40,726	77,894	37,168	1.9
35 Yannawa	27,089	44,666	17,577	1.6
36 Ratchathewi	22,162	32,808	10,646	1.5
37 Ratburana	27,751	41,947	14,196	1.5
38 Ladkrabang	48,129	93,388	45,259	1.9
39 Ladprao	41,882	68,871	26,989	1.6
40 Wangthonglang	36,577	57,309	20,732	1.6
41 Wattana	26,094	38,616	12,522	1.5
42 Suanluang	37,434	63,967	26,533	1.7
43 Saphan Sung	30,846	56,338	25,492	1.8
44 Samphanthawong	10,101	11,003	902	1.1
45 Sathorn	30,105	43,849	13,744	1.5
46 Saimai	63,043	120,783	57,740	1.9
47 Nong Khaem	48,346	90,087	41,741	1.9
48 Nong Chok	43,939	90,320	46,381	2.1
49 Laksi	37,783	59,033	21,250	1.6
50 Huai Khwang	25,433	43,350	17,917	1.7

Source: Researcher

Table 4 shows a forecast of the elderly population using the ARIMA model. It was found that the number of elderly in 2025 increase more than 2018. The tendency to increase is in all districts, with the districts expected to increase the most being Khlong Sam Wa District, with 2.2 times, followed by Bang Khun Thian District and Nong Chok District with 2.1 times, and Thaweewattana District likely at 2.0 times. Therefore, it is very important to prepare a

contingency plan with Bangkok. Because it is likely becoming an aging society in the near future.

3.2. Analysis of Changes in the Aging Society in Bangkok

The principles of the United Nations define the term of elderly to analyze the changes in the aging society from the forecasted population [40]. To study the changes in the aging society among 50 districts in Bangkok, 3 forms were considered: Super aged society, Completes aged society, and Aged society. Considering the size of the elderly population com-pared to the total population of each district according to the United Nations division principle, it shows that the transition from the aging society to the apex and aging period is more complete. It can be seen that the numbers of the elderly in the aging society from the original 24 districts are Nong Chok, Bang Khen, Bang Kapi, Min Buri, Lat Krabang, Bang Khun Thian, Nong Khaem, Phaya Thai, Huai Khwang, Rat Burana, Bueng Kum, Prawet, Khet Suan Luang, Don Mueang District, Bang Khae District, Sai Mai District, Khan Na Yao District, Saphan Sung District, Wang Thong Lang District, Khlong Sam Wa District, Bang Na Dis-trict, Thawi Watthana District, Thung Khru District and Bang Bon District. When analyzing the data for the year 2025, it was found that the size of the aging so-ciety had decreased, remaining in 6 districts, namely Min Buri, Nong Khaem, Lat Krabang, Sai Mai, Khlong Sam Wa, and Nong Chok. It shows that the number of elderly people in Bangkok tends to increase every year, causing each district to change its societal patterns to fit with the pattern of the increasing number of elderly people. Figure 5 shows the trans-formation of the aging society into a more complete aging society in the area of the case study. It shows that the public and private sectors involved in the healthcare of the elderly must be given more importance.

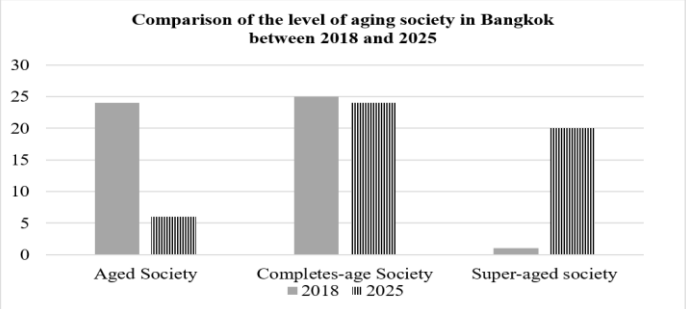


Figure 5. Number of districts that have changed in terms of the aging society
Source: Researcher

From the analysis, it was found that the number of elderly people in Bangkok tends to increase every year. Therefore, the potential for Bangkok to become a super-aged society in every district. It is possible in a short time. Therefore, it is imperative to prepare a health service plan. It needs to speed up the development and management of the system accordingly. In response to the changes in the aging society, this approach may have to take into account all provinces of Thailand, not only Bangkok.

3.3. Primary Healthcare Centers for the Aging Society

3.3.1. PHCs Model Service Coverage in Bangkok

This research applied GIS to analyze the service coverage after forecasted elderly population in 50 districts (a). The map of PHCs positions shows in each district as Figure 6. The points shows the locations of the PHCs, with 68 represented by a symbol and another 77 branch health service centers, represented by symbols (b). Thus, the health service centers account for a total of 145 locations (points) to support patients in Bangkok. They are obligated to take on more duties related to taking care of the elderly.

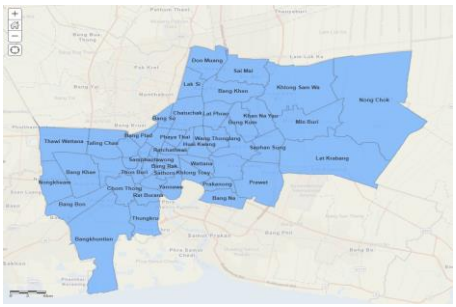
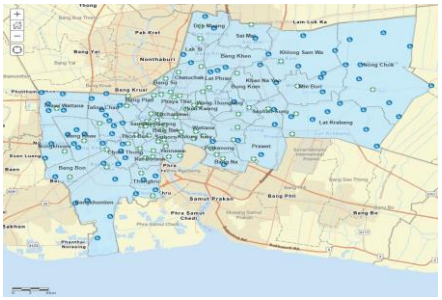
(a)  (b) 

Figure 6. Schematic showing (a) 50 administrative districts in Bangkok (polygon) and (b) point of PHCs model in Bangkok

Source: Researcher

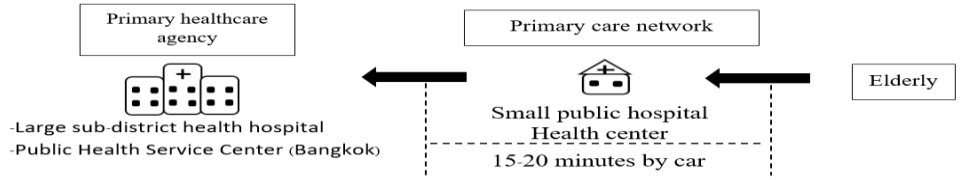


Figure 7. Management style to support the current aging society.

Source: Researcher

PHCs Model, the elderly must travel to the main hospital/clinic by car. They can receive treatment and checkups at 145 health centers within 20 minutes as shown in Figure 7. These map is considering traveling by car, found that it can provide services to the elderly covering all areas of 50 districts in Bangkok.

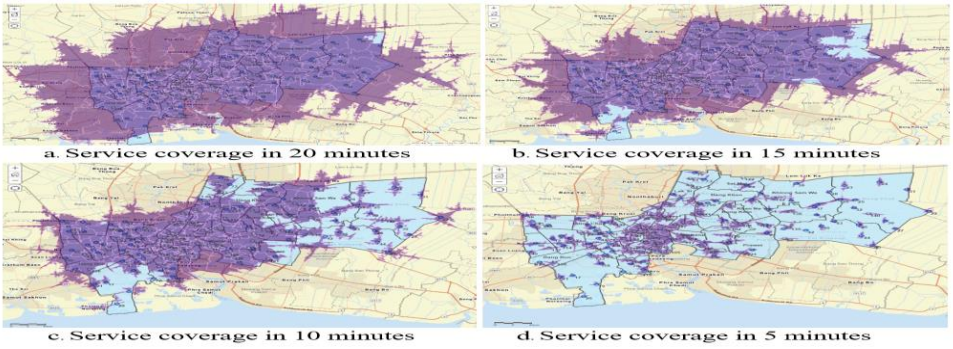


Figure 8. Boundaries for service areas that can be reached by car at different times.

Source: Researcher

On the other hand, if the service area levels of health centers reduced access times in 15 minutes, 10 minutes, and 5 minutes for faster access for the growing elderly density. It was found that in the 10 minute (c.) and 5 minute (d.) periods, the PHCs system was still unable to provide sufficient services, as shown in Figure 8. The limitation of PHCs service access in Bangkok is the problem to health service of elderly. It should have a shorter travel time to reach the health center faster. Thus, there needs to be an increase in the number of health centers. For the elderly can receive treatment and follow-up more conveniently. The new planning of health service should be two sided. The first aspect is the elderly can travel to a health center near their residence in a short period. The second aspect is medical personnel can travel closely to monitor the symptoms of the elderly. According to the limited of number of health centers available, the elderly can only also travel to the health center within 15-20 minutes by car. In the

future, the 145 PHCs is an obstacle for the elderly, if the number of health centers remains the same but the number of elderly people increases. It is difficult to serve health service to elder in shortly. It is still a limitation on the number of health centers. It is showing that if the travel time was shortened, the service centers would not be able to cover the entire area. In addition, there may be obstacles concerning the congestion in the hospital as well.

3.4. Guidelines for Access to Health Centers in The Future for an Aging Society

The development of access to health services of the elderly should be studied in terms of responding to accessibility by walking rather than by car. The health centers are located in community areas by visiting the elderly in residential homes. It can increase the need for mobility by the elderly for convenience. The walking time is to access urban facilities to meet the needs of urban residents, such as public service. It is creating a habit of walking for people in the community and access to health services by walking within 15 minutes [1]. It can be regarded as a walking period suitable for all ages. So, it is a suitable time for participating in activities and walking to places in the community. It is also appropriate for preparing a designated facility. For example, population service centers prepare for prevention, relief, surveillance, and supporting facilities to help when there are serious situations such as epidemics, natural disasters, etc.

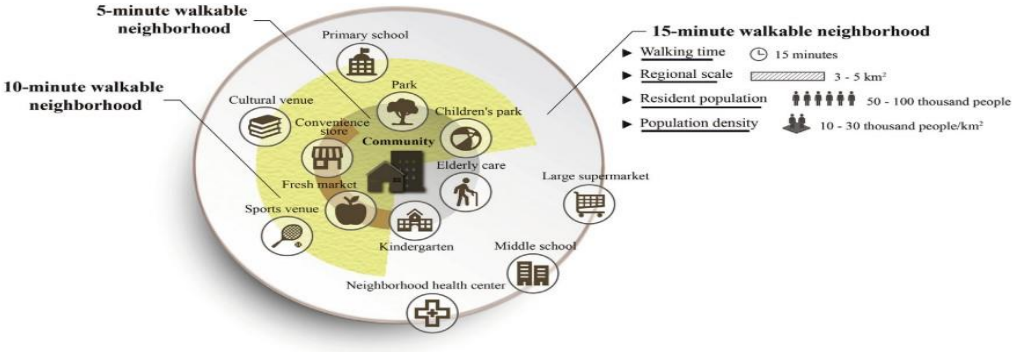


Figure 9. Diagram showing the walking times to access facilities in the community [1]

Figure 9 shows the service area coverage of the facilities. So, people in the community can walk to various locations for services. Determining the location of the facilities appropriately and in accordance with the right time is necessary. That residents can receive services thoroughly and conveniently within in 5 minutes, it is a facility that is very close to the residents of the community, such as elderly care center, small shopping mall, grocery store, park, and playground etc. Moreover, if considering a 10-minute period, it is a sports facility, kindergarten, etc. So, it is accessible a 15-minute walk. The main hospital, large school and department stores. This guideline is the preparations for planning to support an aging society in the future. The government and related agencies should take into account situations where the elderly are alone or without their children to take care of them. Short-term access is essential for care, treatment, and follow-up visits to elderly residents. So, they can receive services in two ways: 1) Travel to receive services at the health center, and 2) Follow-up visits at the residences of the elderly by medical personnel.

In this research, the model of access by walking time was analyzed in the form of a service area analysis using the Dijkstra algorithm. It was found that 145 health centers could not provide comprehensive services to communities. When Bangkok would become an aging society in the future and due to the limited number of PHCs. Through the COVID-19 situation, Thailand has managed care effectively, including a policy to distribute antigen test kits. So, the public can access the COVID-19 test thoroughly. The government plans to distribute testing kits to primary healthcare channels and cooperate with government. They are registered pharmacies to help disseminate the kits to people in a more thorough and accessible way from the Covid-19 vaccine distribution model (CVDMs).

Based on this policy, the researchers have adopted guidelines diagram on Figure 9, it is increasing the efficiency of access to basic treatment services, follow-up visits, and receiving medicines for the elderly. They can

receive comprehensive medical services and travel in a short and convenient time. In addition, many countries nowadays use technology to manage health services. It is more effective access to the community health system. It can be reducing hospital visits by using symptomatic hospital services as monitor symptoms and receive medication. The Republic of China is developing a futuristic medical platform called Ping a Good Doctor. Because the rate of medical personnel is only 20 per 10,000 people, China is considered to have a relatively small proportion if compared to other developed countries. China is applying artificial intelligent (AI) to medical services to analyze existing illnesses by setting up automated, unmanned clinics. They are linked to more than 3,000 clinics and hospitals in the event. It is required for a patient assessed as having a serious illness [42]. China also has an increasing elderly population. It can be considered the development plan. It can be applied to Thailand. The point of health care service of aging should be concerned in 5-minute walk, which is suitable for elderly people who can walk to receive treatment from a community health center [1]. Therefore, the researchers applied the guide-lines and designed a PHCs model with CVDMs in Bangkok to increase the efficiency of service accessibility.

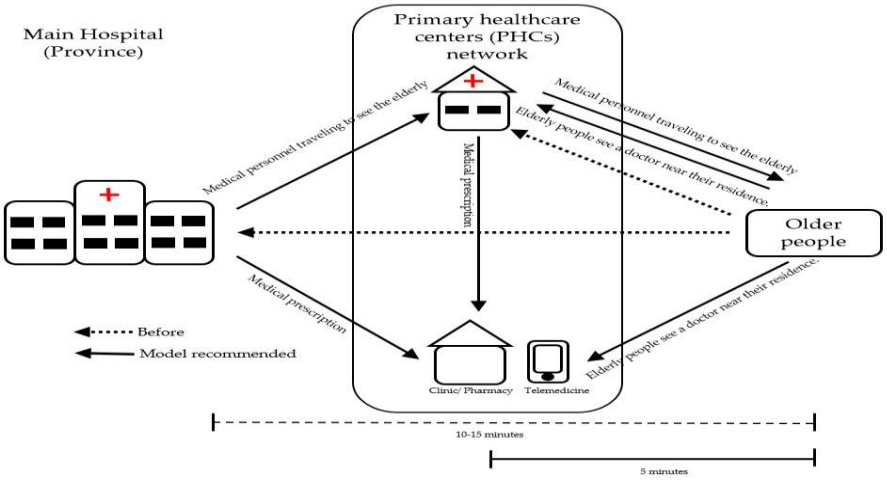


Figure 10. Management styles to support the aging society in the future

Source: Researcher

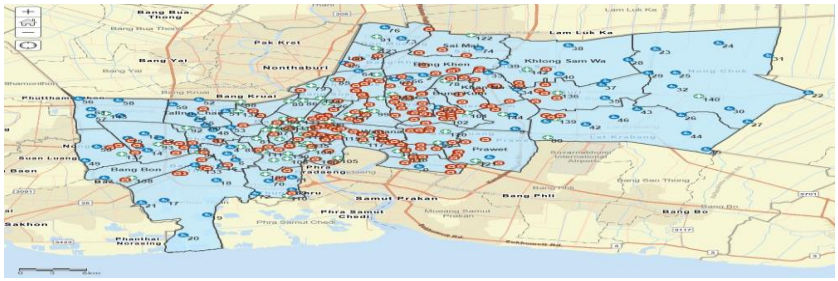
3.4.1. CVDMS with PHCs Model Service Coverage in Bangkok

Initially, the database management system must analyze the elderly population, categorizing it into those with mild symptoms, those with remission, and those being monitored for symptoms or receiving medication. This type of elderly patient can initially see a doctor via Telemedicine to reduce the travel time to the hospital. It can reduce the waiting time at the hospital. This kiosk should be installed in a position near a pharmacy. Once the elderly has met a doctor, they can either pick up medicine from the cabinet or get a prescription and take it to a pharmacy. Drug dispensing is safe because it is dispensed by a pharmacist. If an elderly person with severe symptoms needs to go to the hospital, how-ever, it can take 10-15 minutes to travel on foot or by car.

Increasing options for the elderly and guidelines for monitoring symptoms are needed by bringing clinics, and pharmacies to support medical and healthcare services by government agencies as well as creating a healthcare network by considering treatment patterns. For example, elderly people who need urgent treatment and have symptoms for the first time can travel for treatment at a major hospital. On the other hand, elderly people can receive services at a health center near their residence if only for monitoring symptoms or taking medication. In addition, this approach can be used to order medicines from a doctor to receive medicines at clinics and pharmacies that participate in the government project.

The researchers used the limitation on the number of existing 145 health centers to study the management model to support the aging society in the future, as in Figure 10. The researchers used CVDMs of the 191 government registered clinics and pharmacies participating in the ATK test kit distribution project to be the new

locations as a guideline to in-crease the number of health centers (145 PHCs with 191 CVDMs) in Bangkok. Preparing a plan to cope with the change in the increasing elderly population was carried out by determining the locations of 191 pharmacies and remote kiosks, as shown by the symbols in Figure 11.



Locations of clinics and pharmacies

Figure 11. Locations of CVDMs with PHCs service centers

Source: Researcher

A simulation of the increase in CVDMs with PHCs positions in project was done to support the future model of health services for the elderly. Building cooperation with clinics and pharmacies is another way to expand the service area more comprehensively. In this research, the service area was analyzed by the GIS using the Dijkstra Algorithm by determining the distance of access by walking at 5 minutes, 10 minutes, and 15 minutes according to the PHCs model [1] to compare with the CVDMs with PHCs model.

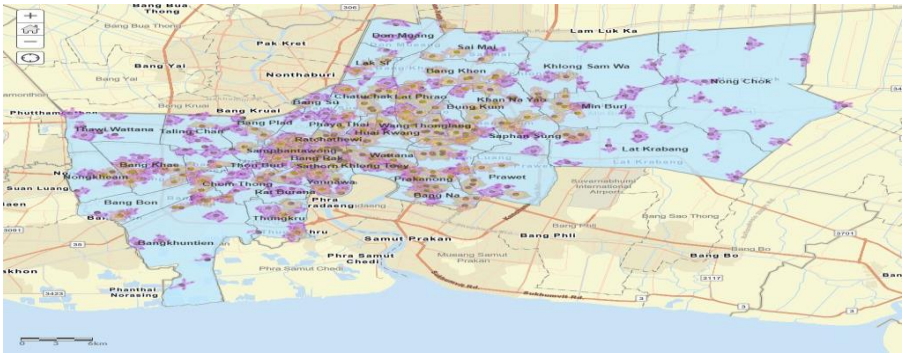


Figure 12. Service areas for health centers based on CVMDS with PHCs model

Source: Researcher

From the original 145 PHCs and 191 CVDMs, show a number of health service center that will be support of aging society on 2025. It is increasing an effective of 2-way health service. In a short planning of the government, it can be covered more areas in Bangkok, as shown in Figure 12.

Table 6. Comparison of service areas PHCS and CVDMS with PHCS model

Walk Minutes	Service Area Comparison		Increase Service Coverage Area (%)
	PHCs Service Model (%)	CVMDs with PHCs Service Model (%)	
5	3.14	7.48	4.34
10	9.31	21.09	11.78
15	17.88	38.23	20.35

Source: Researcher

Table 6 shows a comparison of the PHCs model with CVMDs with PHCs model can support the aging society in the future. The CVMDs with PHCs model can cover a service for the elderly population in Bangkok. If compared to a 5-minute walk, the PHCs model can cover an area of 3.14 percent. The CVMDs with PHCs model can cover more area, representing 7.48 percent, an increase of 4.34 percent. If compared to a 10-minute walk, the PHCs model can cover 9.31 percent of the area, while CVMDs with PHCs model can provide services covering more area, representing 21.09 percent, an increase of 11.78 percent. If com-pared to a 15-minute walk, the PHCs model can cover 17.88 percent of the area. The CVMDs with PHCs model can provide services covering more area, representing 38.23 percent, in-creasing to 20.35 percent. The data shows that an increase in the network of clinics and pharmacies. A service points reach the elderly at the appropriate walking time. It would enable covering the service area to accommodate an aging in Bangkok. It can also help re-duce the travel time for the elderly to go to the hospital. It also decreases the waiting time for the elderly to see a doctor. It can also be used as a guideline to reduce future hospital over-crowding, an issue faced by most developed countries.

The of healthcare logistics is important to prepare hospitals service close in community areas. So, they can provide PHCs to support society in the future. But the PHCs must be accessed quickly and conveniently. The locations must also be taken into account, meaning places where patients will be able to receive treatment with convenience and satisfaction [4]. The PHCs in Bangkok is still less than effective. The problem is the PHCs still unable to support the increasing need for services to the aging society in Bangkok. Therefore, the accessing to PHCs is necessary for increasing the efficiency of service. It has played an important role in setting guidelines for increasing the number of health centers

Moreover, convenient access to services for the elderly and service areas according to the guidelines of the health logistics management system was studied by examining the size of the elderly population. It was found that the number of elderly people is increasing every year. This study forecasted the size of the elderly population between the years 2018-2025. The analysis found the size of elderly people in 50 districts would increase from 2018.

The increase in the number of elderly tends to occur in every district. The area with the highest tendency for the elderly is Khlong Sam Wa District, which tends to increase by 2.2 times. Bang Khun Thian District and Nong Chok District tend to increase by 2.1 times, while Thawi Watthana District is likely to increase by 2.0 times. It shows the number of elderly people in 2025 are increased. It means there are who need medical services at primary care facilities. The service area with PHCs model in Bangkok provides services covering an area of 1,568.79 square kilometers, which is all of Bangkok. It was found that the level of service and access by car in 20 minutes and 15 minutes can provide services covering all areas. It can respond to serving the elderly until future. But, traveling 10 minutes and 5 minutes by car still does not meet the service coverage area. The accessing health centers by walking is necessary to reduce the travel time of the elderly. Thus, the elderly should be able to travel by themselves from their residences. If walking, the elderly should be able to receive comprehensive services. However, the study found that it took the elderly more than 30 minutes to walk PHCs model.

The findings in this study can be a guideline for preparing plans to support the aging society in the future. The model of CVDMS with PHCs has been studied to support the existing 145 PHCs in Bangkok, leading 191 CVDMS to support the access of the elderly by walks at 5 minutes, 10 minutes and 15 minutes. This study found that using the CVDMS with PHCs model can reach health service coverage area of the elderly population in Bangkok. If compared to a 5-minute walk, the PHCs model can provide service coverage of 3.14 percent. However, the CVDMS with PHCs model can provide services covering in-crease of 7.48 percent, totally an increase of 4.34 percent. If compared to walking in 10minutes, the PHCs model can cover 9.31 percent of the area, but the CVDMS with PHCs model can provide service covering increase of 21.09 percent, up by 11.78 percent. In addition, if compared to walking in a 15-minute period, the PHCs model can cover 17.88 per-cent of the area, while the CVDMS with PHCs model can provide service covering an additional area of 38.23 percent, an increase of 20.35 percent.

CONCLUSIONS

The concept of bringing a network of clinics and pharmacies to help support medical services by government agencies will enable an increase in service accessibility. If an elderly person needs treatment with symptoms for the first time, they can travel to the main hospital for treatment. If it is to follow up on symptoms or receive medication, however, the elderly person can receive services at a health center near their residence. If the elderly want to receive prescription drugs from a doctor, they can bring their prescriptions to receive drugs at CVDMS. This is also an advantage for the elderly to consult directly with the pharmacist. Database management thus requires the analysis of elderly patients into classes comprising mild, remission, follow-up, and drug intake. Elderly of the mild type can initially see a doctor from a telemedicine kiosk to reduce traveling time and waiting time to the hospital. If an elderly person with severe symptoms needs to go to the hospital, it can take 10-15 minutes to travel. The results can also be used as a guideline to reduce potential hospital overcrowding, which is a problem suffered by most developed countries. Government agencies should study the most appropriate locations for health service centers to increase the number of health centers in the future and thus increase service efficiency. In addition, preparations should be made for the provision of services that suitable for increasing in the size of elderly population. Therefore, government and private agencies should work together to create a health service coverage network. It can reach health service of the elderly in the community more effectively. This takes into ac-count the services that the elderly travel to receive medical service by personnel. They can visit the elderly at their homes. In addition, government agencies should organize training as well as build knowledge and understanding for medical personnel, including the recruitment of volunteers to attend training on elderly care in order to cope with the aging society in the future.

REFERENCES

[1] M. Weng et al., “The 15-minute walkable neighborhoods: Measurement, social inequalities and implications for building healthy communities in urban China,” J. Transp. Heal., vol. 13, no. 129, pp. 259–273, 2019, doi: 10.1016/j.jth.2019.05.005.

[2] Narongrit Galaput, “Healthcare Logistics,” J. Hematol. Transfus. Med., vol. 20, no. 3, pp. 165–168, 2010.

[3] Ministry of Public Health, “Twenty-Year National Strategic Plan for Public Health (2017-2036),” 2018. [Online]. Available: http://164.115.27.97/digital/files/original/2ddc0ac1ececa4c666af70165c23e011.pdf.

[4] Asia Pacific Observatory on Health Systems and Policies, “The Kingdom of Thailand Health System Review,” 2015.

[5] S. Srivanichakorn, “Over-crowding Problems in Hospitals,” Inst. Heal. Syst. Res., vol. 4, no. 1, pp. 216–223, 2007.

[6] S. Srichuae, V. Nitivattananon, and R. Perera, “Aging society in Bangkok and the factors affecting mobility of elderly in urban public spaces and transportation facilities,” IATSS Research, vol. 40, no. 1. pp. 26–34, 2016.

[7] A. Schnake-Mahl, J. A.R.Willoams, B. Keppard, and M. Arcaya, “A public health perspective on small business development: A review of the literature,” Journal of Urbanism, vol. 11, no. 4. pp. 387–411, 2018.

[8] Strategy and Planning Division, “Urban health service system strategy (2018-2027).” Social Communication Group Office of the National Health Commission, Bangkok, pp. 1–10, 2019.

[9] B. Sasiwimon, T. Pimrat, K. Kainapa, and K. Monpanee, “Health Status and Heakth Service Accessibility: Samsen Community,” J. Boromarajonani Coll. Nursing,Bangkok, vol. 33, no. 2, pp. 54–63, 2017.

[10] M. of P. H. Strategy and Planning Division and the Health District Office 1-13, “Thailand Regional Health Profile 2012-2017,” 2012.

[11] K. Elzy, “75,000 people per square mile? These are the most densely populated cities in the world,” USA TODAY, 2019.

[12] Public Health and Environment Strategic Division, “Report on the elderly in Bangkok from the population base in the civil registration system as of December 2018 and compared with the data as of December 2017,” 2019.

[13] Department of Older Persons (DOP), “Statistical data on the number of elderly people in Thailand,” 2022.

[14] M. of P. H. Office of the Permanent Secretary, “General information health service area Bangkok.” pp. 4–15, 2008.

[15] G. Higgs, “A literature review of the use of GIS-based measures of access to health care services,” Heal. Serv. Outcomes Res. Methodology., vol. 5, no. 2, pp. 119–139, 2004.

[16] BMA GIS Center, “Application of Bangkok Geographic Information System in the field of geographic information systems through the central internet system,” Bangkok GIS, 2018.

[17] C. B. Oscar Rodríguez-Espíndola, Pavel Albores, “GIS and optimization: Potential benefits for emergency facility location in humanitarian logistics,” Geosci., vol. 6, no. 2, 2016.

[18] J. M. Holguin, D. A. Escobar, and C. A. Moncada, “Access to Emergency Medical Services: An Urban Planning Methodology for the Generation of Equity,” Glob. J. Health Sci., vol. 10, no. 6, p. 181, 2018.

[19] N. Thongkham, “Potential Site Analysis for a New Mail Center of Thailand Post Company Limited in The Upper North Region,” Master Thesis, Chulalongkorn University, 2016.

[20] Geographic Information Technology Center Bangkok, “GIS Data Analysis,” BMA GIS Center, 2018.

[21] HealthCare System Division, “Health Service System Plan,” Information and Communication Technology Center, Office of the Permanent Secretary, Ministry of Public Health, 2012.

[22] J. Leangkolkit, “Elderly Care Center Area Selection in Uttaradit Province,” Chulalongkorn University, 2012.

[23] S. S.S. Radiah, M. Noor Hasnah, and O. Mohd, “Location allocation modeling for healthcare facility planning in Malaysia,” Comput. Eng., vol.

62, pp. 1000–1010, 2012.

[24] I. Hongsiritham and T. Panbamrungkij, “GIS-based network analysis for the expansion of service areas of emergency medical service unit during night time in Chantaburi Province,” Naresuan Univerrsity Journals, vol. 11, no. 1, pp. 116–128, 2018.

[25] R. Basu, A. Jana, and R. Bardhan, “A Health Care Facility Allocation Model for Expanding Cities in Developing Nations: Strategizing Urban Health Policy Implementation,” Appl. Spat. Anal. Policy, vol. 11, no. 1, pp. 21–36, 2018.

[26] Solution Center Minitab, “ARIMA (Fitting an ARIMA Model),” National Productivity Institute, 2019.

[27] K. D. Lawrence, R. K. Klimberg, and S. M. Lawrence, Fundamentals of Forecasting Using Excel, no. 1. 2009.

[28] Y. Chalamwong, “A study to review the need for manpower for production planning and human resource development of the country,” 2016.

[29] T. Akarapin and J. Chearnkaitpradab, “Applying The Technical Time Series Model for Forecasting Payment Transaction; Volume through on Mobile Banking,” 2020.

[30] J. Nahar, E. Hertini, and A. K. Supriatna, “Application of GARCH model in the price inflation of foodstuff in West Java,” J. Phys. Conf. Ser., vol. 1722, no. 1, 2021.

[31] S. Jitrat and N. Chancharat, “Accuracy Comparison in the Stock Exchange of Thailand: A Case study of Information Technology and Communication Forecasting between ARIMA Model and E-GARCH Model.,” in The 5th STOU Graduate Research Conference, 2015, pp. 1–12.

[32] K. Oh and S. Jeong, “Assessing the spatial distribution of urban parks using GIS,” Landsc. Urban Plan., vol. 82, no. 1–2, pp. 25–32, 2007.

[33] ESRI, “Algorithms used by the ArcGIS Network Analyst extension,” ArcGIS for Desktop, 2016.

[34] P. Klawwikarn and S. Jirakajohnkool, “Application of Geographic Information Systems for Service Area Analysis of Emergency Medical Service Centers in Loei Province,” Thai J. Sci. Technol., vol. 3, no. 3, 2014.

[35] E. W. Dijkstra, “A Note on Two Problems in Connexion with Graphs,” Numer. Math., vol. 1, no. 1, pp. 269–271, 1959.

[36] W. Kongyong, “A Feasibility Study of a School Bus System Project in Hatyai Municipality,” Master Thesis, Prince of Songkla University, 2012.

[37] National Statistical Office, “The 2015 Core Social Indicators,” Thailand, 2015.

[38] V. Leesmidt and S. Chunharas, “The Appropriate Roles of the Ministry of Public Health within Health Care Decentralization,” 2010.

[39] Bottomliners, “Ping an Good Doctor, the medical platform of the future,” 2020.

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