TIME DISTANCE MINIMIZATION CONTRACTING UNIT FOR PRIMARY CARE SERVICE USING GEOGRAPHICAL INFORMATION SYSTEM: CASE STUDY NAKHONNAYOK PROVINCE

SOMCHAI SAENGSAWANG

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ABSTRACT

The universal coverage health policy of Thailand is a new arrival, one aimed to provide primary care as a fundamental aspect of health service. The primary care unit (PCU) will integrate health care, health promotion and disease prevention. The primary health care will join hands as provider networks aimed to help patients get health services from Contracting Units for Primary Care (CUP) more conveniently. This research is aimed for generating suitable zoning of Contracting Units for Primary care service in Nakhonnayok province by employing data from 2008 from all concerned agencies. The data employed for this study covers average speed of each type of transportation route, u-turn, transportation direction, waiting time of people in each CUP and commuting time spent from each PCU to CUP. Geographical information system (GIS) Extension Network was employed for analyzing and mapping time spent for each CUP accessibility.

The research findings show that time minimization for accessing each CUP can be made possible through moving 10 PCUs to be under the responsibility of a new CUP. By comparing the current method with the newly approved one, the findings reveal that time spent accessing service varies between 0.06 mins to 7.10 mins. In addition, the ratio of medical doctors and nurses per head of population has changed according to the newly approved system, but the change is not greater than the current manpower.

KEY WORDS: GIS/ Contracting Units for Primary Care / Primary Care Unit /NETWORK ANALYSIS

80 pages

การใช้เวลาที่สั้นที่สุดของการเข้าถึงการบริการกับหน่วยคู่สัญญาบริการปฐมภูมิโดยการประยุกต์ใช้ระบบภูมิสารสนเทศ กรณีศึกษา จังหวัดนครนายก

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บทคัดย่อ

นโยบายการสร้างหลักประกันสุขภาพถ้วนหน้า เป็นนโยบายใหม่ของประเทศ หลักประกันสุขภาพให้ความสำคัญกับการมีและใช้หน่วยบริการระดับต้น เป็นจุดบริการด่านแรก อันได้แก่สถานีอนามัยซึ่งจะทำหน้าที่ให้บริการแบบผสมผสาน ด้านรักษาพยาบาล การส่งเสริมสุขภาพ การควบคุมป้องกันโรค และการฟื้นฟูสุขภาพ สถานบริการให้บริการร่วมกันในลักษณะเครือข่าย ซึ่งสำคัญอย่างยิ่ง ในการเข้าถึงหน่วยบริการในระดับเครือข่ายปฐมภูมิได้อย่างรวดเร็วและเหมาะสม ดังนั้นงานวิจัยนี้มีวัตถุประสงค์ เพื่อการจัดแบ่งพื้นที่ให้บริการของการเข้าถึงการบริการกับหน่วยคู่สัญญาบริการปฐมภูมิ ให้เหมาะสมในจังหวัดนครนายก

ข้อมูลที่ใช้ข้อมูลในปี 2551 จากส่วนราชการต่าง ๆ และสำรวจ โดยใช้ปัจจัยที่นำมาศึกษาในครั้งนี้ ได้แก่ ความเร็วเฉลี่ยในการเดินทางของถนนแต่ละประเภท, จุดกลับรถ ทิศทางการเดินรถ เวลาที่รอรับบริการของประชาชน ที่ หน่วยคู่สัญญาบริการปฐมภูมิ และการเดินทางจาก สถานีอนามัยถึง หน่วยคู่สัญญาบริการปฐมภูมิ เมื่อรวบรวมข้อมูลครบถ้วนแล้วนำมาทำการวิเคราะห์เครือข่ายในโปรแกรมประยุกต์ Geographical Information System Extension Network Analyst จัดทำแผนที่แสดงการวิเคราะห์ การเข้าถึงบริการในแต่ละหน่วยคู่สัญญาบริการปฐมภูมิ

ผลการศึกษาพบว่า การลดเวลาการเข้าถึงการบริการกับหน่วยคู่สัญญาบริการปฐมภูมิ ทำให้เวลาเฉลี่ยของการเข้ารับบริการที่ หน่วยคู่สัญญาบริการปฐมภูมิ โดยต้องมีการปรับย้าย สถานีอนามัย จากที่สังกัดอยู่ในปัจจุบัน จำนวน 10 แห่ง ไปยัง หน่วยคู่สัญญาบริการปฐมภูมิ ใหม่ เมื่อเปรียบเทียบกับการเข้ารับบริการในปัจจุบันกับงานวิจัยนี้พบว่าเวลาเข้าถึงกรรับบริการแตกต่างกัน ตั้งแต่ 0.06 นาที ถึง 7.10 นาที อัตราของแพทย์และพยาบาลต่อการรับผิดชอบประชากร เปลี่ยนแปลงไป ส่วนใหญ่ ไม่เกินอัตรากำลังที่กำหนดของกระทรวงสาธารณสุข

80 หน้า

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CHAPTER I
INTRODUCTION

This chapter covers the background and statement of problems, objectives, limitation, scopes and expected results of this research.

1.1 Background and Statement of the Problem

The equality on accessing primary health care service is a main purpose of the national health care system which should be available for all, no matter whether the patient aer rich or poor. The policy of health for all is supported by World Health Organization (WHO) under the policy concept called “Health for All by the Year 2000” [1]. This policy employs primary health care strategy to be the core value which pays attention on two principles to 1) support all to access needed health care service and 2) protect any family from going bankrupt caused from excessive burden of health care expenditure[2]. The extension of the health care guarantee has been continually done through two methods as 1) widen the health care service to cover all individuals and 2) to widen the health care benefit and provide convenient ways for health care accessibility. These two methods are practical ways leading the health care system workably and effectively [3]. Public health policy is done based on Constitution of the Kingdom of Thailand in 1997 which mentions that all Thai people have basic rights to gain public health care from the government. The section 52 of the Constitution indicated that “All individuals have equal rights on getting standard health care service while those who are poor can get the proper health care service provided by public primary care unit and public hospital free of charge”. Furthermore, section 82 of the Constitution mentioned that “the government must provide standard effective health care service for all” [4]. According to these sections shown in the Constitution, health for all project (the 30 baht scheme) had been occurred based on the progressive health support and systematic disease and illness prevention concepts. The 30 baht scheme is

intended to provide health care system to all Thai people equally based on the idea that the underprivileged and vulnerable people must be protected under social participation in order to the maximize profit, achieve transparency and level up the social standard of health care system in the country.

The national health care system suddenly responses to the policy by supporting the strong primary care service through the action of public primary care unit (PCU). As the primary care unit, PCU provide integrated health care, health promotion, disease and illness prevention as well as health rehabilitation. In case of severity, PCU will take responsibility on case referring to the hospital. In addition, PCU network is supported as the provider network aimed to provide the primary care service in case of emergency and fundamental health care provision. The fundamental health care provision covers services for individual and society including physical and mental health support while social health care includes progressive and regressive health provision which is aimed to achieve health behavior change. Vulnerable and risky people are continually monitored by the PCU which acts as a unit strongly connecting people and public health system.

In order to provide effective PCU, there are three elements needed as 1) fundamental infrastructure 2) supportive infrastructure and 3) promotion for basic health care provision. In the first element, convenient location of PCU, systematic information available, financial system, provider network, unduplicated work assignment as well as effective case referral are needed to achieve the ultimate goal of good health care service provided by the effective PCU.

Zoning for PCU and Contracting Units for Primary care (CUP) is very important for achieving the maximized benefit of the service. Convenient accessibility on getting public service means an individual can move from his/her home to PCU conveniently in Nakhonnayok province, zoning for primary care unit (PCU) and contracting units for primary care (CUP) is done based on administrative purpose. PCU and CUP are zoned according to the locations of village, Tumbon (sub-district) and district in which people in many areas can not access health care unit conveniently.

Nowadays, information technology (IT) acts the main role for organization administration in which efficiency and effectiveness of management in any

organization is possible. With this reason, Geographic Information System (GIS) is an alternatively practical chosen which can be applied for zoning. Validity of PCU zoning can be done by calculating distance between patient's house and PCU effectively. The benefit of GIS applied for zoning might be beneficial for being a pioneered study which is available for applying in other province in the future.

It can be concluded that GIS technology is the important choice for helping to access the more effective way of getting to the nearest health care service unit or to the hospital use in the future. It can also be useful to finding the suitable way to divide the easy to access to the nearest hospital for more effective and more accurate way. It can be calculated for the very best result and to help finding the fastest way for the people who located far from the service in appropriate and more accurate time management to get into their nearest health care service provider. It can also be useful for the future of other city to be able to use this innovation called GIS technology to access to their nearest health care services for the best benefit of the citizen of the Kingdom of Thailand.

GIS can be used to map and assess health services. Paper maps sketched by health workers for routing services and planning immunization campaigns do not show the relative positions of populations and health service centers to scale. GIS and GPS can be used to develop social and health service maps that are geographically scaled and positioned. GIS can show how a health service center relates to the population it serves. Overlaying a clinic location with demographic layer and generating buffers around each health clinic lets managers identify any portions of the population that are inadequately served.

To divide the areas of the responsibility of each health care providers units (PCU) and the hospital level (CUP) are playing the important roles for the best services for the people under their coverages. By using the traveling time measurement and the fastest way called the Geographic Information System (GIS) is to get to service from their home to the nearest primary care unit or to the nearest hospital. Therefore by using this system in each area of Nakhonnayok Province which can be seen that they are responsible for the primary health care services by each of their govern areas such as by using the measurement from each of the villages and from the nearby districts to access to their nearest service. GIS method can also help

the local people so that they would get to have this privilege benefits for their nearest locations. It is also the effective way to achieve the best health care service nearby their home and not to travel too far to have their services.

By the use of this GIS system, it can be seen that it is much more convenience and the fastest way to get to the health care service by the nearest primary care units from each traveling time from their suitable location.

At the present, the information technology promotes the important roles for every organization and it also helps the patients to be more convenience in getting to their nearest primary care unit location from their place with the management of their less traveling time. It can also be used as the tools for helping the decision making for the further management of the organization and to help adapting more in effective way in managing the development changing schemes and the new way of the potential managing trend in the very near future.

1.2 Objective of the study

The main objective is to apply GIS for suitable zoning of Contracting Units for Primary care service in Nakhonnayok province

There are three sub objectives

- To estimate time spent for accessing CUP for health service in Nakhonnayok province.
- To estimate the ratio of medical doctor and nurse of each CUP in study area.
- To compare the CUP accessibility and ratio of medical doctor and nurse per population between the current system and the new approved one.

1.3 Limitation

According to the data collection in 2008 it shown for example; the transportation route or the traveling route, testing result of the length of traveling route time by category, the period of time of waiting to have the service in the hospital

which could be different from Nakhonnayok province as well. This data information can be used on the specific time only and nothing elses.

1.4 Scope of the Study

- Nakhonnayok Province located in the east of Thailand. It's covers area of 2,122 km^2.
- Six Contracting Units for Primary care (CUP) in Nakhonnayok Province.
- 56 Primary Care Units (PCU) in Nakhonnayok Province.
- Traveling time of people from each PCU to CUP
- Waiting time until receiving the service at Contracting Unit for Primary care

1.5 Expected Results

Identify the best result of the health this research was made to show the important of GIS data for the future decision making in any investments based on this worthy analysis. The goal was to achieve the outcome in identifying for the health service area of Contracting Unit for Primary care (CUP) in Nakhonnayok Province. This GIS in health care plan service area of CUP in Nakhonnayok Province.

CHAPTRE II
LITERATURE REVIEW

This chapter covers definitions of health system, Geographic Information System (GIS), Network Analysis, the study area and the related researches.

2.1 Definition of Health Systems

2.1.1 Contracting Unit for Primary care (CUP)

Contracting Unit for Primary Care (CUP) is a health service unit that is contracted by the province to be the main deliverer of health care to its registered population. In 2002, Thailand implemented universal coverage of health insurance for the entire population through the 30 baht scheme, which merged welfare schemes protecting the lower income groups, and extended insurance covering to those previously unprotected. Within the 30 baht scheme, payment for health services has been changed from a historical global budget to per capita funding for the catchments population. Provinces were permitted to choose the provider payment method, either exclusive capitation or inclusive capitation. Provinces could also choose the level of the system at which salaries were deducted, either at contracting unit for primary care (CUP) level or at provincial level.

2.1.2 Primary Care Unit (PCU)

Primary Care Units (PCU) is a public health service unit that works with communities, families, and individuals to identify health needs and assets, and supports individual and community action to prevent illness, protect and promote health, and achieve well being.

2.2 Geographical Information System (GIS)

2.2.1 The Definition of Geographic System

GIS technology is evolving rapidly, it is also different from the others map reproduction system. GIS is able to analyze and to use the simulation techniques to set on the model before decision making. Organization and scientists have defined the definition of GIS such as:

Burrough [5] defined that GIS is the tool to collect, record, retrieve, change and display data of the world areas. It describes things in the word in terms of location attributes and topology.

Environmental System Research Institute defined GIS as an organized collection of computer hardware, software geographic data and personnel designed to efficiently capture, store update, manipulate, analyze and display all forms of geographically referenced information.

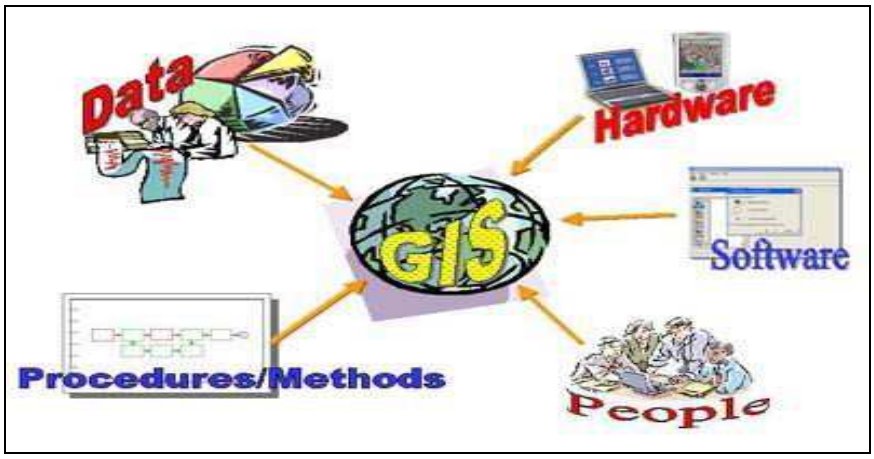
Kasem Goonpradit [6] mentioned that Geographic Information System (GIS) is a computer system which can be work on providing map by importing, managing concerned data also presenting results of the study systematically. By conclusion, GIS is the smartest way to manage database and mapping by using the computer system.

Sanijai Klendao [7] Geographic Information System is also a tool which is applied for manipulating, storing, analyzing retrieving and displaying information. GIS is the database system which was managed to spatial and attributed data. The result can be use to make the decision support.

According to above definition, it can be concluded that Geographic Information System (GIS) is the managing system for spatial data and attributing data. GIS is beneficial for managing complex and much quantified data as it can be promoted to the storage system effectively. GIS is provided for the case of finding data on memory, data analysis, model providing as well as the data expressing in form of the geographic schedule.

2.2.2 Components of Geographic Information System

Geographic Information System consists of five components, as following Figure 2.1:



Source: Geographic Information System (GIS) and mapping-practices and standard. Amarican society for testing and material.Philadelphia.

Figure 2.1 Components of Geographic Information System

2.2.2.1 Software

Software is an application control the computer by appointed step and giving the user needed result. It will manage and control the computer processing on turning off computer.

2.2.2.2 Hardware

Hardware is not only accessories that work with software but also accessories that inputs data processing, displaying, and resulting. Computer served to GIS must have high performance in graphic and should work rapidly. Normally,hardware can be divided by function as following:

- Input Unit is equipment which inputs data from user to computer system such as Keyboard, Mouse, and Digitizer etc.

- Central Processing Unit (CPU) is equipment for computer which carries out control unit (CU) as a data arrangement, memory unit (MU) and arithmetic logic unit (ALU) for comprises and arithmetic logic.

- Output Unit is equipment which displays results such as Monitor, Printer, and Plotter etc.

- Secondary storage unit is equipment which stores such as Hard disk drive, Floppy disk drive, Flash drive etc.

- Communication unit is the equipment which communicates with other computer. For example network card, modem.

2.2.2.3 Data

Application of GIS is efficiently depending on data and information. Geographic data are divided by 2 characteristics

- Attribute characteristics or non-spatial characteristics is identifying the feature of nature include of man-made feature. Attribute may be continuous data such as contour, terrain elevation, or discontinuous data such as the number of inhabitants, land cover type.

- Spatial characteristics is also geo-referenced points which consists of

- Point features describes the position of data for example province, temple etc.

- Linear features describes straight line feature, curve features, width and length of transport, river etc.

- An area feature of polygon describes the boundary of area such as forest area and administrative boundary.

2.2.2.4 Peopleware

Peopleware is important part of processing geographic information system which consists of 1) Manager 2) System analysis 3) Database management 4) Senior worker 5) Mapping operator 6) Data entry 7) Maintenance 8) Programmer 9) Users

2.2.2.5 Methodology

Data management was also important in geographic information system which could be decreased redundancy data. Information system is designed to share data in organization with overlay technique. Application of geographic needs a lot of factor, layer to models environment analysis data system or applies to multi-display [8].

2.2.3 Characteristics of Geographic Information System

Data in geographic Information System can be divided into two types as spatial data or graphic data and non-spatial data or attributing data. Two types of data are related in both terms of continuous and discrete relation.

2.2.3.1 Spatial Characteristic Information

Spatial is described as the location and shape of geographic features. It refers to the locations on the earth's surface by using a standard coordinate system such as Universal Transverse Mercator (UTM). Spatial characteristic can be represented in form of:

- Point features: The point feature will be used for stating the position of any place of study. The size of point will provide how important of place that is shown in the map. Furthermore, the point will explain on location i.e. location of province, villages, schools, etc.

- Linear features: The linear feature is composed of straight line, break line and convex line. Each line will explain characteristics of places on map through its size, width and length for example, streamline, rail line, road, sewer, etc.

- Area features: the area feature is explained the boundary of study are as sometime it is called "Polygon". This feature is composed of many characteristics and will be used as boundary of service, land use, soil, forest etc.

2.2.3.2 Attributed Characteristic Information

The attributed information has stored only non-spatial entities, which have been formed the database. The characteristic of attribute information is a tabular data that normally use (i.e. numeric data representing values for different variables), e.g., population of various areas, agricultural or industrial production, etc. the variables are depending on the need or purposes of users, the data are recorded as tables and can be listed as tables or displayed as diagrams, where it is necessary to analyze or display these data graphically[9].

2.3 Network Analysis Using ArcGIS

2.3.1 ArcGIS Network Analyst

The ArcGIS Network Analyst extension enables users to solve a variety of problems using geographic networks (i.e., streets, highways, rivers, pipelines, electric line, etc.) such as finding the most efficient travel route, generating travel direction, finding the closest facility, or defining service areas based on travel time. ArcGIS Network Analyst adds an integrated graphical user interface providing access to the network modeling capabilities.

2.3.2 The most direct path between two points

The Arc GIS Network Analyst extension enables to solve a variety of problems based on geographic networks (i.e., streets, highways, rivers, pipelines, electric line, etc.). It solves problems such as finding the most efficient travel route across town. generating travel direction, finding the closet emergency vehicle or service facility to an incident, or defining service areas or sales territories based on travel time.

2.3.3 The optimum route between many points

To improve the efficiency of the operations by finding the best routes around town or cross the country. Contracting Unit for Primary care (CUP) locations can be added by interactively point at locations, using mapped location or even geo-coding an address or street intersection on the fly. The ArcGIS Network Analyst can even reorder the Contracting Unit for Primary care (CUP) optimizing the order as needed.

It can be found as the best routes based on the shortest distance or time between here we are and where we want to go or to the destination. It can also be found as the best routes during the rush hour and at midnight, by changing what “cost” the network should be to route on. “Cost” refers to how “expensive” it is, typically in terms of time or distance, to travel from one point to another. To solve the problem it also needs the clear direction. The ArcGIS Network Analyst allows the user to

generate detailed directions along the route, providing as you need it to the solutions for common problems.

2.3.4 The closest facility

It eliminates guesswork and locates the closest available resource at a moment of notice. Dispatch the closest vehicle to its location, or finding the nearest valve in critical situation. Weight the user's decisions on the information that matters most to them: cost, time, and distance. Locate the closest facilities by time or distance. The user can even have the Network Analyst report the closest six facilities with an optimal drive. The Network Analyst will avoid construction and other obstacles as needed as well, providing the best solution for the health service.

2.3.5 Built Service Areas

To find out of what areas and who are the health service providers based on the location. Built Service Area**s** creates the health service areas around the facility. It could be define by distance or time. It is planning for the future by examining where the "holes" are in these existing services.

2.3.6 Drive time analysis

The ArcGIS Network Analyst includes the ability to create which the clear directions customized to suit the user's needs. The user can also specify which data are needed to use when generating the direction and what was the distance units should be used in the direction. An important feature of The Arc GIS Network Analyst is the ability to use additional landmark points within the direction. The direction will include these additional data features, resulting in clear, easier to understand the information. Arc GIS network Analyst can also do point-to point routing and it can also refer local to the landmark when reports route directions. The geographic network data can be done base on Arc GIS coverage's, shape file, CAD drawing. Arc GIS Network Analyst also includes a suite of more of the advanced network analysis tools that can be accessed through Avenue requests. Developers will be able to deliver sophisticated network analysis applications based on these extended capabilities.

2.3.7 Answering Based on Different Criteria

The ArcGIS Network Analyst can use any cost file for its calculation. in which it means the user can really solve the question based on driving time, street length, traffic conditions, or any of a number of criteria. This allows the user to move beyond simple distance based on routing and to make use of the additional available today.

2.3.8 Build Custom Solutions

The ArcGIS Network Analyst was added to the additional functionality to ArcGIS and Avenue. The user can build to complete customized solutions from simple tool to complete the applications using the power of Avenue and the ArcGIS Network Analyst [10].

2.4 Study Area

Nakhonnayok Province consist of four administrative districts (Amphoe) that separated to 41 sub-districts. These are Amphoe Muang Nakhonnayok, Amphoe PrakPree, Amphoe Banna and Amphoe Ongkharak are showed in figure 2.2.

North	connect to Saraburi and Nakhon Ratchasima
South	connect to Prachin Buri and Chachoengsao
East	connect to Prachin Buri
West	connect to Pathum Thani

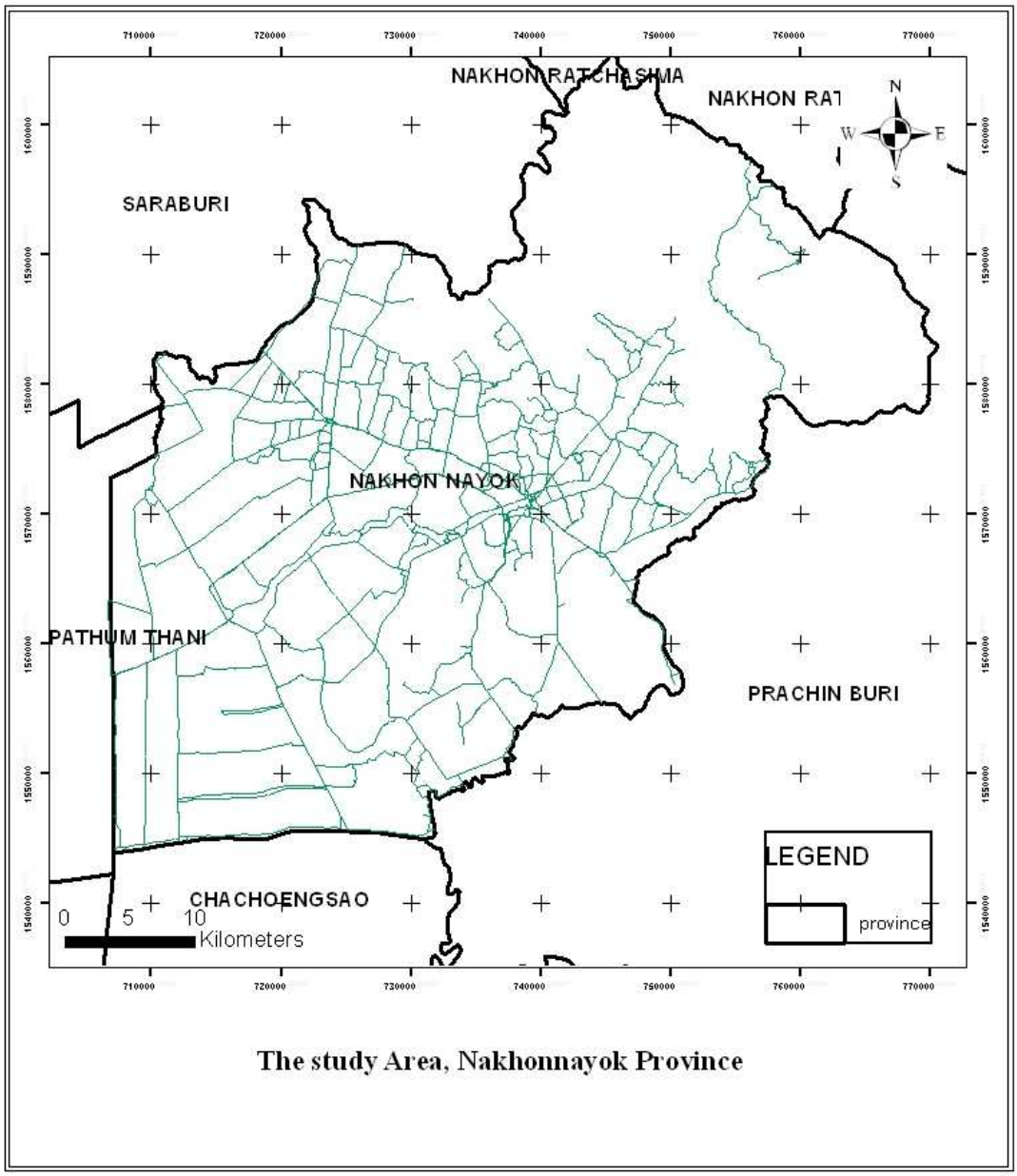


Figure 2.2 The study Area, Nakhonnayok Province

Six Contracting Units for Primary care (CUP) are provided Nakhonnayok Province as shown as the point in Figure 2.3;

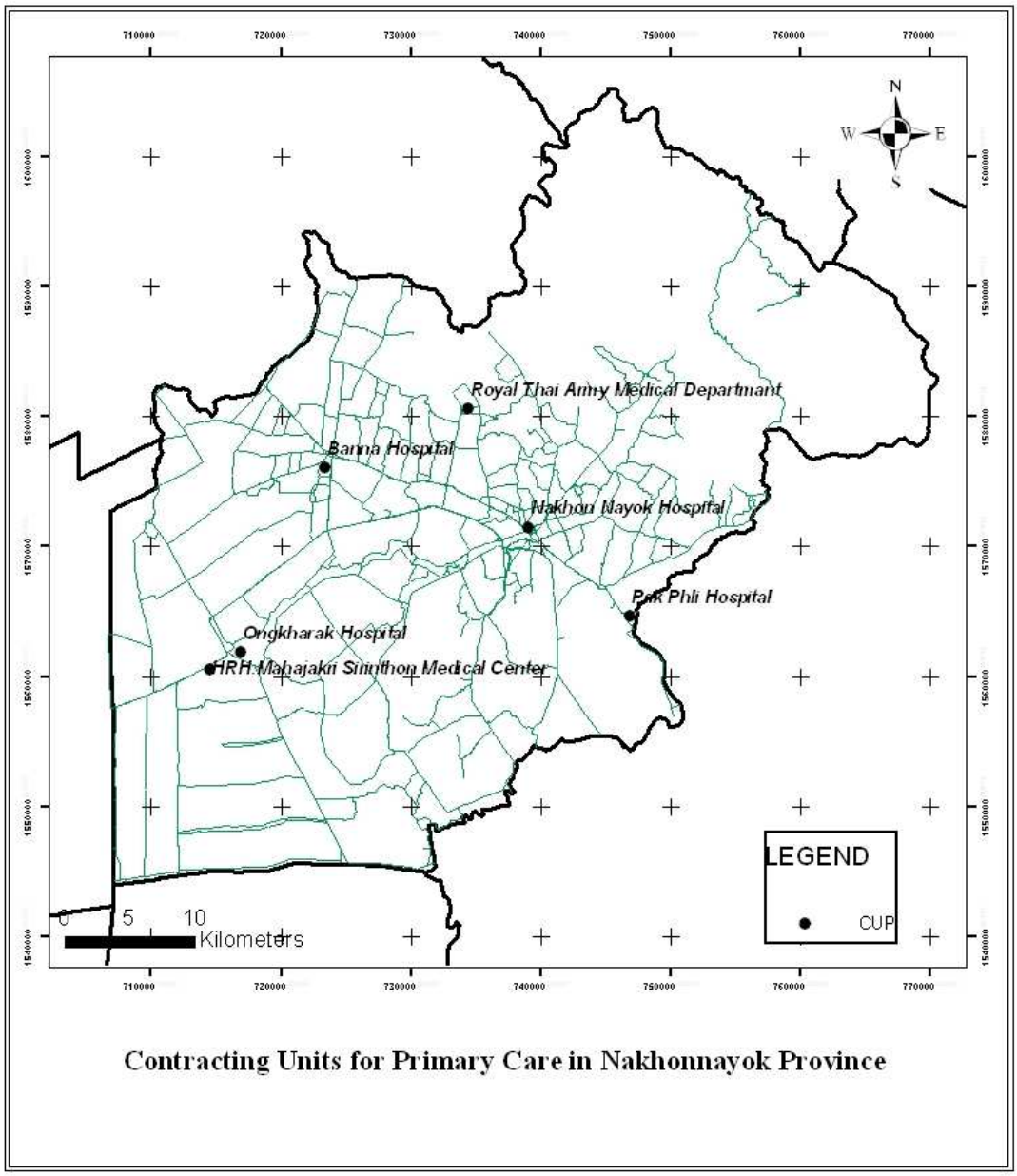
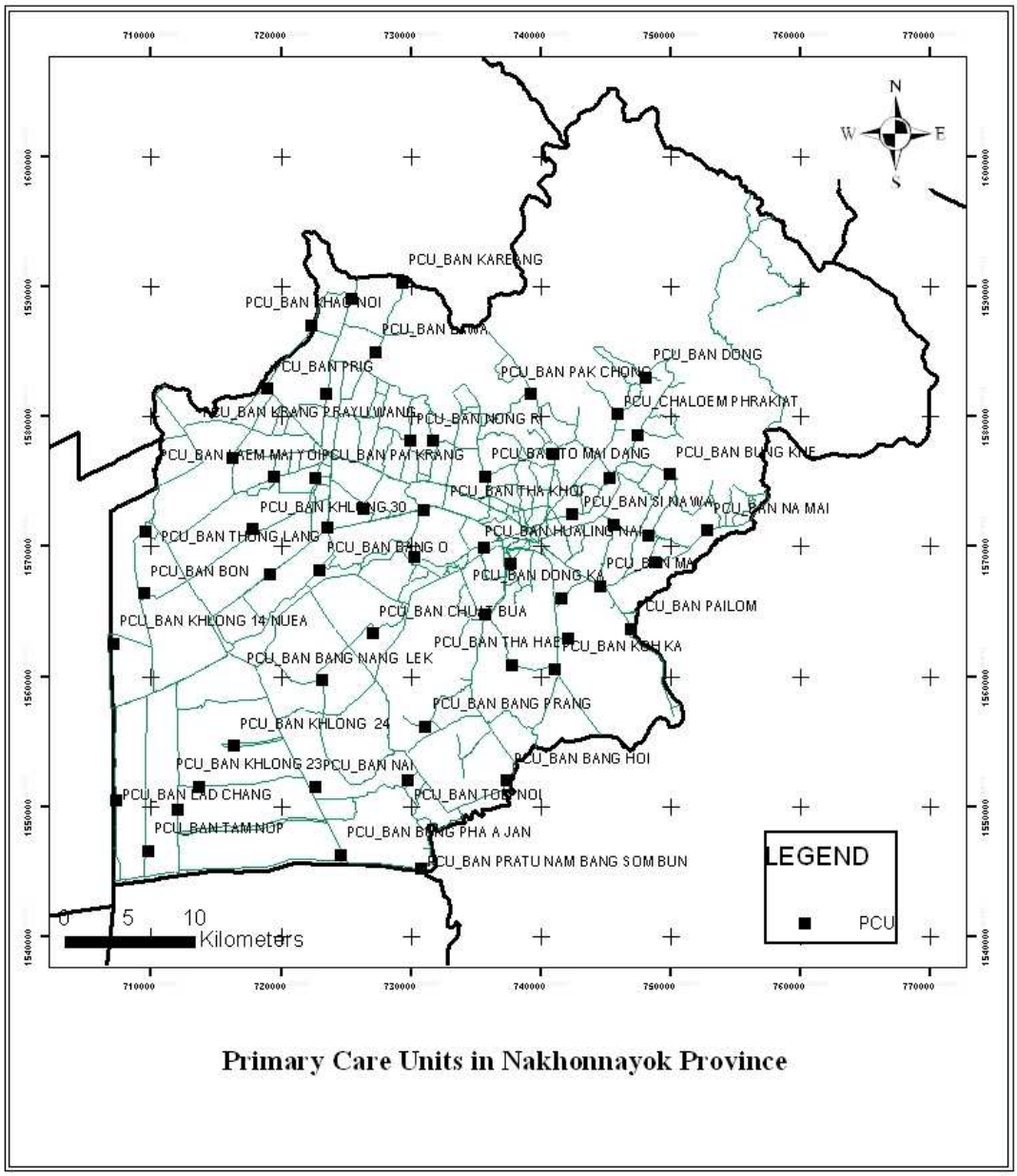


Figure 2.3 Contracting Units for Primary Care in Nakhonnayok Province

There are 56 Primary Care Units (PCU) in Nakhonnayok Province asshown as the point as in Figure 2.4;



Primary Care Units in Nakhonnayok Province

Figure 2.4 Primary Care Units in Nakhonnayok Province

2.5 The Related Research

Pongsri Ngernmool [11] determinates service areas of 6 secondary schools which are members of the Samsen join Campus for the year 2000,2001,2002 A.D. Her research is quite interesting. The reason is that it was carried out by using geographic information system software – MapInfo. Data Input to the system were the location

map of the six schools, a rode map, student address location map, and the service area map of the Samsen join Campus. The criteria of the delineation were: no overlapping among the service areas of the schools, every eligible student will be assigned to a school and students go to the school that is the nearest to their residence. Comparison was made of the service area and the numbers of students was allocated of each school using the present criteria and the criteria used by this research. In conclusion, she was found out that overlapping service areas were solved, and the proportion of students assigned to each school became more balanced.

Nina Bullen [12] The National Health Service in Britain is undergoing far-reaching changes. While District and Regional Health Authorities are currently merging, professionals agree that primary health care is most efficiently managed at the local level. This paper uses geographical information systems (GIS) capabilities to identify a nested hierarchy of localities for the management of primary health care in West Sussex, England. GIS coverage was developed which contained key criteria for defining local areas, including nodes or focal points of service provision, edges which act as physical or psychological barriers to movement, districts such as official administrative areas and interaction criteria such as journey to work, school and family doctor (GP) surgeries. Central to the derivation of the localities was a large matrix of patient to GP flows based on post-coded data. Once managed, these data revealed clear geographical patterns of patient to GP allegiance. A large-scale field survey obtained supporting information on the perception of areas from local residents.

Rosero-Bixby [13] the case study assembles a geographic information system (GIS) to relate the 2000 census population (demand) with an inventory of health facilities (supply). It assesses the equity in access to health care by Costa Ricans and the impact on it by the ongoing reform of the health sector. It uses traditional measurements of access based on the distance to the closest facility and proposes a more comprehensive index of accessibility that results from the aggregation of all facilities weighted by their size, proximity, and characteristics of both the population and the facility. The weighting factors of this index were determined with an econometric analysis of clinic choice in a national household sample. Half Costa

Ricans reside less than 1 km away from an outpatient care outlet and 5 km away from a hospital. In equity terms, 12-14% of populations are underserved according to three indicators: having an outpatient outlet within 4 km, a hospital within 25 km, and less than 0.2 MD yearly hours per person. The data show substantial improvements in access (and equity) to outpatient care between 1994 and 2000. These improvements are linked to the health sector reform implemented since 1995. The share of the population whose access to outpatient health care (density indicator) was inequitable declined from 30% to 22% in pioneering areas where reform began in 1995-96. By contrast, in areas where reform has not occurred by 2001, the proportion underserved has slightly increased from 7% to 9%. Similar results come from a simpler index based on the distance to the nearest facility. Access to hospital care has held steady in this period. The reform achieved this result by targeting the least privileged population first, and by including such measures as new community medical offices and Basic Teams for Integrated Health Care (EBAIS) to work with these populations. The GIS platform developed for this study allows pinpointing communities with inadequate access to health care, where interventions to improve access would have the greatest impact.

CHAPTER III
MATERIALS AND METHODS

This chapter will describe materials and methods that would be used to all steps of this research and the time frame of each step and materials.

3.1 Materials

3.1.1 Hardware

- Global Positioning System (GPS)
- NoteBook Computer
- CPU : Intel Pentium M 1.73 GHz. Or higher
- RAM : DDR 512MB
- Hardisk : 60 GB
- Monitor : VGA Monitor
- Peripherals : Keyboard, Mouse, Printer and DVD-Rom

3.1.2 Software Requirement

- Operating System : Microsoft Windows XP professional
- ArcGIS Version 9.2, Extension Network Analyst
- Microsoft Word 2003
- Microsoft Excel 2003

3.2 Methods

Steps of research as follows Figure 3.1 ;

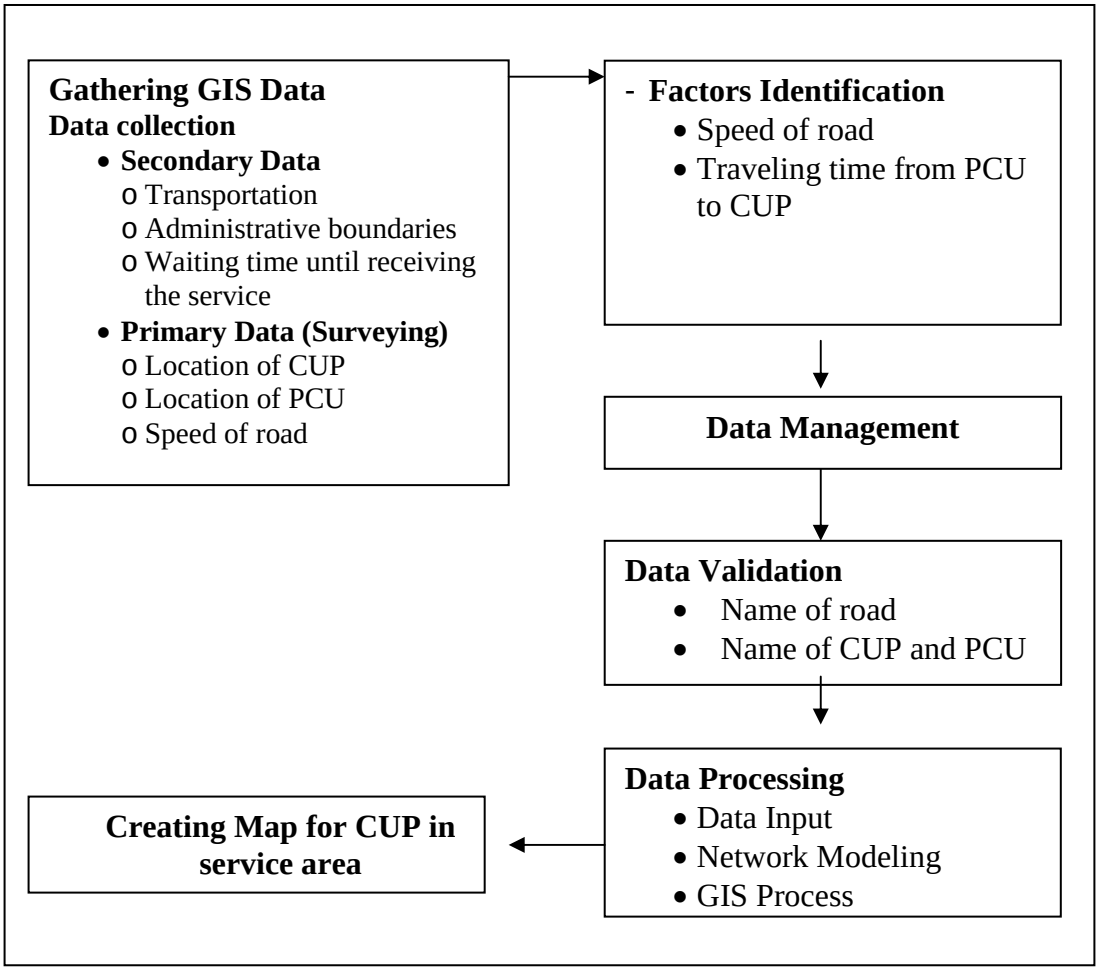


Figure 3.1 Methodology framework Diagram

3.2.1 Gathering GIS Data

3.2.1.1 Data Collection

a) Secondary Data

The secondary data are the collected data from the government is office, in related field of the study. Details of data and their sources are provide in Table 3.1- 3.2

Table 3.1 Secondary Data and sources

Data	Format	Source
1.Administrative boundaries Nakhonnayok Province (2008)	Spatial data (Polygon)	Department of Public Works and Town & Country Planning
2.Transportation map in Nakhonnayok Province (2008)	Spatial data (Line)	Department of Public Works and Town & Country Planning

This research was using the spatial data and non-spatial data from many sources:

- Transportation in Nakhonnayok Province
- Administrative boundaries in Nakhonnayok Province

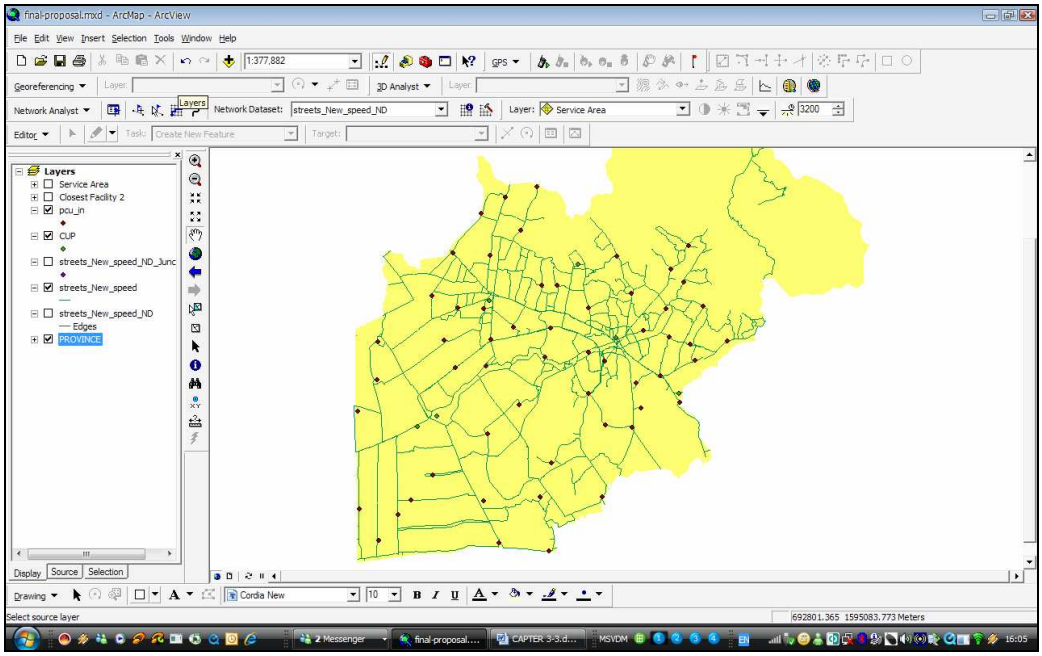


Figure 3.2 Transportation and administrative boundaries in Nakhonnayok province

Table 3.2 Waiting time until receiving the service

No.	CUP	Average time of waiting for service (Minute)
1	Nakhonnayok hospital	23.15
2	Banna Hospital	22.20
3	Pak Phli Hospital	23.00
4	Royal Thai Army medical department	21.45
5	HRH.Mahajakri Sirinthon medical center	21.00
6	Ongkharak hospital	20.00

Source: Nakhonnayok provincial public health office Ministry of Public Health

b) Primary Data: (*Field Survey*) Primary data in this study are collected by field survey. The following are the methodology. The location of CUP and CUP in Nakhonnayok Province are shown in the Tale 3.3-3.4

Table 3.3 Location of CUP in Nakhonnayok Province

ID	CODE	NAME	East	North
1	10698	Nakhonnayok Hospital	739799.14	1571692.78
2	10863	Pak Phli Hospital	746970.34	1564951.98
3	10864	Banna Hospital	723488.54	1576240.32
4	10865	Ongkharak Hospital	717018.41	1562039.64
5	11491	Royal Thai Army Medical Departmant	734520.86	1580755.32
6	14904	HRH.Mahajakri Sirinthon Medical Center	714606.63	1560715.75

Table 3.4 Location of PCU in Nakhonnayok Province

No.	CODE	NAME OF PCU	East	North
1	02384	Ban J Dee Thong	735417.29	1570221.78
2	02385	Ban Tha Khoi	742243.54	1572858.01
3	02386	Ban Khlong Mueang	737438.39	1569074.11
4	02387	Ban Tha Sai	730039.06	1569568.38
5	02389	Ban Bang Hoi	737181.48	1552323.92
6	02390	Ban Bang Prang	730894.87	1556515.23
7	02391	Ban Nong Tong Sai	735469.92	1565071.47
8	02392	Ban Tha Hae	737594.33	1561230.62
9	02393	Ban Si Na Wa	745418.07	1572058.01
10	02394	Chaloem Phrkiat	745676.66	1580520.81
11	02395	Ban Khao Nangbuad	745075.70	1575629.24
12	10195	Ban Dong	747859.16	1583367.93
13	02396	Ban Wang Yai Chim	747291.73	1578922.20
14	02397	Ban Khao Thurain	740729.01	1577506.55
15	02398	Ban Pak Chog	739001.45	1582057.31
16	02399	Ban To Mai Dang	735482.76	1575724.78
17	02400	Ban Wang Pla Chuet	731531.86	1578467.88
18	11601	Ban Pak Kra Thum	730771.99	1573165.28
19	02388	Ban Chuat Bua	726890.70	1563650.21
20	02401	Ban Pailom	746710.07	1563994.46
21	02402	Ban Mai	744312.57	1567282.61
22	02403	Ban Sakae Zueng	741926.05	1563248.94
23	02404	Ban Dongka	741389.88	1566360.39
24	02405	Bann Phom Phet	748618.68	1569155.34
25	02406	Ban Koh Ka	740840.00	1560906.15
26	02407	Ban Hualing Nai	748039.97	1571149.00
27	02408	Ban Bung Khe	749670.58	1575922.49
28	02409	Ban Na Mai	752627.90	1571583.89
29	02410	Ban Nong Ri	729699.42	1578494.49

Table 3.4 Location of PCU in Nakhonnayok Province (cont.)

No.	CODE	NAME	East	North
30	02411	Ban Tang Krabue	726138.34	1573291.40
31	02412	Ban Nong Kan Jam	716087.64	1577158.74
32	02413	Ban Prig	718689.63	1582494.83
33	02414	Ban Pai Krang	722440.47	1575634.76
34	02415	Ban Thong Lang	723323.04	1571772.14
35	02416	Ban Khlong 30	717589.50	1571677.42
36	02417	Ban Bang O	722741.55	1568541.88
37	02418	Ban Lam Mai Yoi	719265.77	1575704.89
38	02419	Ban Krang Pra Tu Wang	723252.99	1582150.28
39	02420	Ban Khao Poem	725209.46	1589437.98
40	02421	Ban Khao Noi	722152.43	1587364.52
41	10196	Ban Kareang	729086.11	1590655.84
42	02422	Ban Lawa	727039.87	1585305.07
43	02423	Pak Khlong 22	711814.57	1550108.51
44	02424	Ban Bung Pha A Jan	724375.23	1546620.77
45	02425	Ban Lad Chang	707045.22	1550807.69
46	02426	Ban Khong 23	713448.50	1551851.21
47	02427	Ban Khlong 24	716121.84	1555005.45
48	02428	Ban Ka Men Fung Tai	709403.10	1571508.59
49	02429	Ban Toei Noi	729508.75	1552310.96
50	02430	Ban Pratu Nam Bang Som Bun	730580.06	1545594.67
51	02431	Ban Bang Nang Lek	722929.34	1560058.62
52	14302	Chaloem Phrakiat Rama 9	718948.61	1568245.09
53	02432	Ban Bon	709233.01	1566749.36
54	02433	Ban Nai	722471.51	1551833.19
55	02434	Ban Tam Nop	709508.57	1546923.26
56	13825	Ban Khlong14 Nuea	706885.70	1562882.13

During the survey, GPS was used to collect the coordinate on the road and used as a tool for measuring the distance. The classifications of road are shown in the Table 3.5-3.7.

Table 3.5 National highway

No.	Road Name	Length (Meters)	Lane	Time (Minutes)	Speed (km/hr.)
1.	Highway305	5,045	4	4.57	66.23
2.	Highway305	16,783	4	15.35	65.60
3.	Highway305	11,000	4	10.00	66.00
4.	Highway33	6,545	4	6.00	65.45
5.	Highway33	16,045	4	15.43	62.39
6.	Highway33	10,500	4	10.43	60.40
7.	Suwannasor RD.	6,450	4	6.50	59.53
	Total	**72,368**		**Average Time**	**63.59**

From the random survey of the National highway, The average speed was 63.59 km/hr., available on October 1, 2008 - October 20, 2008.

Table 3.6 Provincial highway

No.	Road Name	Length (Meters)	Lane	Time (Minutes)	Speed (km/hr.)
1.	Highway3288	7,215	2	9.56	45.28
2.	Highway2023	5,830	2	7.53	46.45
3.	Highway3001	15,318	2	18.32	50.16
4.	Highway3004	13,985	2	18.55	45.23
5.	Highway2003	7,331	2	8.77	50.15
6.	Highway3049	7,044	2	9.98	42.34
7.	Highway2013	1,959	2	3.32	35.40
	Total	**58,682**		**Average Time**	**46.31**

From the random survey of the Provincial Highway, The average speed was 46.31 km/hr., available on October 1, 2008 - October 20, 2008

Table 3.7 Local road or Rural road

No.	Road Name	Length (Meters)	Lane	Time (Minutes)	Speed (km/hr.)
1.	Nakhonnayok Rural Rd. Khrongkan Ban Wat	4,740	2	6.28	45.287
2.	Bot-Hua Thanon Mu4 Rd.	1,642	2	2.24	43.982
3.	Ro Pho Cho Nakhonnayok2005 Rd.	1,683.00	2	2.44	41.385
4.	Khrongkan Ban Laem Mai Yoi Rd.	1,893	2	2.54	44.717
5.	Ban Nong Kum	2,157	2	2.82	45.894
Total		**12,115**	**Average Time**		**44.54**

From the random survey of the Local Road or Rural Road, The average speed was 44.54 km/hr., available on October 1, 2008 - October 20, 2008.

3.2.2 Factors Identification

a) Speed of road

- Local road or rural road
- Provincial High ways (2 lanes)
- National high ways (4 lanes)

b) Traveling time from PCU to CUP

3.2.3 Data Management

Data management for achieving the appropriate processing in GIS Network Analysis can be done through adding Attributes data of street route including field SPEED with 6 numeric of double data and average speed gained

through survey owing to each type of street. Field MINUTES of 6 numeric Float data are added aimed to calculate traveling time through MINUTES=[METERS]*60/3000 and the result is shown in terms of minute.

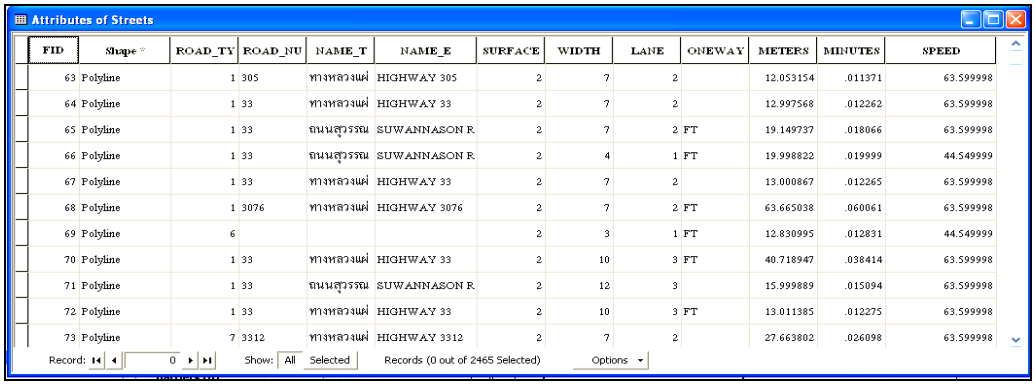


Figure 3.3 Attributes data of street route

3.2.4 Data Validation

Once the necessary data is collected, verification and validation are performed to ensure completeness, correctness, and integrity of the data. The most common method is to manually apply statistical verification and boundary checking on the collected data.

3.2.5 Data Processing

a) Data Input

After GIS database was designed and created, in this step is to gathering all data from field survey access to the database by using imported data both attributing data and spatial data as follows.

1. Real time and average time from the survey in each route.
2. Intersection.
3. U-turn.

According to this step, Access new data and editing the old which is the other sources in order to get the best information.

All of the data are input to the GIS database. The spatial data are input by the scanner and determined the Geo-reference with data approval and data from GPS. The attribute data are input by keyboard. The data approval and data modification in accordance with the Geo-references of the field survey.

b) Network Modeling

The basic network model is made up of links that have an associated attribute known as the impedance. The impedance represents the cost of traveling over the link or the measure of the resistance to a movement of goods through the link. Network centers or facilities represent locations, which can be either distribution resources, such as 56 PCU, 6 CUP. Any places on the network in which resources get picked up or dropped off are referred to as a stop.

Networks typically have rules about how objects were moved through them. For Example, right turns may be prohibited at certain intersections and bridges may be Closed for repairs. Networks are often a combination of one-way and two-way streets, with multiple lanes going in each directions, and some roads may have speeding limits Imposed. The following rules can be modeled.

Travel cost: The average cost of traveling a link, modeled as distance, time or any other costs unit. Identification values to each road for using to find the closest facility. This value is a length for road

One-way streets: Streets that can be traveled in one direction only.

Turns: Turns that are not allowed i.e. left, right, straight or U-turn at an Intersection, or turns that are more “expensive” in terms of travel cost, i.e. right turns at intersections.

Over and underpasses: A street that passes over or under another street, such
Of that cannot make a turn onto the road passing over or passing under.

Closed streets: Streets currently closed to traffic or certain types of streets to avoiding.

c) GIS Process

After input the data and to converse it, will take data to analyze by using Network Analyst extension for ArcGIS. It can also determine conditions to

analyze for finding the closest CUP. This research will determine conditions for finding service area of CUP in Nakhonnayok. This step will acquire the shape file Data of service area that already been to making the map in next step.

Cost Field – From the properties dialogue you may select which attribution to be used to determine the traveling time across a network.

Cost Units – The name of the attribute that is used as the Cost Field will help to determine the Cost Units. If there is no cost variable, the Cost Field will default to <Line Length>, in this case the distance will be measured from the view, and the Cost Units well be set to the map units.

Working Units – Working units can be set to the desired unit for ease in setting up the data and interpreting results. If the Cost Field is set to Line Length, Working units will be locked and set to the distance units (from the View Properties dialogue box).

CHAPTER IV
RESULT

This chapter will describe all steps of the research: Find suitable site for health service in Nakhonnayok province.

Finding from route analysis through GIS network analysis revealed in Figure 4.1

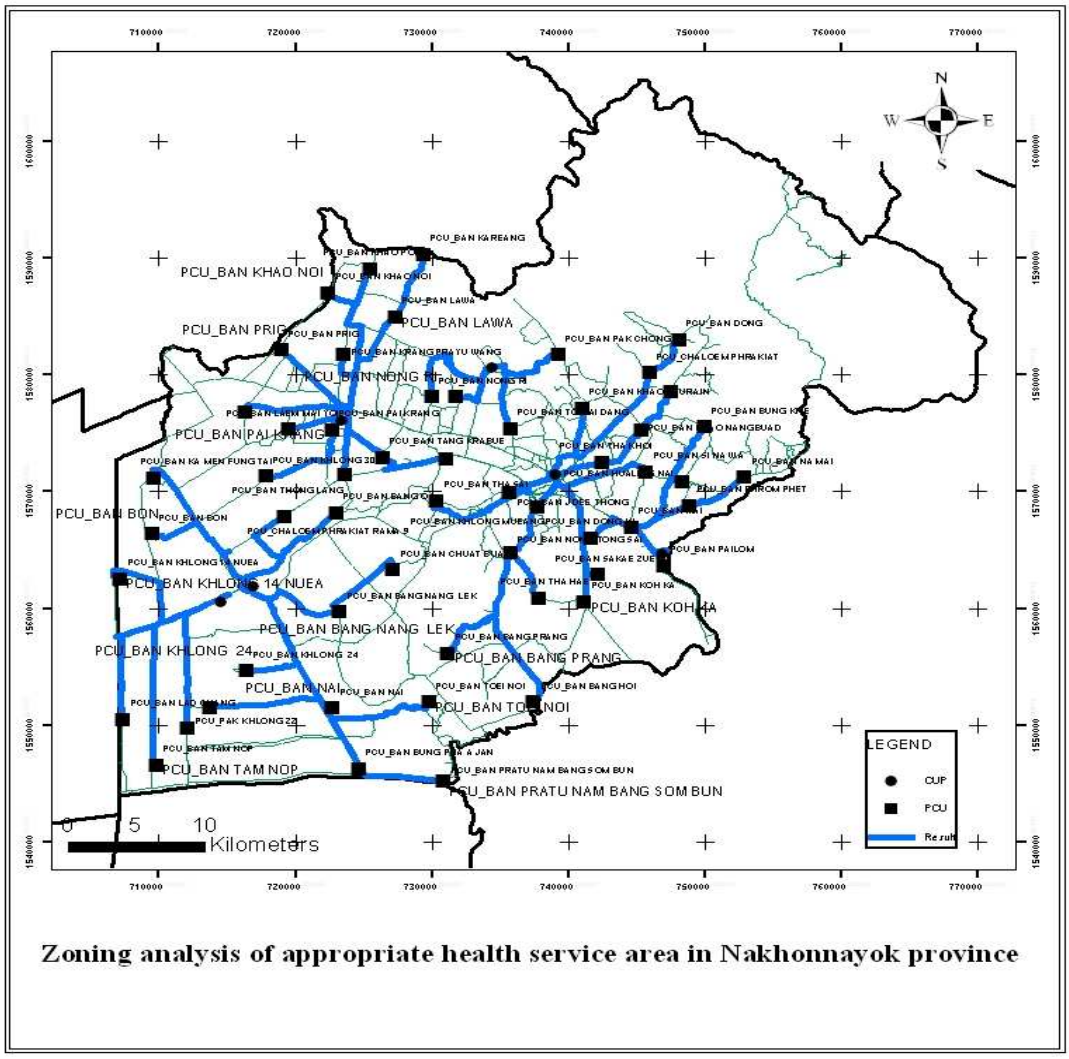


Figure 4.1 Zoning analysis of appropriate health service area in Nakhonnayok Province

4.1 Time spent of clients on accessing health service

Finding from route analysis through GIS network analysis revealed in Figure 4.1 showed that clients' time spending on accessing health service in Nakhonnayok province from each PCU to CUP was in Table 4.1- 4.6.

Table: 4.1 The average time spent for accessing CUP Nakhonnayok hospital for the new approved system

No.	From PCU - CUP	Total_Minutes
1	Chaoem Phrakiat - Nakhonnayok hospital	34.31
2	Ban Koh Ka - Nakhonnayok hospital	35.39
3	Ban Khao Thurain - Nakhonnayok hospital	28.92
4	Ban Khao Nangbuad - Nakhonnayok hospital	31.52
5	Ban Khlong Mueang - Nakhonnayok hospital	27.04
6	Ban J Dee Thong - Nakhonnayok hospital	27.24
7	Ban Dong - Nakhonnayok hospital	38.71
8	Ban Tha Khoi - Nakhonnayok hospital	27.39
9	Ban Tha Sai - Nakhonnayok hospital	32.75
10	Ban Tha Hae - Nakhonnayok hospital	34.57
11	Ban Bang Prang - Nakhonnayok hospital	38.95
12	Ban Bang Hoi - Nakhonnayok hospital	41.03
13	Ban Wang Yai Chim - Nakhonnayok hospital	34.76
14	Ban Si Na Wa - Nakhonnayok hospital	30.94
15	Ban Sakae Zueng - Nakhonnayok hospital	33.85
16	Ban Nong Tong Sai - Nakhonnayok hospital	31.57

Average time spent on commuting from each PCU to CUP in Nakhonnayok hospital was 33.06 minutes.

Table: 4.2 The average time spent for accessing CUP Banna hospital for the new approved system

No.	From PCU – CUP	Total_Minutes
1	Ban Krang Pratu Wang - Banna hospital	27.65
2	Ban Khao Noi - Banna hospital	32.59
3	Ban Khao Poem - Banna hospital	34.04
4	Ban Khlong 30 - Banna hospital	29.04
5	Ban Thong Lang - Banna hospital	27.32
6	Ban Tang Krabe - Banna hospital	26.98
7	Ban Pak Kra Thum - Banna hospital	32.80
8	Ban Pai Krang - Banna hospital	23.30
9	Ban Prig - Banna hospital	29.89
10	Ban Lawa - Banna hospital	29.59
11	Ban Nong Kan Jam - Banna hospital	28.41
12	Ban Laem Mai Yoi - Banna hospital	25.13
13	Ban Kareang - Banna hospital	33.52

Average time spent on commuting from each PCU to CUP in Banna hospital was 29.25 minutes.

Table: 4.3 The average time spent for accessing CUP Pak Phli for the new approved system

No.	From PCU - CUP	Total_Minutes
1	Ban Dong Ka - Pak Phli hospital	31.15
2	Ban Na Mai - Pak Phli hospital	33.20
3	Ban Bung Khe - Pak Phli hospital	34.99
4	Ban Pailom - Pak Phli hospital	27.01
5	Ban Phrom Phet - Pak Phli hospital	29.36
6	Ban Hualing Nai - Pak Phli hospital	31.33
7	Ban Mai - Pak Phli hospital	26.67

Average time spent on commuting from each PCU to CUP in Pak Phli hospital was 30.53 minutes.

Table: 4.4 The average time spent for accessing CUP Ongkharak hospital for the new approved system

No.	From PCU - CUP	Total_Minutes
1	Chaloem Phrakiat RAMA 9 - Ongkharak hospital	28.24
2	Ban Ka Men Fung Tai - Ongkharak hospital	30.92
3	Ban Khlong 23 - Ongkharak hospital	33.06
4	Ban Khlong 24 - Ongkharak hospital	27.67
5	Ban Chuat Bua - Ongkharak hospital	32.45
6	Ban Toei Noi - Ongkharak hospital	34.12
7	Ban Nai - Ongkharak hospital	27.98
8	Ban Bon - Ongkharak hospital	28.82
9	Ban Bang Nang Lek - Ongkharak hospital	25.52
10	Ban Bang O - Ongkharak hospital	28.02
11	Ban Bung Pha A Jan - Ongkharak hospital	31.66
12	Ban Pratu Nam Bang Som Bun - Ongkharak hospital	36.11

Average time spent on commuting from each PCU to CUP in Ongkharak hospital was 30.38 minutes.

Table: 4. 5 The average time spent for accessing CUP HRH.Mahajakri Sirinthon medical center for the new approved system

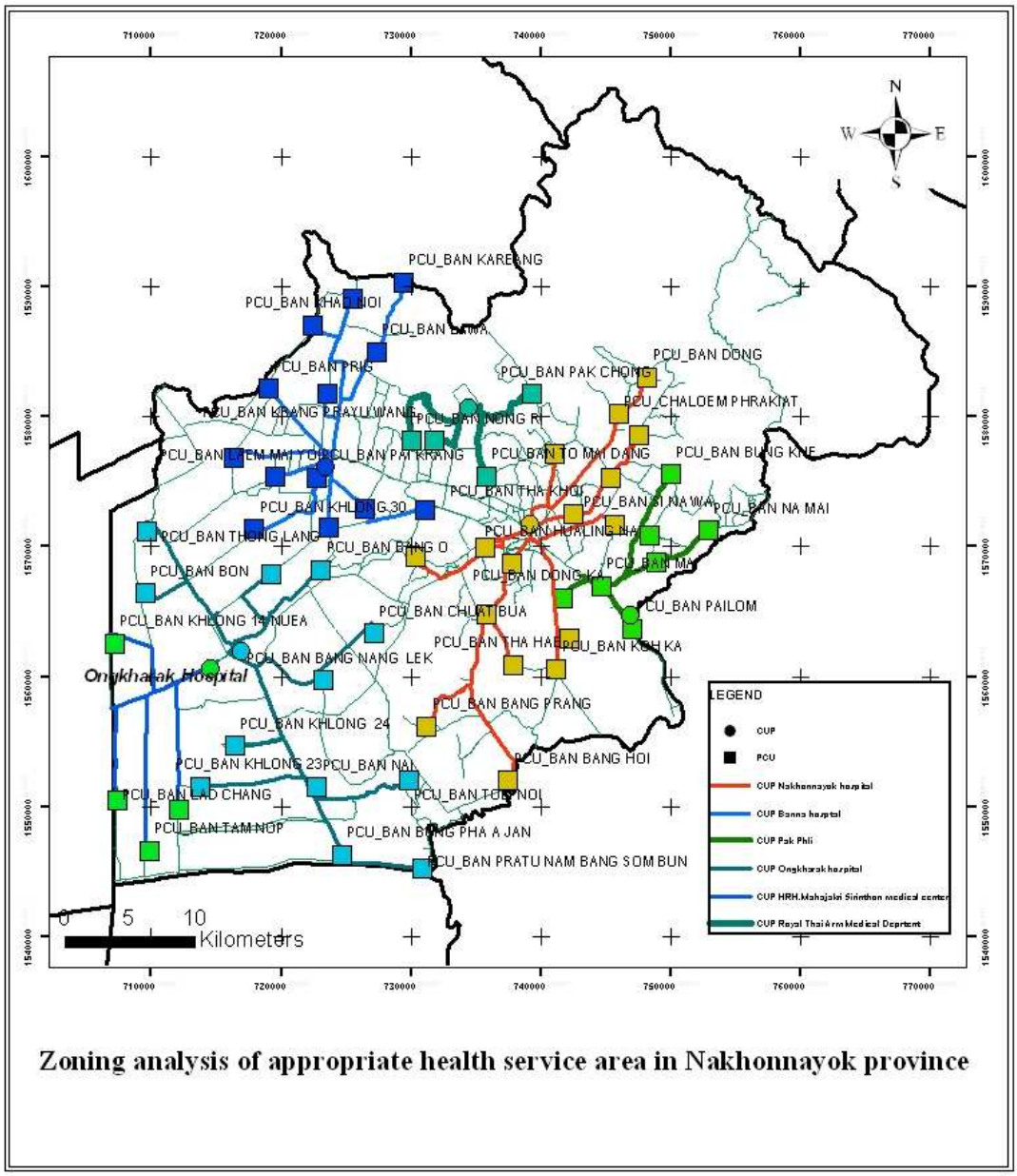
No.	From PCU - CUP	Total_Minutes
1	Ban Khlong 14 Nuea - HRH.Mahajakri Sirinthon medical center	33.32
2	Ban Ta Nop - HRH.Mahajakri Sirinthon medical center	37.17
3	Pak Khlng 22 - HRH.Mahajakri Sirinthon medical center	33.50
4	Ban Lad Chang - HRH.Mahajakri Sirinthon medical center	35.34

Average time spent on commuting from each PCU to CUP in HRH.Mahajakri Sirinthon medical center was 34.83 minutes.

Table: 4.6 The average time spent for accessing CUP Royal Thai Army Medical Department for the new approved system

No.	From PCU - CUP	Total_Minutes
1	Ban To Mai Dang - Royal Thai Army Medical Department	25.68
2	Ban Pak Chong - Royal Thai Army Medical Department	26.18
3	Ban Wang Pla Chuet - Royal Thai Army Medical Department	25.59
4	Ban Nong Ri - Royal Thai Army Medical Department	28.32

Average time spent on commuting from each PCU in CUP Royal Thai Army Medical Department was 26.44 minutes.



Zoning analysis of appropriate health service area in Nakhonnayok province

Figure 4.2 Current zoning of health service area in Nakhonnayok province

Time spent analysis of current zoning showed average time clients spending for commuting from PCU to each CUP in Table 4.7- 4.11.

Table: 4.7 The average time spent for accessing CUP Nakhonnayok hospital for the current system

No.	From PCU - CUP	Total_Minutes
1	Ban Bang Hoi - Nakhonnayok hospital	41.03
2	Ban Bang Prang - Nakhonnayok hospital	38.95
3	Ban Chuat Bua - Nakhonnayok hospital	37.83
4	Ban Dong - Nakhonnayok hospital	38.71
5	Ban J Dee Thong - Nakhonnayok hospital	27.24
6	Ban Khao Nangbuad - Nakhonnayok hospital	31.52
7	Ban Khao Thurain - Nakhonnayok hospital	28.92
8	Ban Khlong Mueang - Nakhonnayok hospital	27.04
9	Ban Nong Tong Sai - Nakhonnayok hospital	31.57
10	Ban Pak Chong - Nakhonnayok hospital	32.05
11	Ban Pak Kra Thum - Nakhonnayok hospital	35.48
12	Ban Si Na Wa - Nakhonnayok hospital	30.94
13	Ban Tha Hae - Nakhonnayok hospital	34.57
14	Ban Tha Khoi - Nakhonnayok hospital	27.39
15	Ban Tha Sai - Nakhonnayok hospital	32.75
16	Ban To Mai Dang - Nakhonnayok hospital	28.10
17	Ban Wang Pla Chuet - Nakhonnayok hospital	32.69
18	Ban Wang Yai Chim - Nakhonnayok hospital	34.76
19	Chaloem Phakiat - Nakhonnayok hospital	34.31

Current average time spent for commuting from each PCU to CUP Nakhon nayok hospital was 32.94 minutes.

Table: 4.8 The average time spent for accessing CUP Banna hospital for the current system

No.	From PCU - CUP	Total_Minutes
1	Ban Bang O - Banna hospital	30.44
2	Ban Kareang – Banna hospital	33.52
3	Ban Khao Noi - Banna hospital	32.59
4	Ban Khao Poem - Banna hospital	34.04
5	Ban Khlong 30 - Banna hospital	29.04
6	Ban Krang Pratu Wang - Banna hospital	27.65
7	Ban Laem Mai Yoi - Banna hospital	25.13
8	Ban Lawa - Banna hospital	29.59
9	Ban Nong Kan Jam - Banna hospital	28.41
10	Ban Nong Ri - Banna hospital	31.13
11	Ban Pai Krang - Banna hospital	23.30
12	Ban Prig - Banna hospital	29.89
13	Ban Tang Krabue - Banna hospital	26.98
14	Ban Thong Lang - Banna hospital	27.32

Current average time spent for commuting from each PCU to CUP Banna hospital was 29.22 minutes.

Table: 4.9 The average time spent for accessing CUP PakPhli hospital for the current system

No.	From PCU - CUP	Total_Minutes
1	Ban Bung Khe - Pak Phli hospital	34.99
2	Ban Dong Ka - Pak Phli hospital	31.15
3	Ban Hualing Nai - Pak Phli hospital	31.33
4	Ban Koh Ka - Pak Phli hospital	36.88
5	Ban Mai - Pak Phli hospital	26.67
6	Ban Na Mai - Pak Phli hospital	33.20
7	Ban Pailo - Pak Phli hospital	27.01
8	Ban Phro Phet - Pak Phli hospital	29.36
9	Ban Sakae Zueng - Pak Phli hospital	35.34

Current average time spent for commuting from each PCU to CUP PakPhli hospital was 31.17 minutes.

Table: 4.10 The average time spent for accessing CUP Ongkharak hospital for the current system

No.	From PCU - CUP	Total_Minutes
1	Ban Bang Nang Lek - Ongkharak hospital	25.52
2	Ban Bon - Ongkharak hospital	28.82
3	Ban Bung Pha A Jan - Ongkharak hospital	31.66
4	Ban Ka Men Fng Tai - Ongkharak hospital	30.92
5	Ban Khlong 24 - Ongkharak hospital	27.67
6	Ban Kklong 23 - Ongkharak hospital	33.06
7	Ban Nai - Ongkharak hospital	27.98
8	Ban Pratu Nam Bang Som Bun - Ongkharak hospital	36.11
9	Ban Toei No - Ongkharak hospital	34.12
10	Chaloem Phrakiat RAMA 9 - Ongkharak hospital	28.24
11	Pak Khlong 22 - Ongkharak hospital	33.56

Current average time spent for commuting from each PCU to CUP Ongkharak hospital was 30.70 minutes.

Table: 4.11 The average time spent for accessing CUP HRH.Mahajakri Sirinthon Medical Center for the current system

No.	Name	Total_Minutes
1	Ban Khlong 14 Nuea - HRH.Mahajakri Sirinthon medical center	33.32
2	Ban Lad Chang - HRH.Mahajakri Sirinthon medical center	35.34
3	Ban Tam Nop - HRH.Mahajakri Sirinthon medical center	37.17

Current average time spent for commuting from each PCU to CUP HRH.Mahajakri Sirinthon medical center was 35.28 minutes.

CUP Royal Thai Army Medical Department has no PCU under responsibility.

4.2 Ratio estimation of medical doctor and nurse

Table 4.12 is show number in change of medical doctors and nurse in each CUP in Nakhonnayok province.

Table: 4.12 Number of Health Personal in Nakhonnayok province, identified by GIS in the fiscal year 2008

CUP	Number of Health Personnel	
	Medical Doctor	Nurse
HRH.Mahajakri Sirinthon medical center	130	263
Nakhonnayok hospital	26	365
Pak Phli hospital	2	36
Banna hospital	8	81
Ongkharak hospital	5	56
Royal Thai Army Medical Department	6	12

Source : Health personal registration data of Nakhonnayok province, Personnel Division, Nakhonnayok Public Health Office, available on February 4, 2008

Table: 4.13 Number of population under responsibility of each PCU in Nakhonnayok province.

CODE	PCU	Population
02384	Ban J Dee Thong	5,992
02385	Ban Tha Khoi	3,268
02386	Ban Khlong Mueang	2,675
02387	Ban Tha Sai	3,371
02389	Ban Bang Hoi	2,940
02390	Ban Bang Prang	2,897
02391	Ban Nong Tong Sai	4,173
02392	Ban Tha Hae	3,864
02393	Ban Si Na Wa	5,035
02394	Chaloem Phrakiat	4,806
02395	Ban Khao Nangbuad	2,998
10195	Ban Dong	2,793
02396	Ban Wang Yai Chim	5,738

Table: 4.13 Number of population under responsibility of each PCU in Nakhonnayok province (Cont.)

CODE	PCU	Population
02397	Ban khao Thurain	5,465
02398	Ban Pak Chong	4,437
02399	Ban To Mai Dang	4,552
02400	Ban Wang Pla Chuet	5,893
11601	Ban Pak Kra Thum	3,895
02388	Ban Chuat Bua	4,664
02401	Ban Pailom	3,768
02402	Ban Mai	2,024
02403	Ban Sakae Zueng	1,063
02404	Ban Dong Ka	1,824
02405	Ban Phrom Phet	2,910
02406	Ban Koh Ka	3,974
02407	Ban Hualing Nai	1,748
02408	Ban Bung Khe	1,601
02409	Ban Na Mai	3,780
02410	Ban Nong Ri	2,454
02411	Ban Tang Krabue	2,731
02412	Ban Nong Kan Jam	4,462
02413	Ban Prig	6,261
02414	Ban Pai Krang	2,409
02415	Ban Thong Lang	2,309
02416	Ban Khlong 30	2,988
02417	Ban Bang O	4,430
02418	Ban Laem Mai Yoi	5,698
02419	Ban Krang Pratu Wang	8,772
02420	Ban Khao Poem	3,152
02421	Ban Khao Noi	3,027
10196	Ban Kareang	2,650

Table: 4.13 Number of population under responsibility of each PCU in Nakhonnayok province (cont.)

CODE	PCU	Population
02422	Ban Lawa	9,169
02423	Pak Khlong 22	3,143
02424	Ban Bung Pha A Jan	3,077
02425	Ban Lad Chang	5,269
02426	Ban Khlong 23	3,360
02427	Ban Khlong 24	3,280
02428	Ban Ka Men Fung Tai	4,418
02429	Ban Toei Noi	1,790
02430	Ban Pratu Nam Bang Som Bun	2,099
02431	Ban Bang Nang Lak	3,357
14302	Chaloem Phrakiat RAMA 9	2,085
02432	Ban Bon	6,877
02433	Ban nai	3,598
02434	Ban Tam Nop	4,937
13825	Ban Khlong 14 Nuea	5,528
10698	Nakhon Nayok Hospital	17,143
10863	Pak Phli Hospital	19,75
10864	Banna hospital	85,45
10865	Ongkharak hospital	42,01
11491	Royal Thai Army Medical Department	37,27
14904	HRH.Mahajakri Sirinthon medical center	34,34
	Total	**254,503**

Source : Population under responsibility of each PCU registration, Nakhonnayok province, Health Guarantee Division, Public Health Office, available on October 1, 2008.

Table: 4.14 The ratio of doctor and nurse per head of population by comparing between the current and the new approved systems

No.	CUP	Ratio doctor		Ratio of Nurse	
		Current system	New approved	Current system	New approved
1	Nakhonnayok hospital	1:3,715	1:3,008	1:265	1:214
2	Banna hospital	1:8,632	1:8,259	1:853	1:861
3	Pak Phli hospital	1:12,334	1:9,815	1:685	1:545
4	Ongkharak hospital	1:8,257	1:9,447	1:737	1:844
5	HRH.Mahajakri Sirinthon medical center	1:1,47	1:172	1:73	1:85
6	Royal Thai Army Medical Department	1:621	1:3,511	1:311	1:1,755

4.3 Comparison on appropriate service

4.3.1 Time spending comparison

Time spent for commuting from PCU to CUP between the current system and the new approved one was different as shown in Figure 4.3.

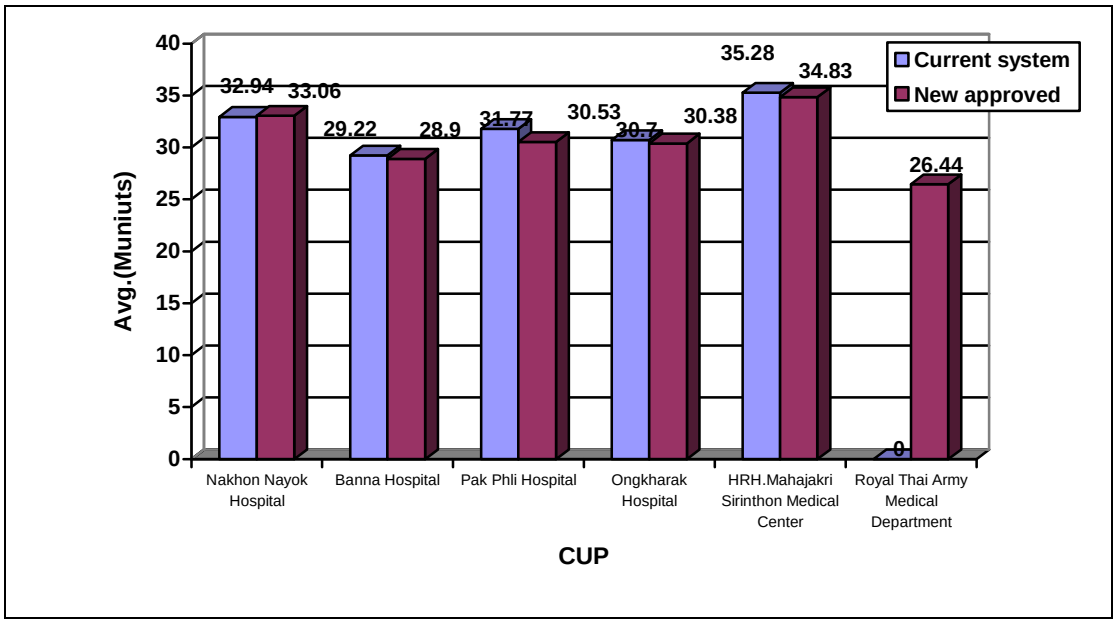


Figure 4.3 The average time spent for commuting from PCU to CUP between the current system and the new approved.

Finding from Figure 4.3 revealed that average time spent was reduced in

- CUP Banna hospital, average time spent for commuting reduced from 29.22 minutes to 28.90 minutes
- CUP Pak Phli hospital, average time spent for commuting reduced from 31.77 minutes to 30.53 minutes
- CUP Ongkharak hospital, average time spent for commuting reduced from 30.70 minutes to 30.38 minutes
- HRH.Mahajakri Sirinthon medical center, average time spent for commuting reduced from 35.28 minutes to 34.83 minutes

Anyway, there were some routes generating the increased time for accessing as

- CUP Nakhonnayok hospital, average time spent for commuting increased from 32.94 minutes to 33.06 minutes
- CUP Royal Thai Army Medical Department , average time spent for commuting increased to meet 26.44 minutes

4.3.2 Doctor and nurse per head of population ratio, compared between current system new approved system

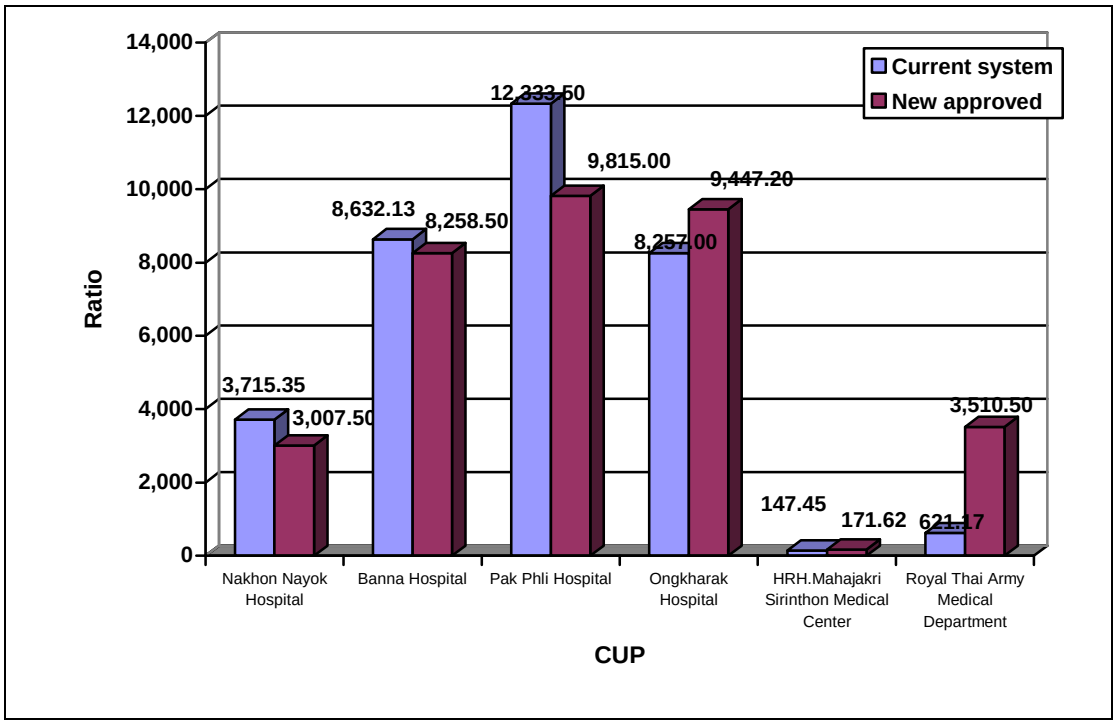


Figure 4.4 The ratio of doctor per population

Finding from figure 4.4 revealed that one medical doctor takes responsibility for reduced number of population as follows:

- CUP Nakhonnayok hospital as one doctor takes responsibility for 1:3,715.35, reducing to be 1: 3,007.5
- CUP Banna hospital as one doctor takes responsibility for 1:8,632.13, reducing to be 1: 8,258.50
- CUP Pak Phli hospital as one doctor takes responsibility for 1:12,333.50, reducing to be 1: 9,815.00

In addition, there are some CUP having increased in responsible population as

- CUP Ongkharak hospital as one medical doctor takes responsibility for 1:8,257.00, increasing to be 1: 9,447.20

- CUP HRH.Mahajakri Sirinthon medical center as one medical doctor takes responsibility for 1:147.45, increasing to be 1: 171.62
- CUP Royal Thai Army Medical Department as one medical doctor takes responsibility for 1:621.17, increasing to be 1: 3,510.50

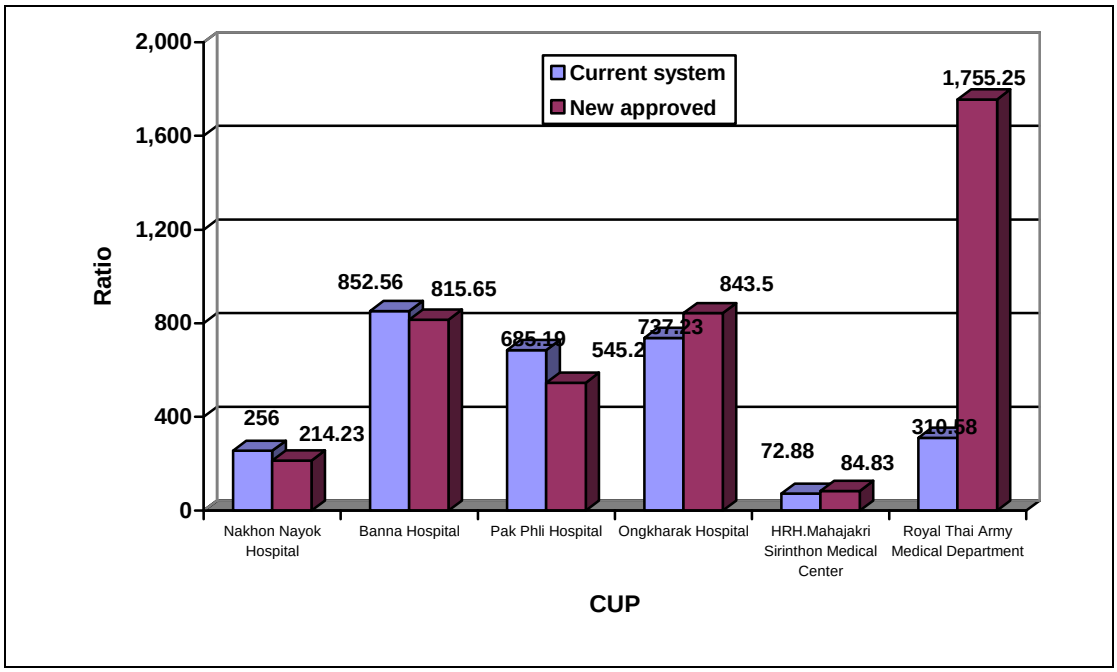


Figure 4.5 The ratio of nurse per population

Finding from Figure 4.5 revealed that one nurse takes responsibility for reduced number of population as follows:

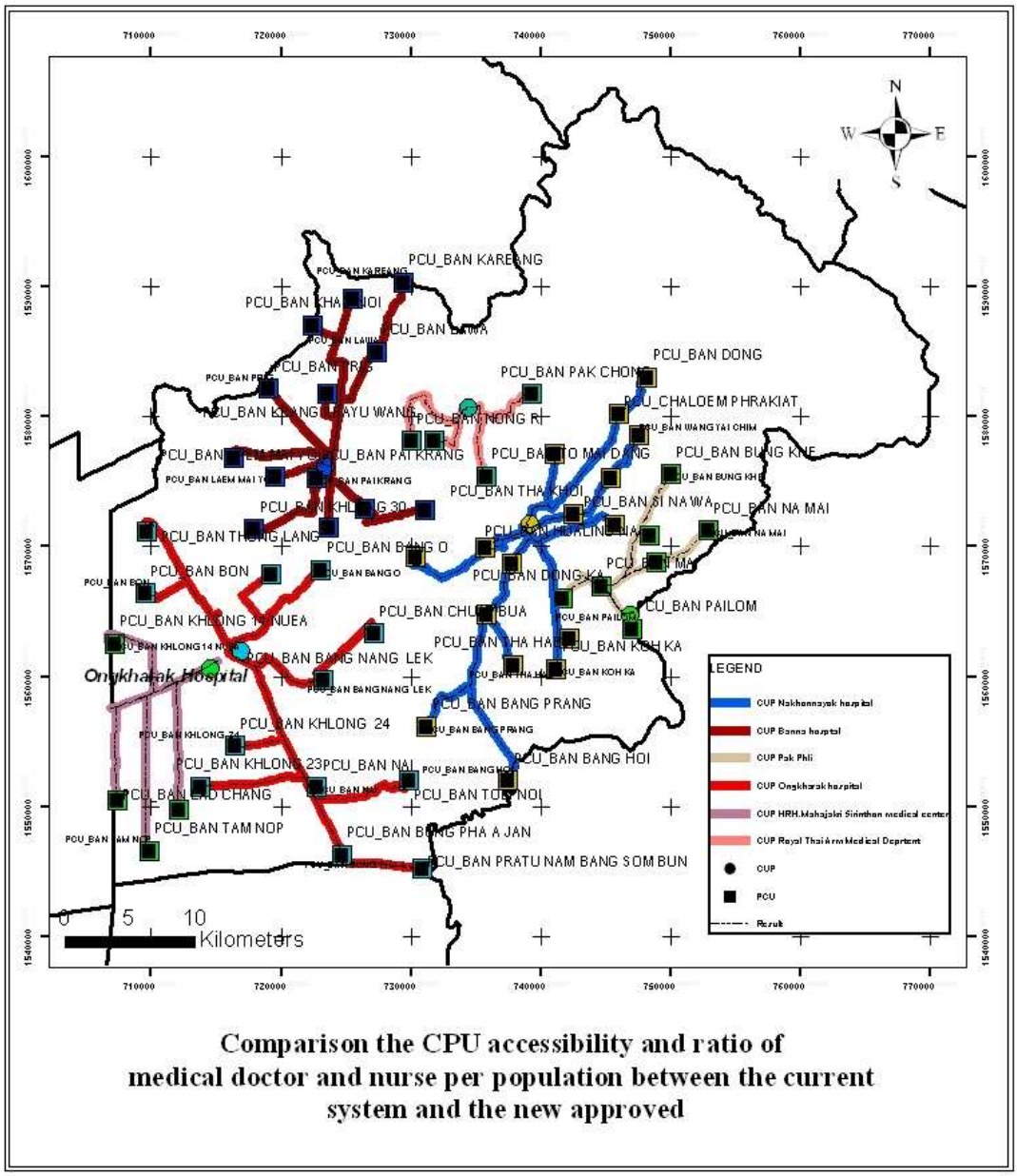
- CUP Nakhonnayok hospital as one nurse takes responsibility for 1:256.00, reducing to be 1: 214.23
- CUP Banna hospital as one nurse takes responsibility for 1:852.56, reducing to be 1: 815.65
- CUP Pak Phli hospital as one nurse takes responsibility for 1:685.19, reducing to be 1: 545.28

Also, there are some CUP having increased in responsible population as:

- CUP Ongkharak hospital as one nurse takes responsibility for 1:737.23, increasing to be 1: 843.50 in the new approved system
- CUP HRH.Mahajakri Sirinthon medical center as one nurse takes responsibility for 1:72.88, increasing to be 1: 84.83 in the new approved system
- CUP Royal Thai Army Medical Department as one nurse takes responsibility for 1:310.58, increasing to be 1: 1,755.25 in the new approved system

4.4 Comparison the CPU accessibility and ratio of doctor and nurse per population

Finding from GIS analysis showed that there are 10 PCUs which can be more easily accessed through the new CUP than the current CUP as revealed in Figure 4.6.



Comparison the CPU accessibility and ratio of medical doctor and nurse per population between the current system and the new approved

Figure 4.6 Comparison the CPU accessibility and ratio of medical doctor and nurse per population between the current system and the new

Finding from GIS analysis showed that there are 10 PCUs which can be more easily accessed through the new CUP than the current CUP as revealed in table 4.15.

Table: 4.15 Time spending between the current CUP and the new CUP

No.	PCU	Time spent for accessing the current CUP(min)	Time spent for accessing the new CUP(min)	Time difference (min)
1	Pak Khlong 22	33.56	33.50	0.06
2	Ban Bang O	30.44	28.02	2.42
3	Ban Chuat Bua	37.83	32.45	5.38
4	Ban Pak Kra Thum	35.48	32.80	2.67
5	Ban Nong Ri	31.13	28.32	2.82
6	Ban Wang Pla Chuet	32.69	25.59	7.10
7	Ban Pak Chong	32.05	26.18	5.87
8	Ban To Mai Dang	28.10	25.68	2.42
9	Ban Sakae Zueng	35.34	33.85	1.49
10	Ban Koh Ka	36.88	35.39	1.49

Regulations for level of hospital and number of health personal per population according to GIS in Nakhonnayok province are shown in table 4.16.

Table: 4.16 Level of hospital and number of health personal per population of each CUP in Nakhonnayok province

CUP	Level	Ratio of Health Personnel/population	
		Medical Doctor	Nurse
HRH.Mahajakri Sirinthon Medical Center	3.1	1: 62,000	1: 5,000
Nakhonnayok hospital	2.3	1: 15,000	1: 3,000
Pak Phli hospital	2.1	1: 10,000	1:1,000
Banna hospital	2.1	1: 10,000	1: 1,000
Ongkharak hospital	2.1	1: 10,000	1: 1,000
Royal Thai Army Medical Department	2.1	1: 10,000	1: 1,000

Source : Health personal registration data of Nakhonnayok province, Personnel Division, Nakhonnayok Public Health Office, available on February 4, 2008

Table: 4.17 Level of hospital and ratio of medical doctor and nurse per population of each CUP in Nakhonnayok province, compared between the current regulation and the new approved system gained from the research

CUP	Ratio of Health Personnel/population The current regulation		Ratio of Health Personnel/population New approved	
	Medical Doctor	Nurse	Medical Doctor	Nurse
HRH.Mahajakri Sirinthon Medical Center	1: 62,000	1: 5,000	1:3,008	1:214
Nakhon Nayok Hospital	1: 15,000	1: 3,000	1:8,259	1:861
Pak Phli Hospital	1: 10,000	1:1,000	1:9,815	1:545
Banna Hospital	1: 10,000	1: 1,000	1:9,447	1:844
Ongkharak Hospital	1: 10,000	1: 1,000	1:172	1:85
Royal Thai Army Medical Department	1: 10,000	1: 1,000	1:3,511	1:1,755

Finding shown in Table 4.17 reveals that the number of health personnel per head of population is lower than the provincial regulation standard in almost all of CUPs, excluding Royal Thai Army Medical Department which is beyond the standard.

4.4.1 Comparison the CPU accessibility and ratio of medical doctor and nurse per population in CUP Nakhonnayok hospital between the current system and the new approved

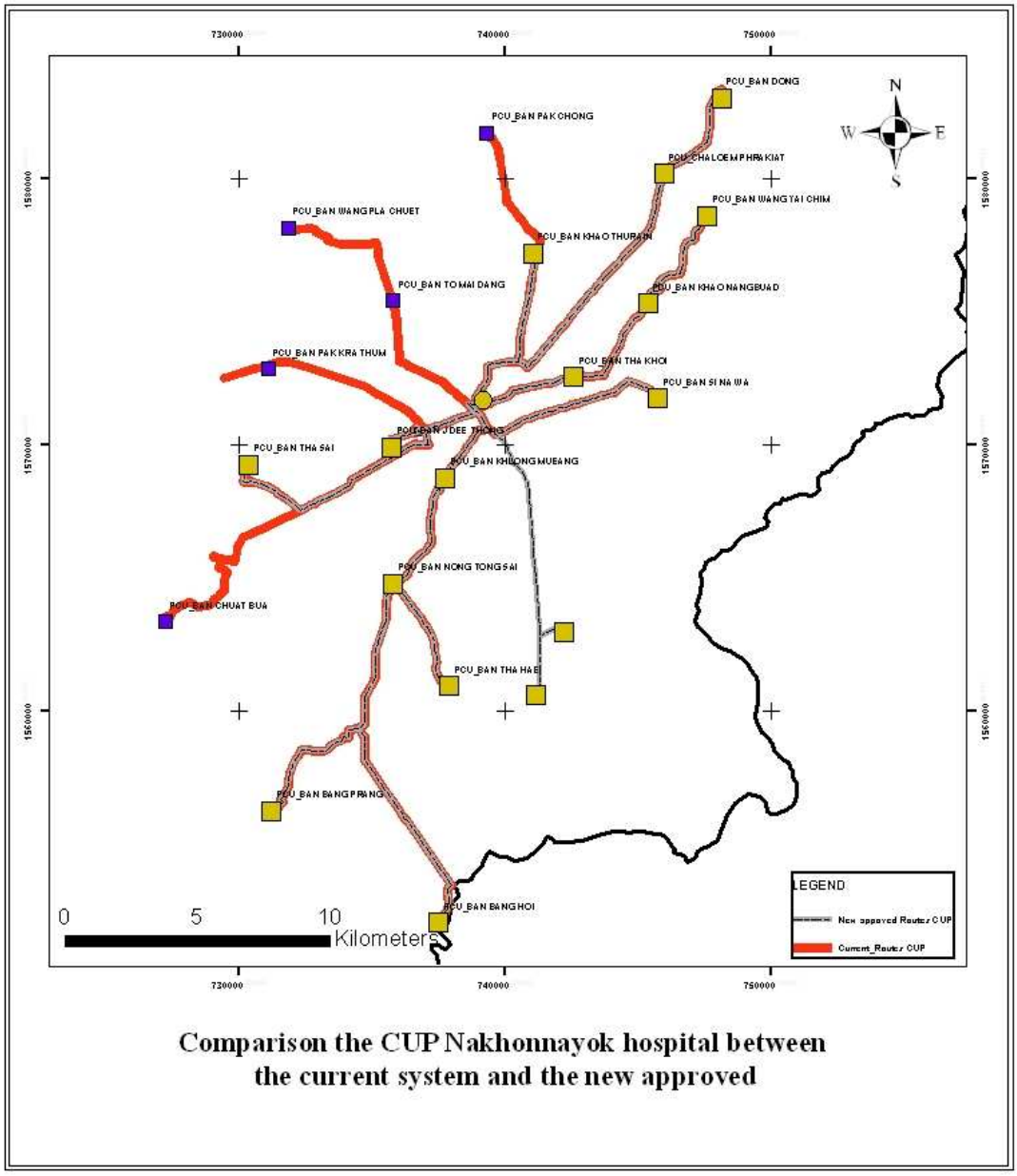


Figure 4.7 Comparison the CUP Nakhonnayok hospital between the current system and the new approved

Zoning analysis for accessing health service and the number of health personnel per head of population in Cup Nakhonnayok hospital by comparing between the current system and the new approved system is shown in Table 4.18

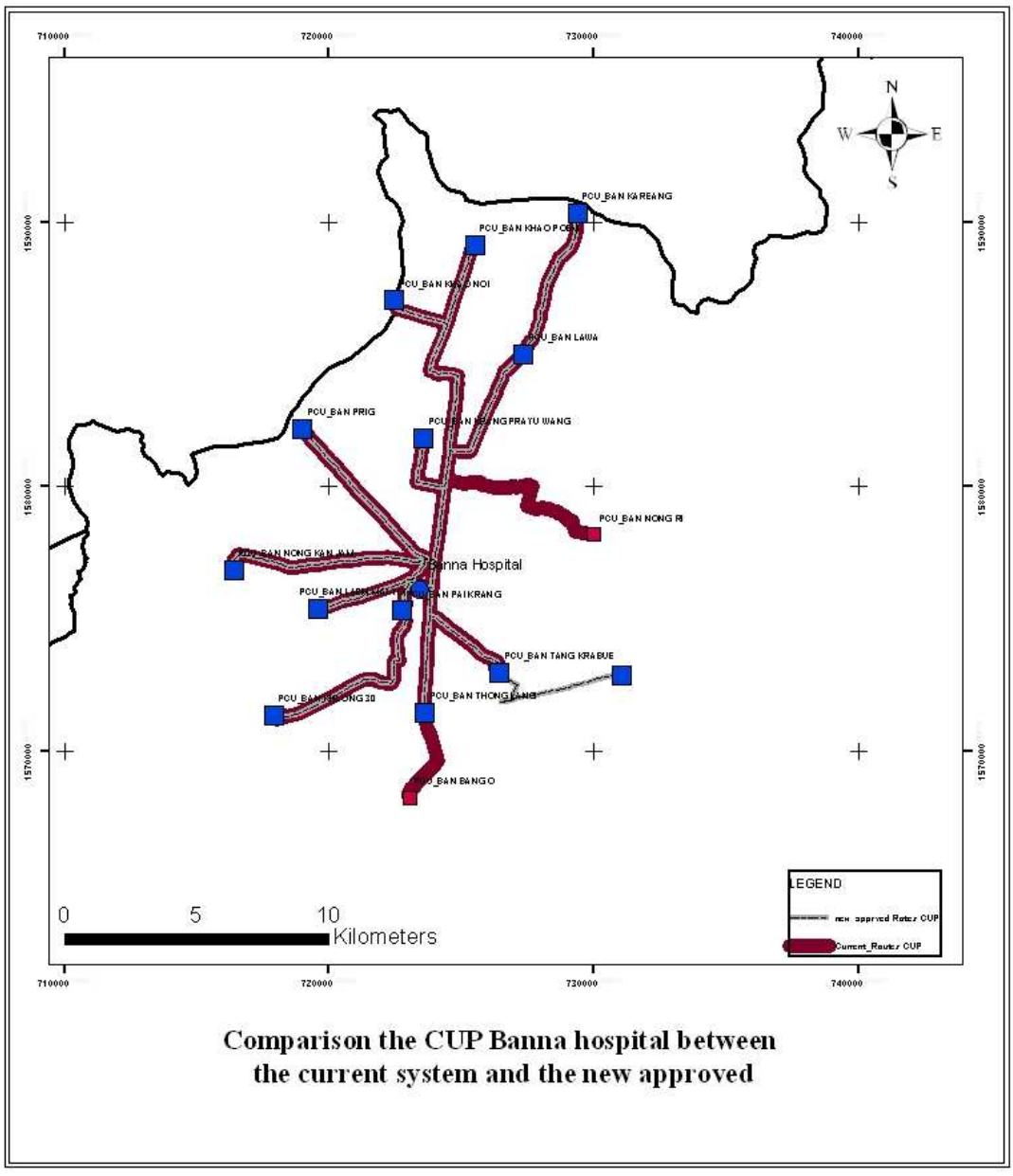
Table: 4.18 Comparison the CUP Nakhonnayok hospital between the current system and the new approved

Change list in CUP	Comparison item	
	Current system	**New approved**
Average time for accessing (min.)	32.94	33.06
Ratio of Health Personnel/population		
• Ratio of Medical doctor (1:Population)	3,715	3,008
• Ratio of Nurse(1:Population)	265	214

It was found that there are 19 current PCUs handling 96,599 of populations and it will decrease to be six PCUs owing to the new approved system for handling 78,195 of populations. In addition, there are two new arrival of PCUs as Ban Koh Ka and Ban Sa Kae Zueng. Also, there are five PCUs moving to be under supervision of the nearby CUP. These PCUs are:

1. Ban Chuat Bua
2. Pakkra Thum
3. Ban Wangpla Chuet
4. To Mai Dang
5. Pak Chong

4.4.2 Comparison the CPU accessibility and ratio of medical doctor and nurse per population in CUP Banna hospital between the current system and the new approved.



Comparison the CUP Banna hospital between the current system and the new approved

Figure 4.8 Comparison the CUP Banna hospital between the current system and the new approved

Table: 4.19 Comparison the CUP Banna hospital between the current system and the new approved

Change list in CUP	Comparison item	
	Current system	New approved
Average time for accessing (min.)	29.22	29.25
Ratio of Health Personnel/population		
• Ratio of Medical doctor (1:Population)	8,632	8,259
• Ratio of Nurse(1:Population)	853	816

It was found that there are 14 current PCUs handling 69,057 of populations and it will decrease to be 13 PCUs owing to the new approved system for handling 66,086 of populations. In addition, there is a new arrival of PCU namely Pakkra Thum .Also, there are two PCUs moving to be under supervision of the nearby CUP. These PCUs are Ban Nong Ri and Ban Bang O.

4.4.3 Comparison the CPU accessibility and ratio of medical doctor and nurse per population in CUP Pak Phli hospital between the current system and the new approved.

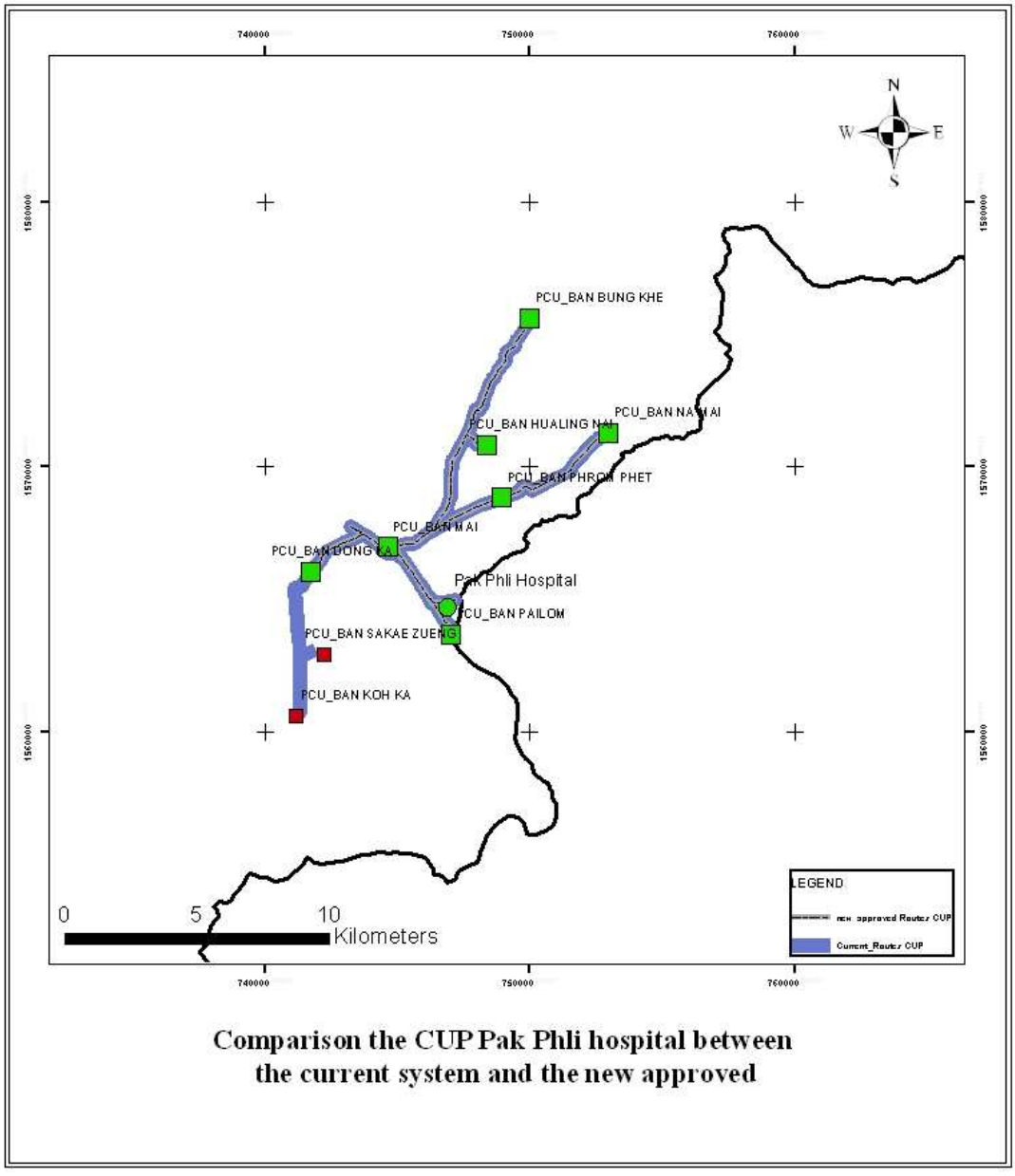


Figure 4.9 Comparison the CUP Pak Phli hospital between the current system and the new approved

Table: 4.20 Comparison the CUP Pak Phli hospital between the current system and the new approved

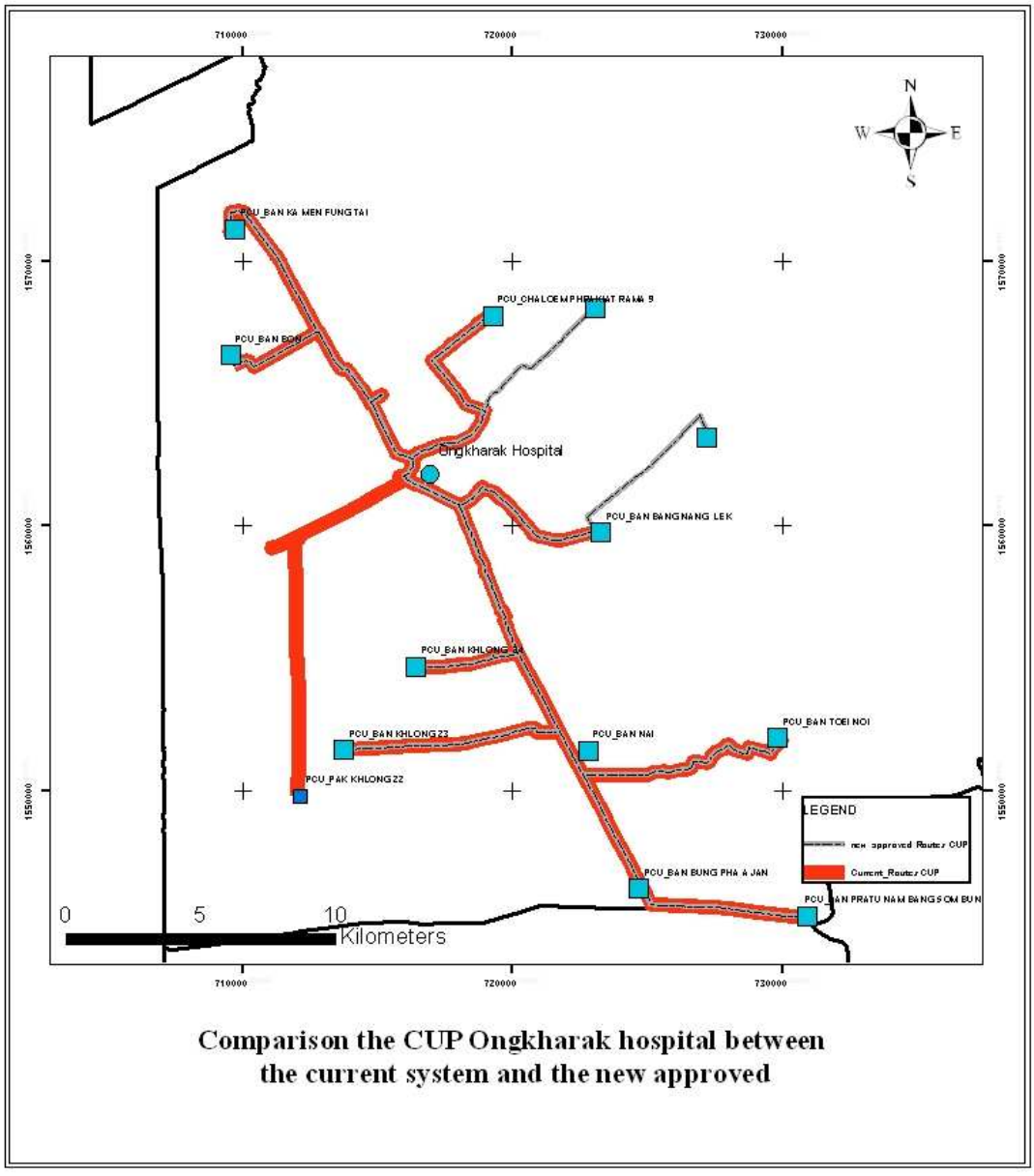
Change list in CUP	Comparison item	
	Current system	New approved
Average time for accessing (min.)	31.17	30.53
Ratio of Health Personnel/population		
• Ratio of Medical doctor (1:Population)	12,334	9,815
• Ratio of Nurse(1:Population)	737	545

It was found that there are nine current PCUs handling 24,667 of populations and it will decrease to be seven PCUs owing to the new approved system for handling only 19,630 of populations. Anyway, there is no new arrival of CPU but there are two CPUs moving to be under supervision of nearby CUP as follows.

1.Ban Sakea Zueng

2.Ban Koh Ka

4.4.3 Comparison the CPU accessibility and ratio of medical doctor and nurse per population in CUP Ongkharak hospital between the current system and the new approved.



Comparison the CUP Ongkharak hospital between the current system and the new approved

Figure: 4.10 Comparison the Cup Ongkharak hospital between the current system and the new approved

Table: 4.21 Comparison the CUP Ongkharak hospital between the current system and the new approved

Change list in CUP	Comparison item	
	Current system	New approved
Average time for accessing (min.)	30.70	30.38
Ratio of Health Personnel/population		
• Ratio of Medical doctor (1:Population)	8,632	8,259
• Ratio of Nurse(1:Population)	853	816

It was found that there are 11 current PCUs handling 41,285 of populations and it will increase to be 12 PCUs owing to the new approved system for handling the higher number by 47,236 of populations. Anyway, there is two new arrival of PCU as follows.

1. Chuat Bua
2. Ban Bang O

Also, there is one CUP moving to be under supervision of the nearby CUP namely:

Ban Pak Klong 22

4.4.3 Comparison the CPU accessibility and ratio of medical doctor and nurse per population in CUP HRH.Mahajakri Sirinthon medical center between the current system and the new approved.

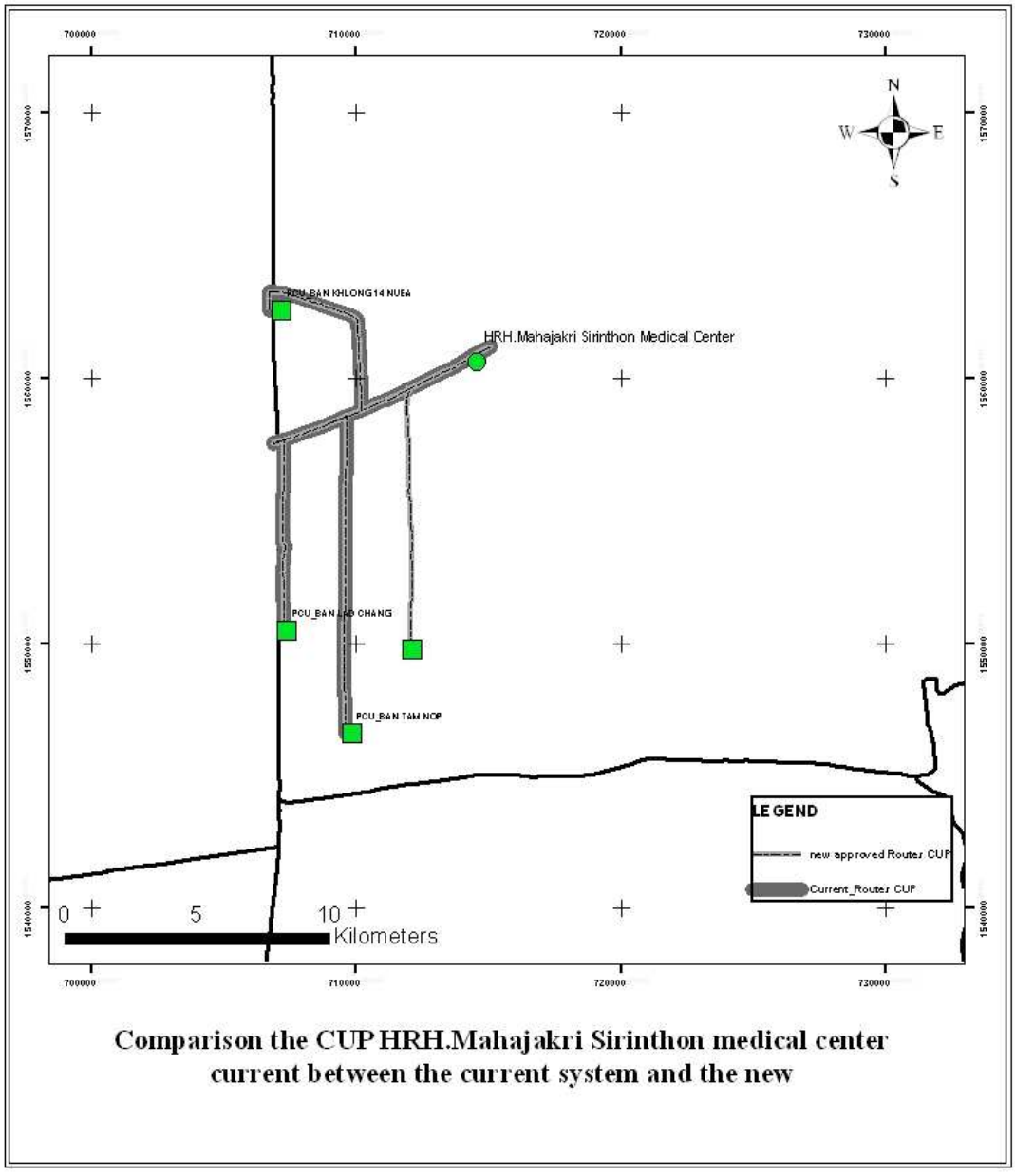


Figure 4.11 Comparison the between the HRH.Mahajakri Sirinthon medical center current system and the new approved

Table: 4.22 Comparison the CUP HRH.Mahajakri Sirinthon medical center between the current system and the new approved

Change list in CUP	Comparison item	
	Current system	New approved
Average time for accessing (min.)	30.70	30.38
Ratio of Health Personnel/population		
• Ratio of Medical doctor (1:Population)	8,632	8,259
• Ratio of Nurse(1:Population)	853	816

It was found that there are 3 current PCUs handling 19,168 of populations and it will increase to be 4 PCUs owing to the new approved system for handling 22,311 of populations. In addition, there is a new arrival of PCU namely Pak Khong 22 and there is no PCU moving to be under supervision of the nearby CUP.

4.4.3 Comparison the CPU accessibility and ratio of medical doctor and nurse per population in CUP Royal Thai Army Medical between the current system and the new approved.

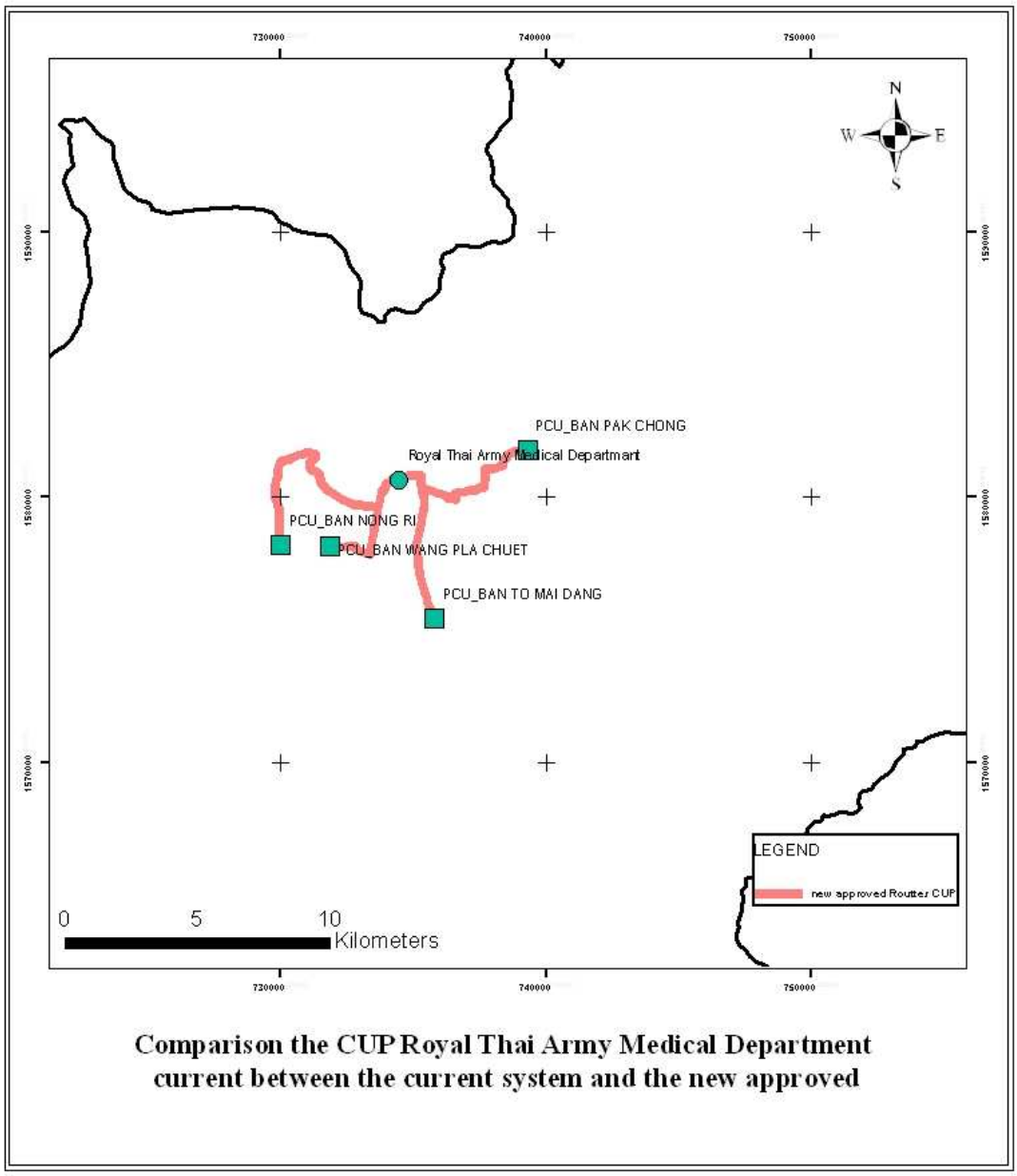


Figure 4.12 Comparison the between the CUP Royal Thai Army Medical Department current system and the new approved

Table: 4.23 Comparison the CUP Royal Thai Army Medical between the current system and the new approved

Change list in CUP	Comparison item	
	Current system	New approved
Average time for accessing (min.)	0.0	26.44
Ratio of Health Personnel/population		
• Ratio of Medical doctor (1:Population)	621	1,755
• Ratio of Nurse(1:Population)	311	1,755

It was found that there no current PCU but it will be 4 new PCUs handling for 21,063 of populations owing to the new approved system. The names of the new PCUs are

1. Ban Nong Ri
2. Ban Wang Pla Chuet
3. Ban To Mai Dang
4. Ban Pak Chong

CHAPTER V
DISCUSSION AND CONCLUSION

5.1 Discussion

A main objective of this research is for providing the appropriate zone of the primary health care unit through GIS, based on time spent on running from PCU to CUP and awaiting time in CUP.

Finding from the analysis showed that time spent for getting service at CPUs and CUPs in Nakhonnayok province was different depended on types and routes of transportation as well as waiting in each CUP. Finding from the research leads to the appropriate model on time management for accessing each CUP of patients which finally brings about appropriate workload among medical doctors and nurses.

This research collected data from many sources and by surveying. Data were analyzed through ArcGIS for finding the appropriate route and time spent for accessing PCU and CUP in Nakhonnayok province. The finding showed that there are 10 PCUs in which people can access with the more appropriate time.

Finding from the analysis can estimate accessibility time of people on commuting from PCU to CUP throughout the province

- Also, researcher found that the current and the new approved routes of transportation is not difference in time due to the location of each PCU is not much far. Furthermore, the size of the province is quite small, being square, thus, transportation routes in the province are normally short.

- The new approved system revealed from this research leads to more appropriate routes of transportation which finally affects the ratio of medical doctor and nurse per head of population. Some areas are in the same while there are some hospitals facing with unbalance ratio of nurse which is needed to be adjusted. Anyway, the finding also mentions the difference among hospitals in terms of their mission and supervision.

- The new approved system shows that average time spent for accessing each CUP was ranged from 30.38 to 34.83 mins. For zoning, the finding showed that there are 10 PCUs which are needed to move to be under supervision of nearby CUPs in order to save accessing time. Even though there is not much in time difference between the current system and the new-approved one (by range between 0.06-7.10 minutes), there are 3 CUPs in which the time spent is different by 5 minutes. These PCUs are PCU Ban Chuat Bua, PCU Ban Pak Chong and PCU Ban Wang Pla Chuat. In fact, time saved by 5 mins. can be very important for the urgent cardiovascular and injured patients.

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There is a specification of career, especially among those who are specialist doctors. In some cases, medical doctors who are specialists are needed but it is not available in some hospitals. Thus, patients always go to the hospitals which can serve their health needs.

5.2 Conclusion

5.2.1The research result confirms that GIS can be applied for calculating the proper route of transportation for accessing CUP with the most time saved.

5.2.2 The current system for accessing each CUP is not much different from the new-approved one due to the small size of the province in which each PCU is located closely to each other.

5.2.3 Moving the PCUs to CUPs for more time saved might be done simultaneously with health personnel adjustment.

5.3 Recommendation

5.3.1 The advantages of Research

5.3.1.1 Route analysis modeling found from this research can be applied for other provinces

5.3.1.2 Time spending estimation concept found from this research can be applied for setting the policy for referred cases to the more proper hospitals.

5.3.1.3 Finding from this research can be applied for distributing health officers to be more proper with the need of the area.

5.3.1.4 Also, finding can be applied for calculating the appropriate health service accessibility among people owing to the government policy which is intended to improve 2-3 PCUs in Amphor and setting Tampon's health promotion hospital.

5.3.1.5 Finding can be also applied for calculating the routes in Nakhonnayok province.

5.3.6 The transportation routes found from this research can be applied for finding the distance among each spot of transportation routes in Nakhonnayok province.

5.3.2 Further For Methodology

5.3.2.1 Distance survey for calculating average speed of each route should be done according to the real time usage of people, for example, in the morning time in which the traffic is quite jam. Finding from the real time survey can lead to the more validity of average time spent. Moreover, the survey should be done throughout the province.

5.3.2.2 In fact, time spent for waiting the traffic light is needed to be counted

5.3.2.3 The routes in which pass the tourist destination is always crowd and consume time. Thus, these routes should be grouped separately for calculating the more proper time spent.

5.3.2.4 Average accessibility time in this research is gained from the Provincial Public Health Office. For more accuracy, real time survey might be needed in order to calculate precisely of minimum and maximum time for service accessibility.

5.3.2.5 The research should be done in other provinces which are bigger in size.

5.3.2.6 Other types of health employee should be employed to include with the further study.

5.3.2.7Population data should come from surveying for more proper calculation

5.3.3 Further for direction

5.3.3.1 Distance survey for calculating average speed of each route should be done according to the real time usage of people, for example, in the morning time in which the traffic is quite jam. Finding from the real time survey can lead to the more validity of average time spent. Moreover, the survey should be done throughout the province.

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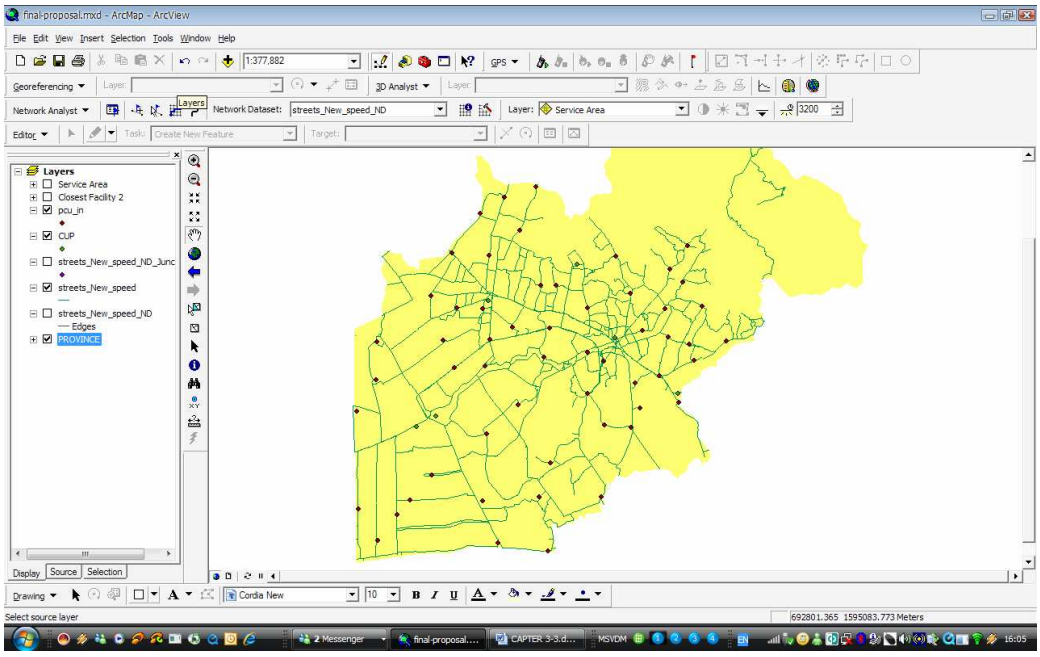
APPENDIX

THE PROCESS OF THE STUDY

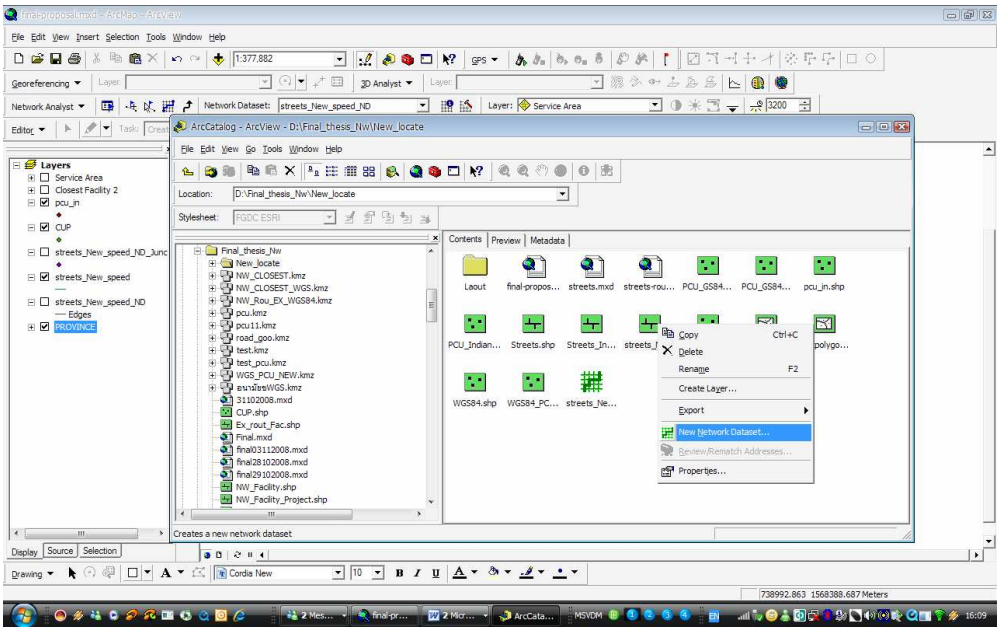
1. Open a view with a line theme.



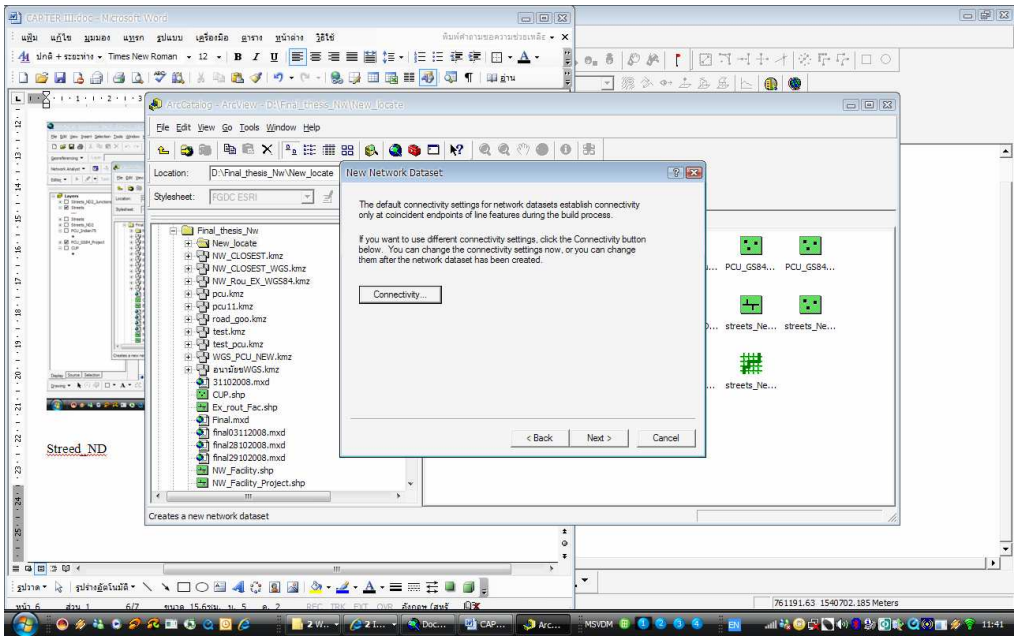
2. Creating a network dataset ArcCatalog.

   2.1 To start ArcCatalog by either double-click a shortcut installed on desktop or using the programs list in Start menu.

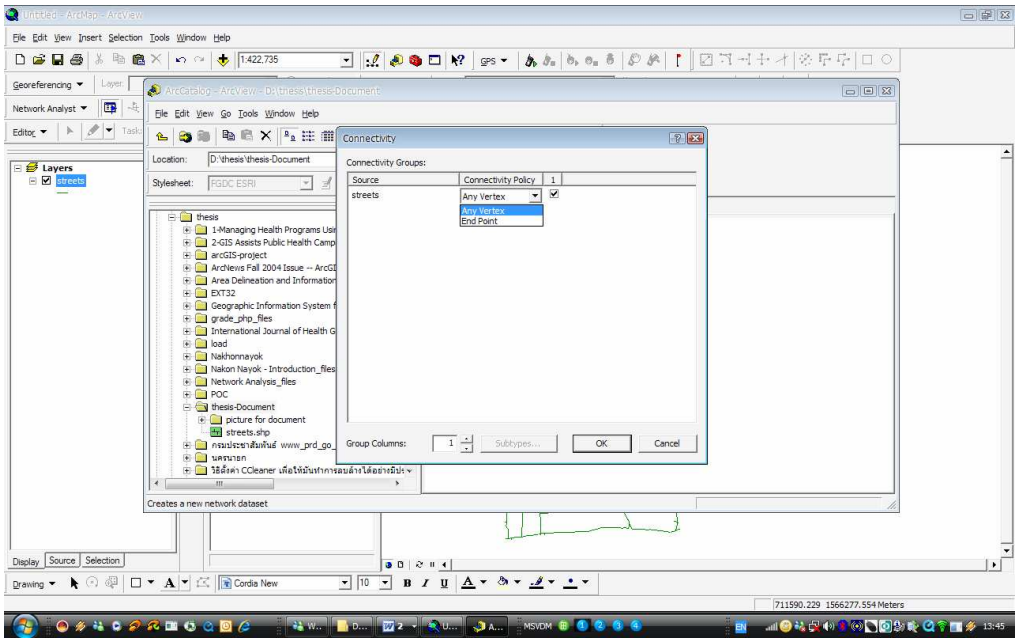
   2.2 Right-click the streets shape file and choose New Network Dataset. This shapefile contains street data for Nakhonnayok Province.

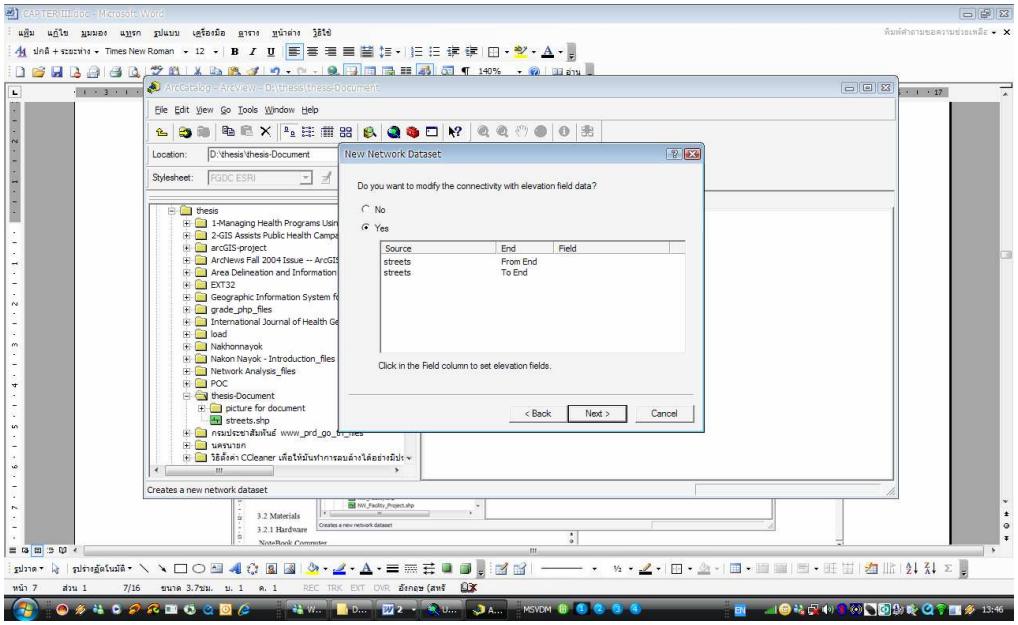


2.3 The name of network dataset is set to Streets_ND by default. Click Next to continue.



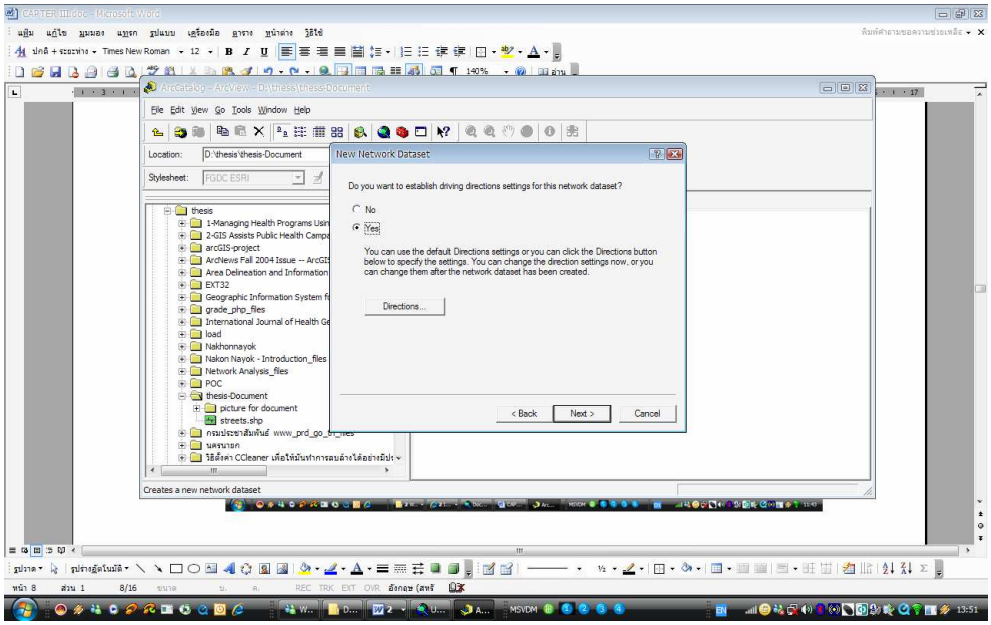
2.4 Click Connectivity to setup connectivity Policy as Any Vertex.



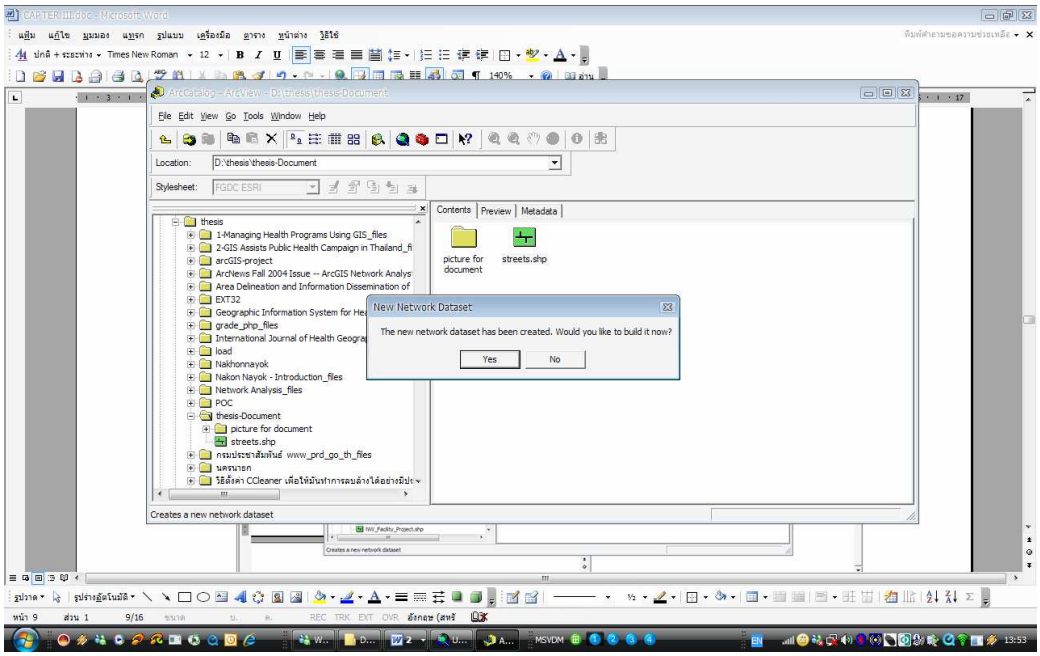


2.5 Click Yes and click Next to continue

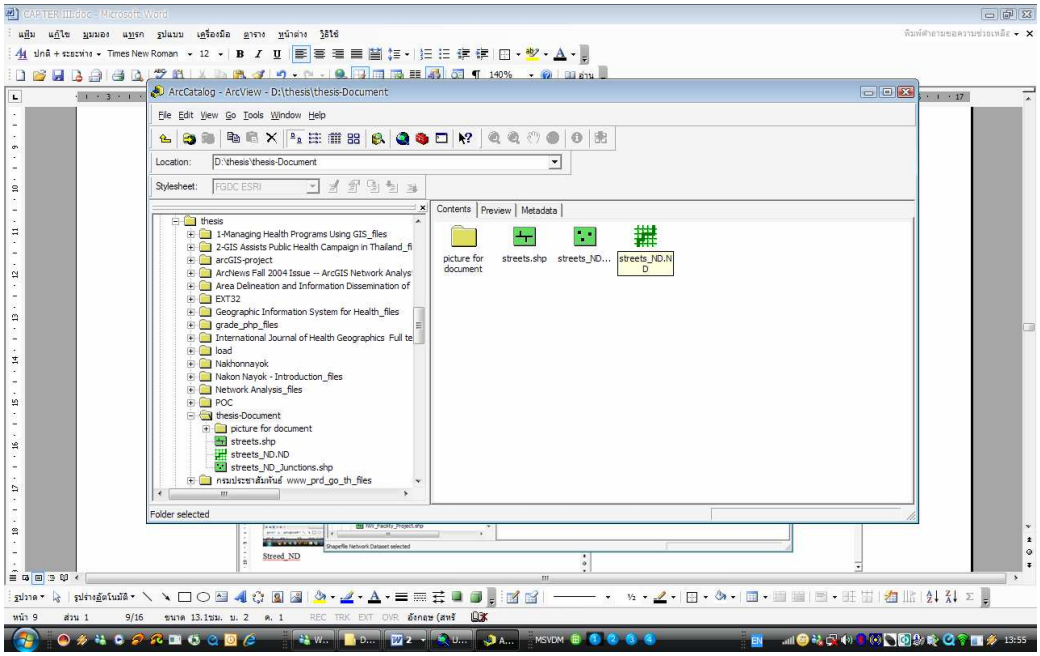
2.6 Click Next to continue.



2.7 Click Yes and click Next to continue

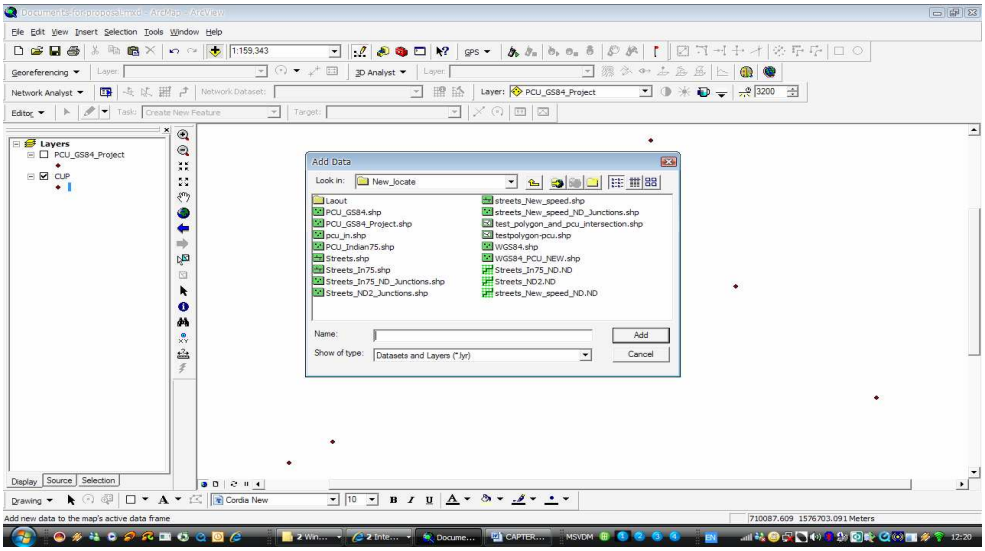


2.8 Would you like to build it now ? Click Yes to build the network dataset have to finish.

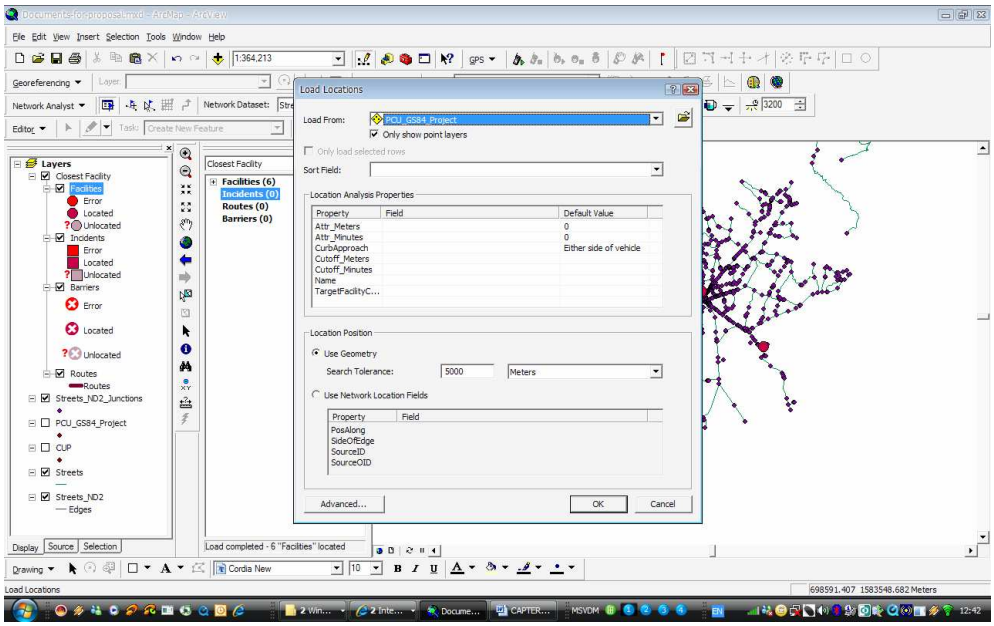


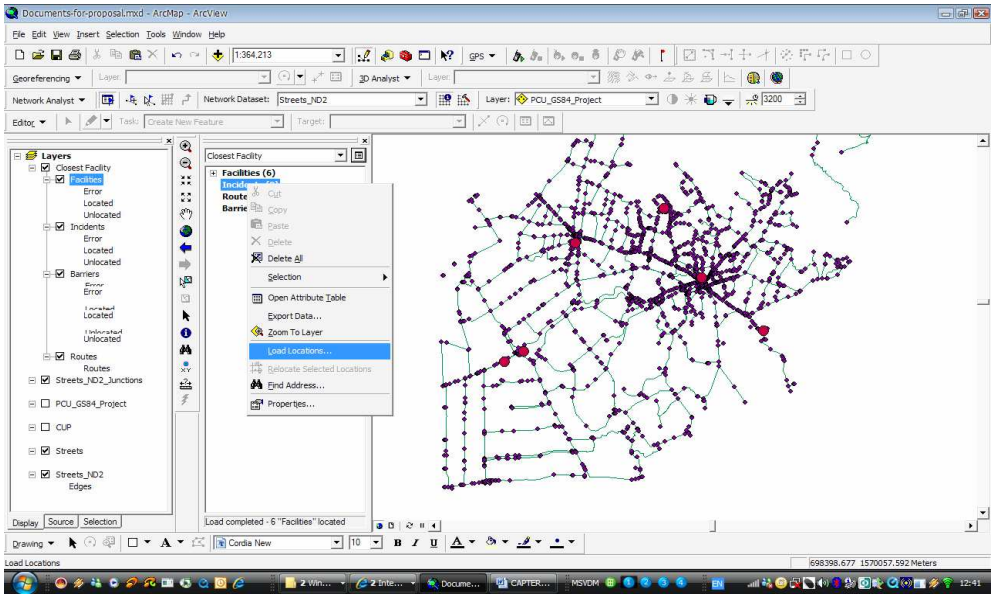
3. Finding the closest facility

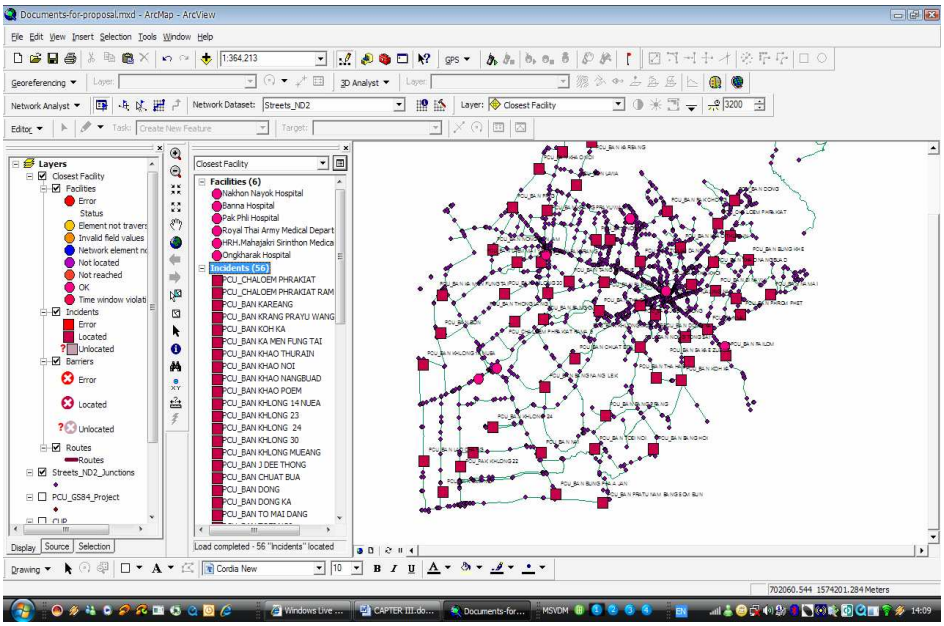
3.1Open a view with streed_ND.ND theme



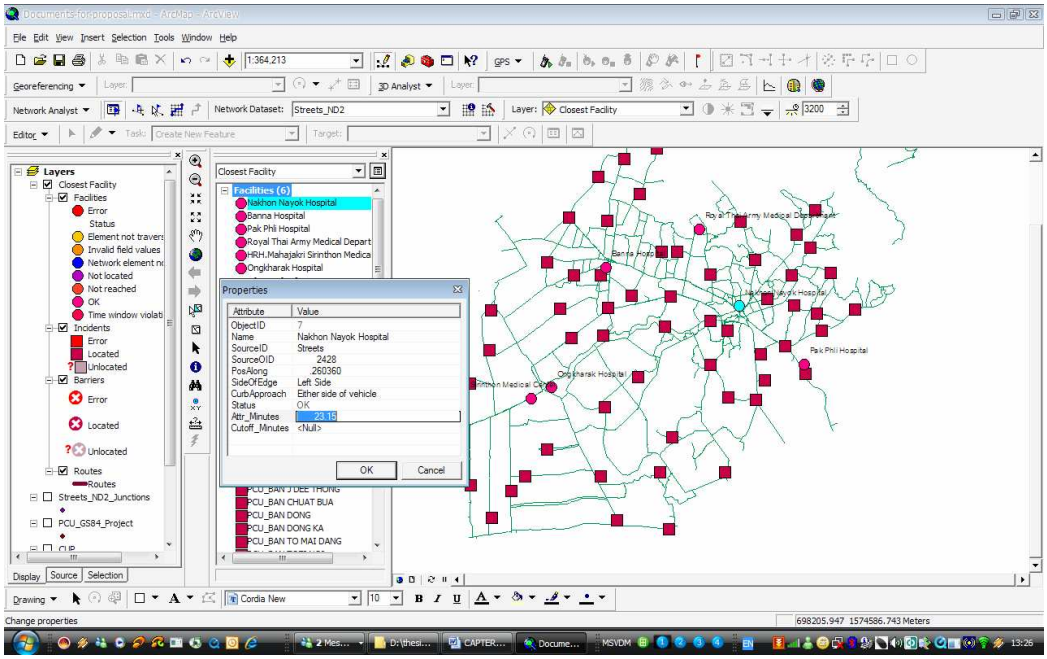
3.2 Right-click the facilities to load CUP location and the Incidents to load PCU location


Load Locations
Load From:
PCU_GS84_Project
Only show point layers
Only load selected rows
Sort Field:
Location Analysis Properties
Property
Field
Default Value
Attr_Meters
Attr_Minutes
CurbApproach
Either side of vehicle
Cutoff_Meters
Cutoff_Minutes
Name
TargetFacilityC...
Location Position
Use Geometry
Search Tolerance:
5000
Meters
Use Network Location Fields
PosAlong
SideOfEdge
SourceID
SourceOID
Advanced...
OK
Cancel
Load completed - 6 "Facilities" located
Load Locations
698591.407 1583548.682 Meters

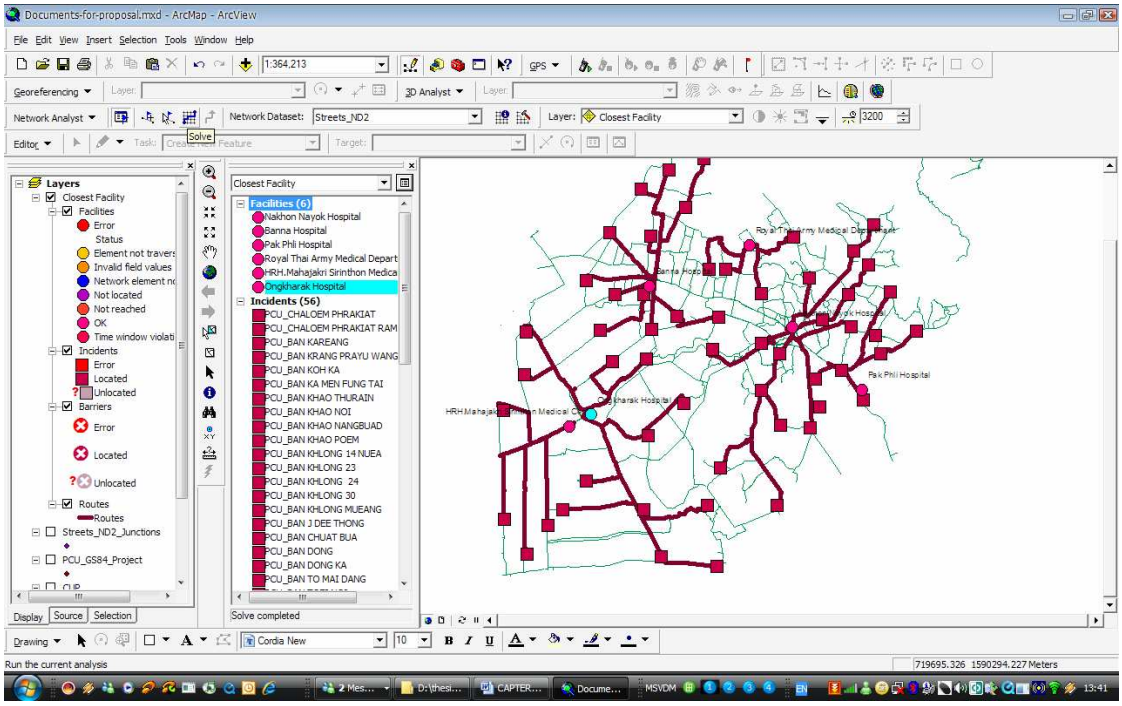

Documents-for-proposal.mxd - ArcMap - ArcView
Cut
Copy
Paste
Delete
Delete All
Selection
Open Attribute Table
Export Data...
Zoom To Layer
Load Locations...
Relocate Selected Locations
Find Address...
Properties...
Load completed - 6 "Facilities" located
Load Locations
698398.677 1570057.592 Meters



4. Setup for waiting for service at CUP



4.2 Click Solve bottom to finish



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