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Accessibility and Service Availability of Health Care Facilities in selected Urban and Rural Municipalities of Kapilbastu and Rupandehi Districts, Nepal

by

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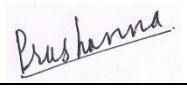
Science Pledge

By my signature below, I certify that my project report is entirely the result of my own work. I have cited all sources of information and data I have used in my project report and indicated their origin.

29/6/2021	
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I would like to express my special thanks and gratitude to Dr. Shahnawaz who gave me the opportunity and fruitful guidance to do this project on the topic " The Accessibility and Service Availability of Health Care Facilities of selected Urban and Rural Municipalities of Kapilbastu and Rupandehi Districts, Nepal".

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Abstract:

Health care facility means an office or institution providing care or treatment of diseases, whether physical, mental, or emotional, or other medical, physiological, or psychological conditions, including but not limited to, hospitals, rehabilitation hospitals, or other clinics, including weight control clinics, nursing homes, homes for the aging or chronically ill, laboratories, and offices of surgeons, chiropractors, physical therapists, physicians, dentists, and all specialists within these professions. The accessibility and availability of health care facilities are identified as the basic right of humans. Accessibility mainly depends on the availability and affordability of the services. The study mainly focused on the accessibility, health care facilities infrastructure, human resources, service utilization, and service availability of the health care facilities of Krishnanagar Urban Municipality and Shuddhodhan Rural Municipality of Kapilbastu District same as Lumbini Sanskritik Urban Municipality and Kotahimai Rural Municipality of Rupandehi District. The study applied ArcGIS Raster-based analysis to create service areas based on travel time. The population lies in the service area of health care facilities and the hospital was calculated by utilizing overlay analysis. The municipality's health care facility availability index was analyzed using the service availability and readiness assessment (SARA) method.

The study shows that 10, 5 8, and 6 health care facilities were present in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively where One hospital and 9 health posts in Krishnanagar Urban Municipality were as one primary hospital; one primary hospital and 4 health post in Shuddhodhan Rural Municipality; one primary hospital and 7 health post in Lumbini Sanskritik Urban Municipality; one primary hospital and 5 health post in Kotahimai Rural Municipality. Within the study area, households of 6743 and a population of 53520 in Krishnanagar Urban Municipality, household of 6628 and populations of 56857 in Shuddhodhan Rural Municipality, household of 10113 and populations of 82081 in

Lumbini Sanskritik Urban Municipality, and household of 6417 and populations of 4591 in Kotahimai Rural Municipality are present.

When comparing the urban and rural municipality of Kapilbastu District shows that the accessibility of the primary hospital of Krishnanagar Urban Municipality is better than Shuddhodhan Rural Municipality and the accessibility of all Health care facilities of Krishnanagar Urban Municipality is nearly the same as that of Shuddhodhan Rural Municipality. When comparing the urban and rural municipality of Rupandehi District show that the accessibility of the primary hospital of Kotahimai Rural Municipality is better than Lumbini Sanskritik Urban Municipality and the accessibility of all Health care facilities of Kotahimai Rural Municipality is nearly the same as that of Lumbini Sanskritik Urban Municipality. Comparing the two urban municipalities show the accessibility of the primary hospital of Krishnanagar Urban Municipality is better than Lumbini Sanskritik Urban Municipality and the accessibility all health care facility of Krishnanagar Urban Municipality is nearly same as Lumbini Sanskritik Urban Municipality. Comparing the two rural municipality show that the accessibility of primary hospital of Kotahimai Rural Municipality is better than Shuddhodhan Rural Municipality and the accessibility of all health care facilities of Kotahimai Rural Municipality is nearly same as Shuddhodhan Rural Municipality.

In three conditions, compare between the urban and the rural municipality of Kapilbastu District, the service availability index of the urban municipality, i.e. Krishnanager Urban Municipality is Higher than that of rural municipality i.e. Shuddhodhan Rural Municipality. In the same way, compare between the urban and the rural municipality of Rupandehi District, the service availability index of Urban Municipality i.e. Lumbini Sanskritik Urban Municipality is lesser than Urban Municipality i.e. Kotahimai Rural Municipality except by using the catchment population of primary hospital. Likewise, comparing urban municipality of two District (Kapilbastu and Rupandehi), the service availability index of the urban municipality of Kapilbastu District is higher than of Rupandehi District and collating rural municipality of

two District, the service availability index of the rural municipality of Kapilbastu District is lesser than the Rupandehi District.

Thus, Overall accessibility to health care facilities of all four municipalities is far better. The majority of the population of both municipalities can be reached to health care facilities within 30 minutes' travel time but the service availability of all four municipalities is under target set by World Health Organization (WHO) which required improvement. Comparatively, Krishnanagar Urban Municipality has better service availability than the other three municipalities. Krishnanagar Urban Municipality has superior service availability than Lumbini Sanskrit Municipality and Kotahimai rural municipality has better service availability than the Shuddhodhan Rural Municipality. Mainly population growth, better public transportation, and economic activities were a major factor which affects the accessibility of health care facilities, on the other hand, number of the facility, inpatient, outpatient, hospital admission rate, number of beds, and health worker in the hospital was the factor effect the service availability of municipality. It is very important to balance the population, accessibility, and service availability of the health care facility.

Table of Contents

List of Tables

List of Figures

List of Maps

Acronyms and Abbreviations

CBS	: Central Bureau Statistics
CSV	: Common Separated Values
ESRI	: Environmental System Research Institute
GIS	: Geographic Information System/Science
HP	: Health Post
kmph	: Kilometers per hour
MSS	: Minimum Service Standard
N	: Number
OD	: Origin and Destination
OSM	: Open Street Map
SA	: Service Area
SARA	: Service Availability and Readiness Assessment
S.N	: Serial Number
Sqkm	: Square Kilometer
UN	: United Nations
UNICEF	: The United Nations Children's Fund
UTM	: Universal Transverse Mercator
VR	: Village Road
WASH	: Water, Sanitation and Hygiene
WGS	: World Geodetic System
WHO	: World Health Organization
WN	: Ward No

Chapter-1. Introduction

1.1. Background

Health care facility means an office or institution providing care or treatment of diseases, whether physical, mental, or emotional, or other medical, physiological, or psychological conditions, including but not limited to, hospitals, rehabilitation hospitals, or other clinics, including weight control clinics, nursing homes, homes for the aging or chronically ill, laboratories, and offices of surgeons, chiropractors, physical therapists, physicians, dentists, and all specialists within these professions (Health care facility Definition: 2k Samples | Law Insider, 2021). According to World Health Organization (WHO), "Healthcare facilities are hospitals, primary health care centers, isolation camps, burn patient units, feeding centers, and others". Health care facilities help to improve the quality of life and social well-being of contemporary society. Accessibility mainly depends on the availability and affordability of the services (Rekha et al., 2017). The main role of a health care facility is to provide continuous and comprehensive care to the patients. It also helps in making the patient available with the various social welfare and public health services initiated by the concerned governing bodies and other organizations (CCCHC, 2020). In an international organization such as the United Nations (UN) and the WHO, the accessibility and availability of health care facilities are regarded as fundamental human rights. When people choose a health care facility, they want to consider how close it is since they live or work and people will consider that whether a health care provider can treat you and finally the quality of the facility (MedlinePlus, 2020). Service availability refers to the physical presence of the delivery of services, encompassing health infrastructure, core health personnel, and service utilization (WHO, 2021). Health care facility availability is defined as the presence of a trained provider at a facility when expected and providing the services as defined by his or her job description (PHCPI, 2018).

People living in rural areas suffer from a lack of access to healthcare services as people living in urban areas. Most of the health care facilities are located in urban areas and most of the time only option to reach health care facilities to get treatment is the foot which causes the delay to reach health care facilities to get treatment (Pokharel, 2013). A significant component of the health care system is the human health resource (Sherchand, 2013). But two-third of government staff are working in the Kathmandu Valley or in other major cities which create a lack of human resource in a rural area (MoHP, 2015). In the rural area, most of the roads are earthen and gravel roads which are in poor condition, and during the monsoon season, earthen roads are more chance to damage (The Rising Nepal, 2020). Primary health care services are provided by government health care facilities. Rural people are fully dependent upon these facilities because modern health care facilities are centralized around the urban and semi-urban areas and their service is expensive which can't be offered by rural people (Yadav, 2010). Accessibility of health care facilities is the distance or time taken to access from facilities by the demand (Batty, 2009). The purpose of the project is to identify the accessibility and service availability of existing health care facilities and find out that the health care facilities are sufficient for the people living in the municipality. The study will help the municipality and the district level decision-maker to improve the quantity and quality of existing health care facilities by identifying the service availability, human resource of health care facilities, distribution, the proportion of health care facilities to population, and travel time to reach the health care facilities. This study will help the planner to decide on additional health care facilities at the municipality level.

1.2. Objective

The main objective of the study is to assess the accessibility and service availability of health care facilities of Krishnanagar Urban Municipality and Shuddhodhan Rural Municipality of Kapilbastu District and Lumbini Sanskrit Urban Municipality and Kotahimai rural municipality of Rupandehi District.

The specific objectives of this project are:

- To study the location of the distribution of the health care facilities.
- What type of service is provided by the health care facilities?
- To study service availability of health care facilities by the municipality
- Calculate the travel time required to access the desired health care facilities within the study area.
- Calculate household and population access to health care facilities in different travel.
- To identify the ratio of service availability of health care facilities by the municipality to population.

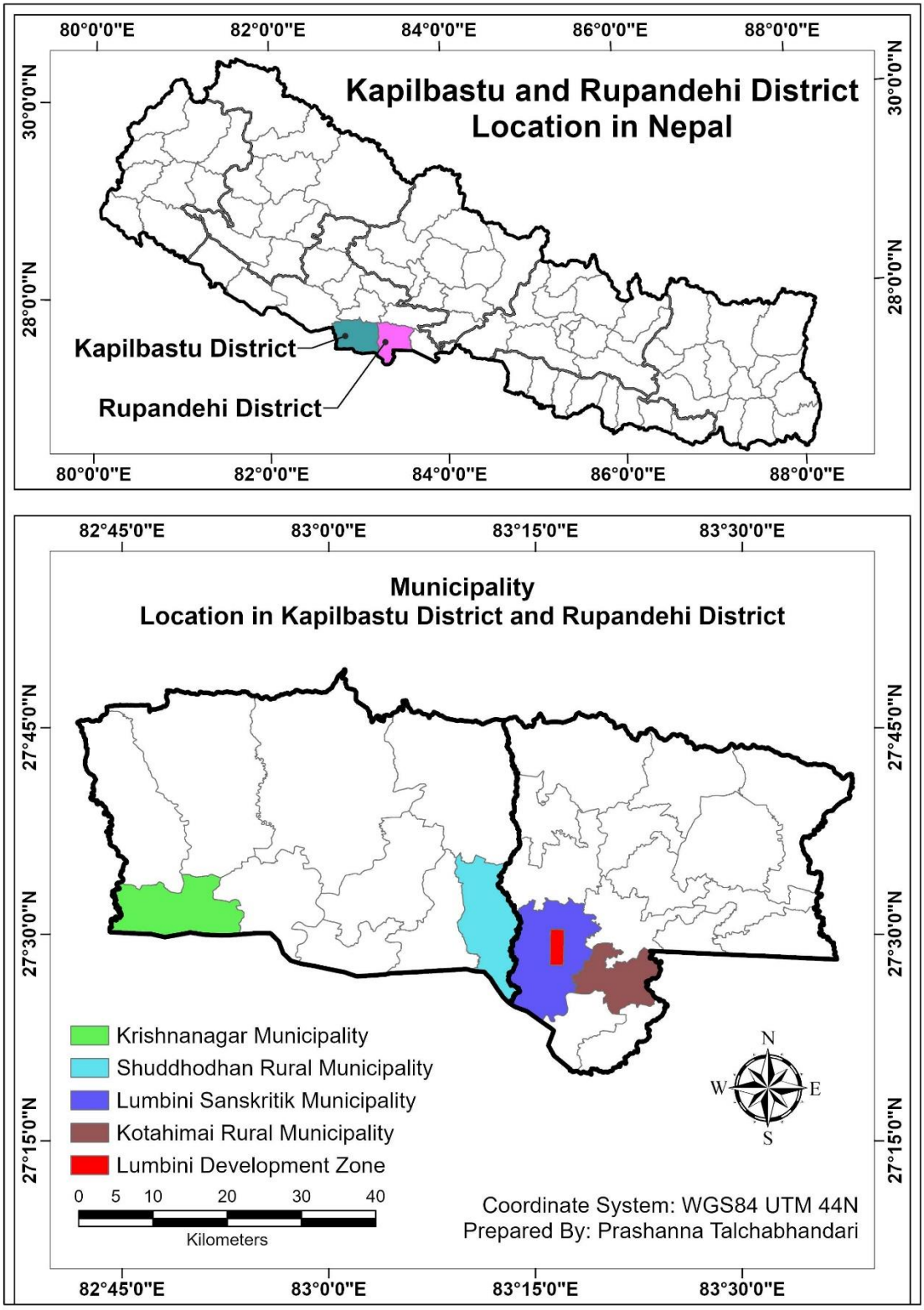
1.3. Study Area

The study was carried out in Krishnanagar Urban Municipality and Shuddhodhan Rural Municipality of Kapilbastu district; Lumbini Sanskritik Urban Municipality and Kotahimai Rural Municipality of Rupandehi district of Province 5, Nepal (Map 1.1). The extent boundary of Krishnanagar Urban Municipality is from 27º 34' 21"N, 82º 44' 13"E to 27º 34' 20"N, 82º 53' 58"E. The total geographic area of Krishnanagar Urban Municipality is 96.63 Sqkm.

According to the census 2011, the male population is 32357, the female population is 30065 and the total population is 62422. Similarly, the extended boundary of Shuddhodhan Rural Municipality is from 27º 35' 56"N, 83º 9' 7"E to 27º 25' 4" N, 83º 13' 58"E. The total geographic area of Krishnanagar Urban Municipality is 91.70 Sqkm. According to the census 2011, the male population is 22828, the female population is 22473 and the total population is 45301.

The extended boundary of Lumbini Sanskritik Urban Municipality is from 27º 32' 39"N, 83º 13' 0.34"E to 27º 23' 38" N, 83º 19' 48"E. The total geographic area of Lumbini Sanskritik Urban Municipality is 112.26 Sqkm. According to the municipality profile, the male

population is 19651; the female population is 14731 and the total population is 34383 (Lumbini Sanskritik Urban Municipality Profile, 2021).



Map 1.1. Location Map

The Lumbini Development Zone is excluded from the study area. The Lumbini is unique as a spiritual, historical, and archaeological site. It is of major global interest and importance and was inscribed on the UNESCO World Heritage List in 1997 (UNESCO 1998:46). The Lumbini Development Master Plan was approved by the Nepal Government in1978. The Lumbini Development Zone spread 1 x 3 square miles oriented along the north-south axis, encompasses three zones (1) the Sacred Garden, (2) the Monastic Zone, and (3) the New Lumbini Village, based on the notion of the path to enlightenment. Each of the zones covers an area of a square mile. The Lumbini Development Zone was designed by a Japanese architect prof. Kenzo Tange in1978 (Molesworth and Muller-Boker, 2021; Lumbini Development trust, 2021).

The extent boundary of Kotahimai Rural Municipality is from 27º 29' 22"N, 83º 17' 37"E to 27º 24' 11" N, 83º 24' 9" E. The total geographic area of Kotahimai Rural Municipality is 58.26 Sqkm. According to the municipality profile of Kotahimai Rural Municipality, the total household number is 5,593, the male population is 18303, the female population is 19932 and the total population is 41006 (Kotahimai Rural Municipality, 2021).

1.4. Literature Review

1.4.1. Access and Accessibility of Health care facilities

In an International organization such as the UN and World Health Organization WHO, accessibility to healthcare facilities is identified as the basic right of humans. Accessibility is an important indicator of equity in the health system. Accessibility and access are often used interchangeably in many fields such as medicine and social sciences. Access refers to the capacity of people to obtain healthcare at the right place (Humphreys and Smith, 2009). Access to health care is the relationship between need, provision, and utilization of health services. Access to health care is concerned to improve the health of people with health care resources (Gulliford et al., 2002). According to Humphreys and Smith, " Healthcare accessibility refers to the extent to which individuals and communities can easily

obtain health services when needed. The most basic dimension of healthcare accessibility is geographical reflecting the spatial separation of healthcare consumers (the demand side of the concept) and the healthcare facilities and services themselves (the supply side)". Penchansky and Thomas (Penchansky and Thomas, 1981) have defined five dimensions of access: 'availability', 'accessibility', 'accommodation', 'affordability', and 'acceptability'.

- 'Availability', the relationship between the quantity and type of existing services. It refers to the adequacy of the health care systems and services to meet the needs of individuals and populations.
- 'Accessibility', the relationship between the location of supply and the location of clients, taking account of client transportation resources, travel time, distance, and cost.
- 'Accommodation', the relationship between how the supply resources are organized to accept clients.
- Affordability, the relationship of prices of services and providers' insurance, ability to pay, and existing health insurance.
- 'Acceptability', the relationship of clients' attitudes toward provider personal behavior as other characteristics of providers'.

For a healthy society, availability of and accessibility to health services are important factors (Reshadat et al., 2019).

1.4.2. Measuring Accessibility

The Measures of accessibility are defined as " quantify the relationship between obstacles arising from the geographic location of services (travel time, cost, distance) and the capacities of potential healthcare users to overcome these obstacles" (Humphreys and Smith, 2009).

Accessibility can be divided into two categories: Potential and revealed accessibility (Joseph and Phillips, n.d.). Potential accessibility deals with the actual use of health care services and the revealed accessibility focus on the geographical patterns and aggregate supply of medical care resources (Murad, 2007). By Wang and Luo (2005), Health care accessibility is divided into two categories into spatial and non-spatial accessibilities. Spatial

accessibility emphasizes the importance of geographic barriers (distance or time) between consumers and providers whereas non-spatial accessibility focuses on non-geographic barriers or facilitators such as social class, income, ethnicity, age, sex, etc. (Wang and Luo, 2005). As accessibility can be measured by a different approach, depending upon the parameters, data used, and application. Geographic Information System (GIS) has introduced a new approach to analyzed and visualized accessibility through the management of larger data sets and increased the accuracy and sophistication (Humphreys and Smith, 2009). The accessibility tools available in a GIS are divided into two main types: raster data model and vector data model (Murad, 2007).

1.4.2.1 Network (Vector)-based data model

The basic network data model represents a series of nodes (points) that are connected by edges (lines). Many recent studies of health service accessibility have utilized the network data model for calculating travel time estimates (Delamater et al., 2012). Gravity or spatial interaction models are considered advanced tools for defining the accessibility of vector data. These tools are offered by some GIS software such as ArcGIS (Murad, 2007).

One of the methods used to measures accessibility is Euclidean (distance measure). Impedance is the major character's that affect measures of geographical accessibility. Impedance (the ‘friction of distance’) can be represented by Euclidean distance, distance along with a road network, travel time, or travel cost (Tanser, Gijsbertsen, and Herbst, 2006).

ArcGIS Network Analyst is a powerful extension of ArcGIS that provides network-based spatial analysis (Dabhade, Kale and Gedam, 2015) and used to generate the best route, shortest time, least-cost path analysis and to calculate service area (Bagheri, Benwell, and Holt, 2005). Network analysis is an application tool in geographic information science (GIScience) which is the most powerful and most accurate research. Network analysis has a strong theoretical basis in the mathematical disciplines of graph theory and topology. It is the topological relationships inherent in networks that led to revolutionary advances in GIS data structures. The network must content an edge and vertex feature. Properties of the topological function of a network are connectivity, adjacency, and incidence. (Curtin, 2007). There are seven types of network analysis: Route, Closest facility, Service areas, Origin and Destination (OD) cost matrix, Vehicle routing problem, Location-allocation, Time-dependent analysis (ESRI, 2020b).

1.4.2.2 Raster-based model

The second method to measure accessibility is the Raster-based method or gravity-based model. The raster-based method was more sensitive to travel speed settings (Delamater et al., 2012). Different type of gravity model is developed with improvement in GIS (Yang, Goerge and Mullner, 2006). The most popular method is the two-step floating catchment area (2SFCA), a three-step floating catchment area (3SFCA). 3SFCA considers three variables; attractiveness of healthcare facilities, travel time or distance between the location of services center and the residence, and population demand for healthcare facilities (Rekha et al., 2017).

The authors reviewed the conceptual and practical difference between raster and network-based methods for measuring geographical accessibility to health care. According to the study, inequalities in geographic access to health care result from the configuration of facilities, population distribution, and transportation infrastructure. In recent accessibility studies, the traditional distance measure (Euclidean) has been replaced with more plausible

measures such as travel distance or time. The finding of the study was the raster-based method was more sensitive to travel speed settings, while the network-based method was more sensitive to the specific population assignment method (Delamater et al., 2012).

1.4.2.3 Travel-time surfaces and cost-based surfaces

Travel-time surfaces are a subset of cost-based surfaces in which each cell represents the acclimated cost between a cell and the nearest sources. With the creation of these surfaces, a simple point-in-raster function can extract the value of the travel-time surface at a particular location (Mulrooney et al., 2017). Calculates the least accumulative cost distance from or to the least-cost source, while accounting for a surface distance along with horizontal and vertical cost factors (ESRI, 2021c).

1.4.2.4 Service areas

The service area is defined as " A network service area is a region that encompasses all accessible streets, that is, streets that lie within a specified impedance. Service areas show which roads can be reached within a given distance or drive time. They often show response coverage for emergency vehicles (ESRI, 2021d). For instance, the 10-minute service area for a facility includes all the streets that can be reached within 10 minutes from that facility". It can pinpoint all the streets in a given road network that can be reached from a start point facility in a certain period (GIS Geography, 2020).

1.4.2.5 Cleaning up bad digitization

Road network shapefile is the important element for the analysis of the study which includes an edge source. First of all, a clean and correct road network should have prepared. These roads required topology cleanup to converted it to the geometric network. Topology in GIS is an automatic method to clean up digitized feature errors (Theobald, 2001). To remove the digitization error such as data duplication, short object, zero object, overlapping nodes,

etc., pre-defined rules "Must not intersect", "Must not intersect or Touch Interior" and "Must be single part" of topology function can be applied.

1.4.2.6 Define attributes and determine their value

In this study, the speed limit attribute is the most important attribute used in raster base network analysis. It is the parameter that decides how long it takes to drive from origin to destination point or determine the service area. The travel time of each section depends upon two components "Speed" of the road and "pixel value of the raster. The travel time in minutes was calculated by using a formula:

$$t\ (min) = \frac{(pixel\ Resolution\ in\ meter) * (60 minutes/hour)}{1000 meter\ * speed\ limit\ Rast\ in\ km/hour}$$

1.4.2.7 Speed

The speed limit data for the road in Nepal is not available. If a speed limit sign does not apply to the road and the road is not in a speed limit area, the school zone or shared zone, the speed limit for the road is the default speed limit. The default speed limit for the road in a built-up area equal to 30 kilometers per hour (kmph) and the default speed limit for the road that is not in a built-up area equal to 70 kilometers per hour (Ministry of Physical Infrastructure and Transport, 2016).

The provisioned speed limit for the vehicles is as follows:

a) Car, jeep, van, and pickup: a maximum of 80 kilometers per hour
b) Tempo, scooter, power tiller, and tractor: a maximum of 40 kilometers per hour
c) Motorcycle: a maximum of 50 kilometers per hour
d) Bus, minibus, truck, and mini truck: a maximum of 50 kilometers per hour on a hilly road and a maximum of 70 kilometers per hour on a plane/ surface road (Government of Nepal, 1997).

In this study, it is assumed that we will be considering drive time for cars, Jeep, Van, Public vehicles such as buses, minibusses to travel to the nearest health care facilities where basic health services were provided.

Roads of Nepal are classified into a) National Highways b) Feeder Roads c) District roads, and d) Urban roads (Government of Nepal, Ministry of Physical Infrastructure and transport, Department of Roads, 2013). Therefore, based on the available road category information in the OpenStreetMap data and consultation with an individual from different parts of the study area, the roads were classified as follows (Table 1.1).

Table 1.1. Classification of Road Network and Speed Limit

Class	Type	Description	Speed Limit (kmph)
1	Motorway	Motorway/freeway	< 60
2	Trunk	Important roads, typically divided	<50
3	Primary	Primary roads, typically national	<40
4	Secondary	Secondary roads, typically regional	<30
5	Tertiary	Tertiary roads, typically local	<20
6	Unclassified	Smaller local roads	<15
7	Residential	Roads in residential area	<10
8	Pedestrian	Pedestrian only streets	Walking Speed
9	Service	Service roads for access to the building, parking lots	Walking Speed
10	Track	For agricultural use, in forests, etc. Often gravel roads.	Walking Speed
11	Footway	Footpath	Walking Speed
12	Path	Unspecified paths	Walking Speed
13	Pedestrian	For people	Walking Speed

The average walking speed of a human is 4.9 kmph to 6.43 kmph. Walking speed depends on the level of fitness, the type of terrain, the age of people, and also the gender of people. On average, men walk faster than women, with the speeds between the sex being most similar when people are in their 20s. Both men and women have a walking speed that stays fairly consistent until reaching their 60s (Cronkleton, 2019). The walking speed of poor-health older adults is less than 2.16 kmph (Graham et al., 2010).

Since this study about reach to health care facilities with a poor health condition, therefore, average walking speed is adopted as 2.16 kmph

1.4.3. Service Availability and readiness of Health care facilities

The first method to measure service availability and readiness of health care facilities is service availability and readiness assessment (SARA). The service availability and readiness assessment (SARA) methodology was developed through a joint WHO – United States Agency for International Development (USAID) collaboration (WHO, 2015). SARA survey is used to measure health care facility condition whether it can provide basic or specific services with a set of core indicators (Ahmadi-Javid, Seyedi and Syam, 2017; Jigjidsuren et al., 2019). SARA is designed as a systematic survey to generate a set of core indicators of services, which can be used to measure progress in health system strengthening over time. SARA is a health care facility assessment tool designed to assess and monitor the service availability and readiness of the health sector and to generate evidence to support the planning and managing of a health system (Libya, 2017). According to WHO, The SARA focuses on service availability and service readiness.

1.4.3.1 SARA service availability indicators

Service availability refers to the physical presence of the delivery of services, encompassing the health infrastructure, core health personnel, and service utilization (Islam, Laskar and Macer, 2016). Service availability is described by three areas of tracer indicators: a) Health infrastructures b) Health workforce density c) Service utilization

a) Health infrastructures

- Facility density per 10000 populations: the facility density is primarily an indicator of outpatient service access.

- Inpatient bed density per 10000 populations: inpatient bed density provides an indicator of inpatient services access. Pediatric beds (cots) are included, but maternity beds are excluded.
- Maternity bed density per 1000 pregnant women: maternity bed density provides an indicator of access to delivery services. Data on maternity beds can be used to calculate the density of maternal beds per 1000 pregnant women per year. The denominator is estimated from the population data. The indicator does not include delivery beds.

b) Health workforce density

- core medical professionals per 10000 populations: physicians, non-physician clinicians, registered nurses, and midwives. This includes part-time physicians who are given the value of 0.5 in the scoring.

c) Service utilization

In populations with poor or suboptimal health infrastructure, the service utilization rate is an indicator of access.

- Number (N) of outpatient visits per capita per year: the number of visits for ambulant care, not including immunization, over the total population.
- The number of hospital discharges per 100 populations (excluding deliveries): this indicator provides additional information on the availability and access to inpatient services.

Indicators are expressed as a percentage score compared with a target or benchmark established by WHO. Table 1.2 shows the computation of each service availability indicator and the associated target.

Table 1.2. Service availability indicators and associated target

Indicator		Target	Score
Health infrastructure			
Facilities	N per 10000 population	2	n/2*100 (max. 100)
Inpatient beds	N per 10000 population	25	n/25*100 (max. 100)
Maternity beds	N per 1000 pregnant women	10	n/10*100 (max. 100)
Health workforce			
Core health workforce	N per 10000 population	23	n/23*100 (max. 100)
Service utilization			
Utilization	Outpatient visits per person/year	5	n/5*100 (max. 100)
Utilization	Hospital discharges per 100 pop/year	10	n/10*100 (max. 100)

d) Service Availability Index

The service availability indices for health services infrastructure, health workforce, and service utilization and the overall service availability index are calculated using the formulas in Table 1.3 and represented as percentage scores. The Service Availability Index is a reflection of the availability of health services and is calculated as the unweighted average of the three areas: infrastructure, workforce, and utilization.

Table 1.3. Service availability index

Indicator		Target	Score
Health Service infrastructure Index	Average score of the three indicators: facility density, inpatient beds, maternity beds	100	((a) + (b) + (c)) / 3
Health Workforce Index	Core health workers	100	(d)
Service Utilization Index	Average score of the two indicators: outpatient visits, hospital discharges	100	((e) + (f)) / 2
Service Availability Index	Un-weighted average of the three areas: infrastructure, workforce, and utilization	100	[((a+b+c)/3+d+((e+f)/2)]/3

1.4.3.2 SARA service readiness indicators

Service Readiness is the ability of health care facilities to offer general health services and specific services. Readiness is defined as the availability of components required to provide services such as basic amenities, basic equipment, standard precautions, laboratory tests, and medicines and commodities (Islam, Laskar and Macer, 2016).

Service readiness is described by five areas of domain.

a) **Basic amenities:** mean availability of each of seven tracer items (power, improved water source inside or within the ground of the facility, room with auditory and visual privacy for patient consultations, access to adequate sanitation facilities for clients, communication equipment (Phone or SW radio), the facility has access to a computer with email/internet access, emergency transportation);
b) **Basic equipment:** mean availability of each of six tracer items (adult scale, child scale, thermometer, stethoscope, light source)
c) **Standard precautions for infection prevention:** mean availability of each of nine tracer items (safe final disposal of sharps, safe final disposal of infectious wastes, appropriate storage of sharps waste, appropriate storage of infectious waste, disinfectant, single-use - Standard disposable or auto-disable syringes, soap and running water or alcohol-based hand rub, latex gloves, guidelines for standard precautions)
d) **Diagnostic capacity:** mean availability of each of eight laboratory tests with appropriate equipment (hemoglobin, blood glucose, malaria diagnostic capacity, urine dipstick-protein, urine dipstick-glucose, HIV diagnostic capacity, syphilis rapid test, urine test for pregnancy)
e) **Essential medicines:** mean availability of each of 20 essential medicines (amlodipine tablet or alternative calcium channel blocker, amoxicillin [syrup/suspension or dispersible tablet], amoxicillin tablet, ampicillin powder for

injection, aspirin cap/tab, beclometasone inhaler, beta-blocker [e.g.bisoprolol, metoprolol, carvedilol, atenolol], carbamazepine tablet, ceftriaxone injection, diazepam injection, enalapril tablet or alternative ACE inhibitor [e.g. lisinopril, ramipril, perindopril], fluoxetine tablet, gentamicin injection, glibenclamide tablet, haloperidol tablet, insulin regular injection, magnesium sulfate injectable, metformin tablet, omeprazole tablet or an alternative such as pantoprazole, rabeprazole, oral rehydration solution, oxytocin injection, simvastatin tablet or other statins [e.g. atorvastatin, pravastatin, fluvastatin], thiazide [e.g. hydrochlorothiazide], zinc sulfate [dispersible tablets or syrup].

1.4.4. Minimum Service Standards (MSS) Tool for Health Post

Minimum Service Standard (MSS) is a benchmark of hospital service quality in providing services to the public (Kuzairi et al., 2018). The MSS aspires to ensure the readiness of health care facilities to deliver quality services. The MSS helps to quantify the evidence through its scores and determines the status of the health post in terms of its readiness and service availability. The Ministry of Health and Population, Government of Nepal development developed the MSS for all levels of health care facilities (NHSSP, 2019). The purpose of MSS is to improve the quality of healthcare services being provided by state-run health care facilities and for evidence-based planning (Poudel, 2019). A serious effort was put into exercise to improve the quality of care in Nepal. For this, there is a new paradigm or an approach of Minimum Services Standard (MSS) has been implemented and now, it is being scaled up to all over the country. In its implementation, there is 3 key area of focus: (1) Governance and management (2) Clinical Service management and (3) Hospital support system management (Bhattachan, 2019; NHSSP, 2019).

According to the Government of Nepal (Government of Nepal, Ministry of Health, 2019), the Minimum Service Standard of human resources in health posts and the hospital is as follows:

Minimum of 6 to 8 staff is appointed in Health Post. In the case of hill and mountain region, minimum of 6 staff and in case of terai region, minimum of 8 staff. The list of human resources is designated as Table 1.4. and a minimum of 46 staff is the designation in District Hospital list are as Table 1.5.

Table 1.4. List of human resources in the health post

Designation	Required Numbers
Health Post Officer	1
Auxiliary Nurse Midwife (ANM)*	3
Auxiliary Health Worker (AHW)*	3
Office Support	1
Total Required	8

* Hill & Mountain - 2, Terai – 3

Table 1.5. List of human resources in District Hospital

Department	Designation	Required Numbers
Medical Department	MDGP/Gynecologist/Pediatrician	1
	Medical Officer-1	4
	Health Assistant/SAHW	2
	AHW	3
	Radiographer	2
	Pharmacy Assistant	1
	Anesthesia Assistant	1
	Lab Technician	1
	Lab Assistant	1
Nursing Department	Nursing Officer/ Sister	1
	Staff Nurse1	5
	ANM1	5
	CSSD worker	1
Administration Department	Administrator	1
	Admin Assistant	1
	Medical recorder	1
	Office support	1
	Receptionist	1
	Housekeeping Worker	3
	Laundry Worker	1
	Security Guard	2
	Cook	1
	Cook's Assistant	1
	Driver	2
Finance Department	Accounts Officer	1
	Accountant	1
	Cashier	1
	Total Required	46

1.4.5. Level of Health care facilities

According to Nepal Heath Infrastructure Development Standards (Government of Nepal, Ministry of Health, 2018), establishing and upgrading health institutions is based on various factors such as accessibility, catchment population, geography, availability of suitable land, condition of existing or nearby facilities, and morbidity statistics. Health care facilities are classified into five levels based on a minimum set of health services: Community-level (Health Posts or Community Health Units); Primary Hospitals; Secondary Hospitals; Tertiary Hospitals; Academic or Super-specialty hospitals. There are 3,290 health posts, 778 primary hospitals, 10 secondary hospitals, 9 tertiary hospitals, 11 central levels of a super specialty hospital, and 8 medical academics.

1.4.5.1 Community-level (Health Posts or Community Health Units):

At least one health post in ward level of Rural Municipality and one community health unit in ward level of Urban Municipality shall be established. Health posts (HP) are further sub-divided into 4 types: Type 1, Type 2, Type 3, and Type 4. Since Health posts don't provide inpatient service, so beds aren't necessary. More than 12000 populations are served by Type 1, 7001 to 12000 populations are served by Type 2, 3001 to 7000 populations are served by Type 3 and less than 3000 populations are served by Type 4 (Table 1.6). According to the Ministry of Health and Population (Government of Nepal, Ministry of Health, 2019, 2018), Health care facilities of ward level provide only basic health services (Table 1.7).

1.4.5.2 Primary Hospital:

Rural municipalities and Urban municipalities will have at least one primary Hospital each. The Primary Hospital will provide services to the referred cased for health post. Primary Hospital is divided into two types: Primary Hospital A and Primary Hospital B. Primary Hospital A is established in Urban Municipality and Primary Hospital B is established in

Rural Municipality. Again, Primary Hospital A is further subdivided into 3 types: Type A1, Type A2, Type A3. With 15 to 99 beds are accommodated and from 50000 to 100001 population is served by Primary Hospital A. Primary Hospital B is further subdivided into 3 types: Type B1, Type B2, Type B3. With 5 to 15 beds are accommodated and from 15000 to 20001 population are served by Primary Hospital B (Table 1.6). According to the Ministry of Health and Population (Government of Nepal, Ministry of Health, 2019, 2018), Primary hospitals provide both basic health services and medical services (Table 1.7).

1.4.5.3 Secondary Hospital:

The secondary hospital lies under the Province level. It will take care of patients referred by the community level, rural municipality, and municipality level health care facilities. The Secondary Hospital provides basic services, medical services, Departments and wards, Emergency services, Promotion, and preventive services surgical services, and others (Table 1.7).

Table 1.6. Category of Health post and Primary Hospital (Ministry of Health, 2016)

Type	Category	Bed number	Served population
Primary Hospital A	Type A1	51-99	100001 - 300000
	Type A2	26-50	50001 - 100000
	Type A3	15-26	20001 - 50000
Primary Hospital B	Type B1	15	More than 20000
	Type B2	10	15001 - 20000
	Type B3	5	Less than 15000 to 15000
Health Post	Type 1	-	More than 12000
	Type 2	-	7001 - 12000
	Type 3	-	3001 - 7000
	Type 4	-	Less than 3000

1.4.5.4 Tertiary Hospital:

The Tertiary Hospital is managed by the Federal government. The Tertiary Hospitals will provide referral and specialized services. The Tertiary hospital provides basic services, medical services, Departments and wards, Emergency services, Promotion, and preventive services surgical services, and others (Table 1.7).

1.4.5.5 Academic and Super-Specialty Hospital:

The Academic and Super-Specialty Hospital will be managed by the Federal government. The Super-Specialty Hospital will provide specialized services or specific diseases or specialties and will take referrals from the primary, secondary, and Tertiary Hospitals. The academic will responsible for conducting academic research and related activities in Super Specialty and Tertiary Hospitals managed by the federal government.

Table 1.7. Type of service provided by the Health care facilities of Nepal

S.N	Type	Category	Services to be discharged
1	Health post and Community health unit	Health post	At least one health care facility in each ward level of the urban and rural municipality **Basic service:** Immunization, family planning, ante-natal care, normal delivery, new-born care, nutrition counseling, treatment of TB and other common communicable diseases and conditions, management of epidemic, basic mental health service, counseling, screening and primary treatment of non-communicable diseases, medicine distribution, pathology lab and other diagnostic services, promotion and prevention of eye/sight and dental problems; and other diagnostic, curative, primitive, and preventive basic health services defined by the Federal Ministry of Health.
2	Urban Health Promotion Center (Janata	Health post	At least one health care facility in each ward level of sub/ Metropolitan city **Basic service:**

	Swathys Kendra)		Immunization; nutrition counseling; promotion and prevention and primary treatment of non-communicable diseases; family planning; Adolescent reproductive and sexual health services; Psychosocial counseling; Geriatrics counseling; Health Inspection Services to protect and promote the health and environment; and other services prescribed by Ministry of Health, Government of Nepal.
3	Primary Hospital Class B	Hospital	This primary hospital class 'B' will be based in a rural municipality **Basic Service:** Immunization, family planning, ante-natal care, normal delivery, new-born care, nutrition counseling, Treatment of TB and other common communicable diseases and conditions, management of epidemic, basic mental health service, counseling, screening, and primary treatment of non-communicable diseases, medicine distribution, pathology lab, and other diagnostic services, promotion and prevention of eye/sight and dental problems; and other diagnostic, curative, primitive, and preventive basic health services defined by the Federal Ministry of Health. **Medical services:** Common gynecological and obstetric services; Out Patient Department (OPD) services; Comprehensive emergency obstetric and neonatal care (CEONC); Basic Surgery Services; The primary treatment for eye/sight and dental problems; 24-hour emergency service
4	Primary Hospital Class A	Hospital	This primary hospital class 'A' will be based in municipality and Sub-metropolitan city **Basic Service:** Immunization, family planning, ante-natal care, normal delivery, new-born care, nutrition counseling, Treatment of TB and other common communicable diseases and conditions, management of epidemic, basic mental health service, counseling, screening, and primary

			treatment of non-communicable diseases, medicine distribution, pathology lab, and other diagnostic services, promotion and prevention of eye/sight and dental problems; and other diagnostic, curative, primitive, and preventive basic health services defined by the Federal Ministry of Health. **Medical services:** Common gynecological and obstetric services; **Out Patient Department (OPD) services:** general Medicine, Gynecology and Obstetrics, Pediatric and Orthopedic Services Comprehensive emergency obstetric and neonatal care (CEONC), specialized and major surgery services including Orthopedic surgeries. **Basic Surgery Services:** Treatment for eye/sight and dental problems; 24-hour emergency service
5	Secondary Hospital	Hospital	**Basic Service**: Immunization, family planning, ante-natal care, normal delivery, new-born care, nutrition counseling, Treatment of TB and other common communicable diseases and conditions, management of epidemic, basic mental health service, counseling, screening, and primary treatment of non-communicable diseases, medicine distribution, pathology lab, and other diagnostic services, promotion and prevention of eye/sight and dental problems; and other diagnostic, curative, primitive, and preventive basic health services defined by the Federal Ministry of Health. **Medical services:** General Physician Services, General Surgery Services, Gynecological and Obstetric services, Dental Services, Orthopedic Services, Ophthalmological services **Departments and wards**: Urology, dermatology, gyne/obs., orthopedics, pediatric, psychiatric, ear, nose, and throat (ENT)

			Emergency services: 24-hour emergency with surgery services; **Promotion, preventive services, and surgical services:** Simple surgeries, gynecological or obstetric Surgeries, ENT and orthopedic Surgeries **Others:** Hemodialysis, intensive care unit, neonatal intensive care unit.
6	Tertiary Hospital	Hospital	**Basic Service**: Immunization, family planning, ante-natal care, normal delivery, new-born care, nutrition counseling, Treatment of TB and other common communicable diseases and conditions, management of epidemic, basic mental health service, counseling, screening, and primary treatment of non-communicable diseases, medicine distribution, pathology lab, and other diagnostic services, promotion and prevention of eye/sight and dental problems; and other diagnostic, curative, primitive, and preventive basic health services defined by the Federal Ministry of Health. **Medical services:** General Physician Services, General Surgery Services, Gynecological and Obstetric services, Dental Services, Orthopedic Services, Ophthalmological services **Departments and wards**: Urology, dermatology, gyne/obs., orthopedics, pediatric, psychiatric, ear, nose, and throat (ENT) **Emergency services:** 24-hour emergency with surgery services; **Promotion, preventive services, and surgical services:** Simple surgeries, gynecological or obstetric Surgeries, ENT and orthopedic Surgeries **Others:** Hemodialysis, intensive care unit, neonatal intensive care unit

1.4.6. Overlay Analysis

The overlay is a GIS operation that superimposes multiple data sets (representing different themes) together to identify relationships between them. An overlay creates a composite map by combining the geometry and attributes of the input data sets (GIS Wiki, 2020).

Overlay analysis is an age-old technique of deriving new information from two or more layers of data covering the same area. For Overlay analysis of Vector and raster, there are tools are available in ArcGIS software (GIS for the Curious, 2020).

1.4.6.1 Overlay with vector data

Feature overlays of vector data are created when one vector layer (points, lines, or polygons) is merged with one or more other vector layers covering the same area with points, lines, and/or polygons. A resultant new layer is created that combines the geometry and the attributes of the input layers. Available tools in ArcGIS for overlay vector data are Count overlapping features, Erase, Identity, Intersect, Spatial Join, Symmetrical difference, Union, Update.

1.4.6.2 Overlay with raster data

Raster overlay involves two or more different sets of data that derive from a common grid. The separate sets of data usually give numerical values. These values then are mathematically merged to create a new set of values for a single output layer. Raster overlay is often used to create risk surfaces, sustainability assessments, value assessments, and other procedures. Available tools in ArcGIS for overlay raster data are map algebra.

For this study, the Spatial join tool of vector overlay is applied to find out the number of households, the population within the defined service area.

1.4.7. Coordinate System

A coordinate system is a reference system used to define the location of geographic features within a common geographic framework. There are two types of coordinate systems used in GIS, Geographic coordinate system and Projected coordinate system. There are several hundred geographic coordinate systems, thousands of projected

coordinate systems and custom coordinate systems are available for use (ESRI, 2020a). The data come from a different source and coordinate system. Hence, to develop integrated, accuracies, and constant in data, analysis, and mapping coordinates must be the same for all data. To transfer one coordinate system to another coordinate system is called coordinate transformation.

In the context of Nepal, Most of the data available in three coordinate systems:

a) Modified Universal Transverse Mercator

The Survey Department of Nepal used the Modified UTM coordinate system. This coordinate system is based on Gauss-Krueger Projection. In this projection system, The Earth is divided into 120 zones each of 3º. Nepal has a central meridian of 81º, 84º, and 87º (Bhandari, 2016). The parameter of the modified universal transverse Mercator is as shown in Table 1.8.

Table 1.8. The spatial reference of Modified Universal Transverse Mercator

Coordinate System	Everest_Adj_1937_Transverse_Mercator
Projection	Transverse Mercator
Datum	Everest 1830
False Easting	500,000 m
False Northing	0
Central Meridian	84
Scale Factor	0.9996
Latitude Of Origin	0.0000
Units	Meter

b) Universal Transverse Mercator (UTM)

The UTM system of the map projections has consisted of 120 separate Transverse Mercator projections. The world is divided into 60 longitudinal zones and each zone is further divided into two separate hemispheres: The northern hemisphere and the Southern hemisphere. Nepal lies in two Northern hemispheres, 44N and 45N. The parameter of the modified universal transverse Mercator is as shown in Table 1.9. This study area is located in the 44N Northern hemisphere.

Table 1.9. The spatial reference of Universal Transverse Mercator (UTM)

Coordinate System	WGS 1984 UTM Zone 44N
Projection	Transverse Mercator
WKID	32644
Authority	EPSG
Linear Unit	Meters (1.0)
False Easting	500,000 m
False Northing	0
Central Meridian	81
Scale Factor	0.9996
Latitude Of Origin	0.0000

c) World geodetic system 1984 (WGS1984)

The WGS 1984 coordinate system is geocentrically positioned with respect to the center of the Earth and it is a three-dimensional, right-handed, Cartesian coordinate system with its original coordinate point at the center of mass of an ellipsoid (Sharma, 2016).

For this study, I select UTM 44N as a coordinate system. UTM system allows the coordinate numbering system to be tied directly to the distance measuring system. All UTM coordinates are measured in meters and finally, grid values increase from left to right and bottom to top.

1.5. Assumption and Limitation of the study

The following assumptions were made to carry out the study

- This project was carried out in a shorter period with available secondary data on the location of health care facilities with detailed information, the location of households with population data, and the road network. Additional information and new changes occurring on recent dates were not been covered in this project. Validation and verification of the household were not carried out. Most of the roads were used from a secondary source and modified using the World Imagery Base map available in ArcMap but no field verification was done.

- This project has been conducted based on the literature review. No field verification has been done to validate the method of calculation of service availability in the study as well as the results.
- For network data, the Open Streetmap data has been used and its verification and update has been done based on Google Earth Image. Speed limit data were not available for roads of Krishnanagar Urban Municipality and Shuddhodhan Rural Municipality. The travel speeds were estimated by first categorizing the road into different hierarchies. The estimated true speed of each segment of road based upon road surface type is outside the scope of this study.
- The service area of health care facilities calculated in the project is based upon a network analyst tool available in ArcGIS Pro. Though this method is considered fairly accurate, it is not without uncertainty. Therefore, the service area polygons constructed from the network-based data model can be considered as an approximation for the given travel speed. Also, the total population count of the study area varied slightly over different traffic scenarios due to inconsistencies along the boundary of the service area formed.
- Minimum of 6 to 8 staff is appointed in Health Post as per MSS.
- SARA is a health care facility assessment tool designed to assess and monitor the service availability and readiness of the health sector but in this project, only service availability is analyzed.
- The inpatient population is 12% of the total population served by the primary hospital.
- The maternity population is 8% of the total population served by the primary hospital.
- 30% of the total bed allocated for the hospital is allotted for the maternity ward.
- Un-travel area in four municipalities very minimum that way the mask using land use was omitted.

Chapter-2. Methodology

This study was based on Raster based method to develop travel time surface by applying a raster calculator, Cost Distance algorithm (Mulrooney et al., 2017). The service availability of Krishnanagar Urban Municipality, Shuddhodhan rural municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai was based on SARA and network analysis. The study focused on analyzing the present service availability of health care facilities by municipality using the SARA method. The number of households and population access to health care facilities in different normal drive times was analyzed by using the Network analysis tool of ArcGIS Pro. Finally, the ratio between population and service availability was determined. Detail process is presented in the following sections.

2.1. Work Flow

The overall methodology for Assessing the service availability of Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskrit Municipality, and Kotahimai Rural Municipality with the application of GIS composed of the following procedure in Figure 2.1:

- The health care facilities' data were collected through the Health Infrastructure Information System, Public information Portal, Nepal. The households' data were downloaded from the Ministry of water supply in a CSV file and converted into a shape file using ArcGIS. The road network shapefile was downloaded from openstreetmap.org. In addition, the administrative boundary is downloaded from the Department of Survey, Nepal.
- Downloaded road network shapefile was clipped in ArcGIS using municipality boundary of Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality.
- Four geodatabases were created and also create a multimodal network dataset for Each municipality.

- Road network shapefile of four municipalities were imported in geodatabase respectively.
- Build topology to clean up road networks by setting rules.
- After cleaning up the road network, the speed limit field is added by using Add fields option.
- Road Network of vector format converted to raster surface with a 10m pixel resolution, using the Speed Limit attributes as Value Field.
- A continuous speed limit raster was created No Data pixels (where a road did not exist) were *reclassified* to a speed limit of 2.16 Kmph to represent walking or off-road travel.
- A new travel-cost raster (t) was created using the following formula:

$$t\ (\min) = \frac{(pixel\ Resolution\ in\ meter) * (60 minutes/hour)}{1000 meter\ * speed\ limit\ Rast\ in\ km/hour}$$

- The travel-cost surface was masked by the municipality boundary.
- Cost Distance algorithms generate an accumulative cost surface connecting a source layer represented as a point with a pixel used as little cost (in this case travel time in minutes).
- Reclassify the cost distance raster into different travel time (0-15,15-30,30-45,45-60,)
- To find out which household holds point lies in which service area, the spatial join of overlay analysis was applied in each case.
- Now, the Service Availability was analyzed which consists of three components: (a) Health Infrastructure Density (b) Health workforce density (c) Service utilization.
- The Health Infrastructure Density consists of three components: (1) facility density per 10000 populations (2) inpatient bed density per 10,000 populations (3) maternity bed density per 1000 pregnant women. Each component was compared with a

score set by WHO. Firstly, these three were calculated then Health Infrastructure Density was calculated. The core health workforce density indicator and was calculated

- The Service Availability was calculated by summing three components.
- Now, Find out the ratio between population and Service Availability.

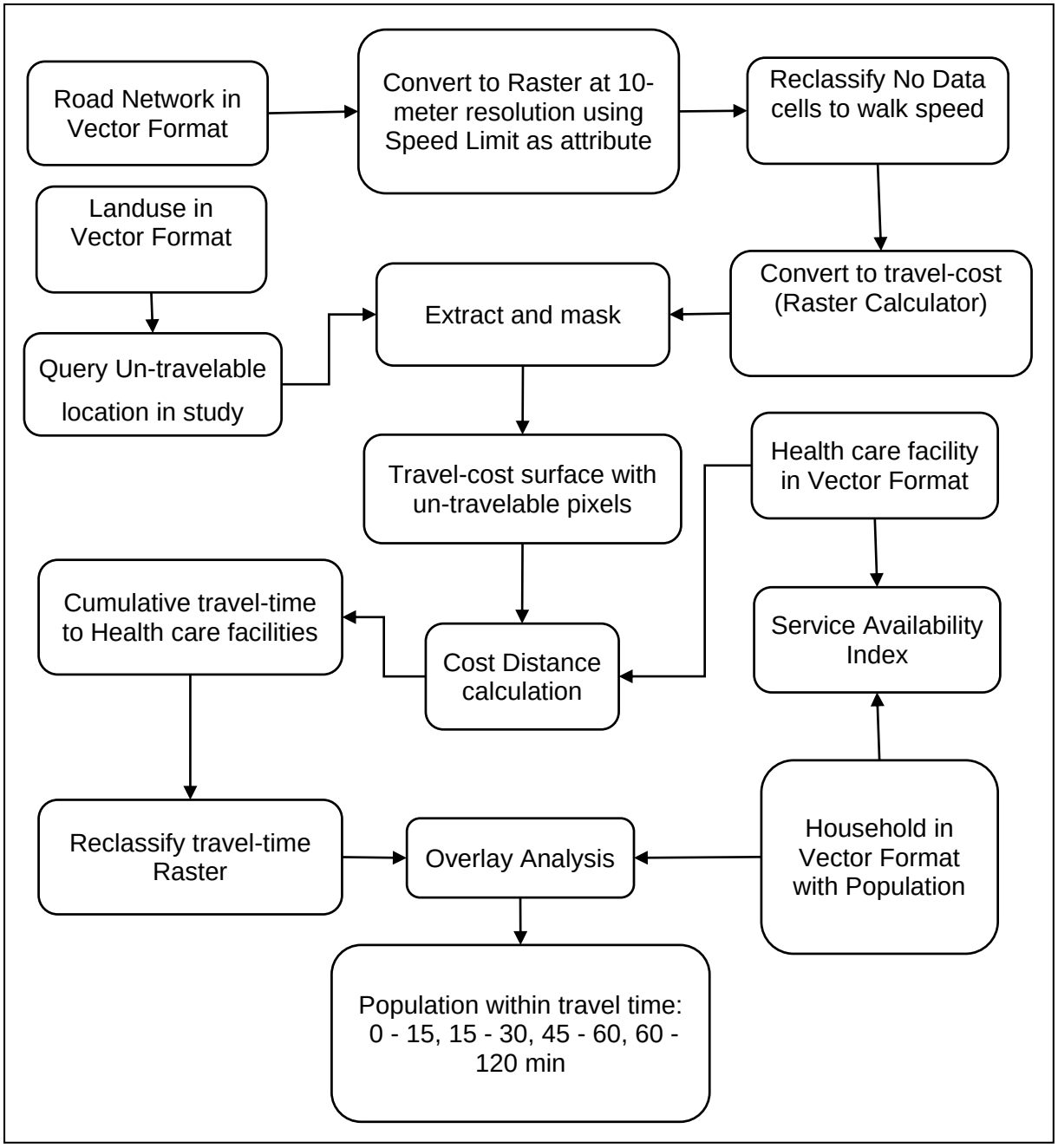


Figure 2.1. Workflow of accessing the service availability of municipality

2.2. Data and Software Used

The accessibility and Service availability of health care facilities of municipalities was analyzed using the World Imagery Base map, administrative boundary, location of health care facilities, Location of the household, and road network.

2.2.1. World Image Base map

There are many options available such as Google Image, Open Street Map, Satellite Image, etc. For this study, the World Imagery base map from ESRI of 2020 available in ArcMap with 1m resolution was used to update and modified the downloaded road network.

2.2.2. Administrative Boundary

An administrative boundary is downloaded from the Department of Survey, Nepal in 2019. This dataset content local unit/ municipality level boundary in polygon feature and aggregates to country, state, and district level. The coordinate system of the administrative boundary was in Word geodetic system 84 (WGS 1984) and then converted to WGS 1984 UTM zone 44N.

2.2.3. Location of the household

The household data was collected from the Ministry of water supply, Nepal in excel/CSV format. This survey was conducted in 2019 for the WASH plan by municipalities. This data contains the male/female population of each household. Then the CSV file of household data was converted into a point feature in ArcGIS. The coordinate system of the data was in Word geodetic system 84 (WGS 1984) and then converted to WGS 1984 UTM zone 44N. The data contain ward numbers, house owner names, male population, female population, and total population.

2.2.4. Road network Data

The road centerline data of 2014 are downloaded from openstreetmap.org. The road data were clipped according to the administrative boundary of Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality. The road data was verified and updated regarding World Imagery base maps from ESRI, 2020. The projection system of road network data was in World geodetic system 84 (WGS1984) and converted to WGS 1984 UTM Zone 44N for this study. The added new roads are classified as "Unclassified" types. The speed limit for different roads assigned in Table 1.1.

2.2.5. Health care facilities Location and Data

Health care facilities data were collected from the Health Infrastructure Information System, Public information Portal, Nepal. On this portal, the location of each Health care facility was located on the google earth image date 2020. From the reference of this map, each point feature of health care facilities was created in ArcGIS Pro. The coordinate system of the data was in World geodetic system 84 (WGS 1984) and then converted the projection system to WGS 1984 UTM zone 44N. The served population was derived from the Ministry of Health (Ministry of Health, 2017). The data contained fields like name, category, type, and served the population of health care facilities as shown in Table 2.1.

2.2.6. Landuse Data

The landuse data of 2014 are downloaded from openstreetmap.org. The landuse were clipped according to the administrative boundary of Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality. The projection system of landuse data was in World geodetic system 84 (WGS1984) and converted to WGS 1984 UTM Zone 44N for this study.

2.2.7. Software Used

For the study, ArcGIS Pro was used for data preparation, processing, map preparation, and Spatial Analyst Tools. The Spatial Analyst Tools of ArcGIS pro were used for the analysis of travel time from health care facilities. Finally, word and MS Excel were used for report preparation.

Table 2.1. List of Health care facilities

SN	Name	WN	Type	Category	Served Population
Krishnanagar Urban Municipality					
1	Shivanagar HP	1	Health post	Type 4 HP	1191
2	Krisnanagar HP	2	Health post	Type 4 HP	1224
3	Sirsihawa HP	3	Health post	Type 3 HP	1460
4	Purusottampur HP	4	Health post	Type 3 HP	2712
5	Bhilmi HP	5	Health post	Type 4 HP	973
6	Ajigara HP	6	Health post	Type 4 HP	827
7	Shiva Raj Hospital	7	Hospital	Primary Hospital B3	24248
8	Vidhyanagar HP	8	Health post	Type 4 HP	884
9	Ramnagar HP	9	Health post	Type 3 HP	1154
10	Bhagawanpur HP	10	Health post	Type 3 HP	1178
Shuddhodhan Rural Municipality					
11	Patariya HP	1	Health post	Type 3 HP	2926
12	Nandanagar HP	1	Health post	Type 3 HP	6718
13	Labani PH B	3	Hospital	Primary Hospital B3	5414
14	Bithuwa HP	4	Health post	Type 4 HP	6247
15	Hathihawa HP	5	Health post	Type 2 HP	9412
Lumbini Sanskritik Urban Municipality					
16	Bhagawanpur HP	1	Health post	Type 2 HP	5693
17	Lumbini PH A2	3	Hospital	Primary Hospital A2	9150
18	Tenuhawa HP	5	Health post	Type 2 HP	5894
19	Ekala HP	8	Health post	Type 2 HP	6375
20	Khudabagar HP	9	Health post	Type 3 HP	1859
21	Madhubani HP	10	Health post	Type 3 HP	5151
22	Masina HP	11	Health post	Type 3 HP	2911
23	Aama HP	12	Health post	Type 3 HP	4050
Kotahimai Rural Municipality					
24	Sipawa HP	1	Health post	Type 3 HP	3139
25	Sakraun Pakadi HP	2	Health post	Type 4 HP	4077
26	Maryadpur HP	3	Health post	Type 4 HP	428
27	Bairghat HP	4	Health post	Type 4 HP	170
28	Majhagawa PH B2	5	Hospital	Primary Hospital B2	9373
29	Bogadi HP	7	Health post	Type 2 HP	6728

Chapter-3. Process and Result

This chapter discusses the process and result of categorization of health care facilities, the number of households and population in the municipality, service availability of health care facilities, household and population access to each health care facility in two cases of network analysis and Overlay analysis in detail.

3.1. Categorization of Health care facilities based on service provided

Based on the criteria discussed in section 1.4.7, the health care facilities were divided into health posts and hospitals. Health posts are further sub-divided into Health Post and Community Health Unit and urban Health Promotion center and Hospital are sub-divided into Primary Hospital Class A, Primary Hospital Class B, Secondary Hospital and Tertiary Hospital (Table 3.1). Out of 10 health care facilities, 1 hospital and 9 health posts are located in Krishnanagar Urban Municipality. Out of 5 health care facilities, 1 hospital and 4 health posts are located in the Shuddhodhan rural municipality. Out of 8 health care facilities, 1 hospital, and health posts are located in the Lumbini Sanskritik Urban Municipality whereas out of 6 health care facilities, 1 hospital and 5 health posts are located in the Kotahimai rural municipality.

Table 3.1. The number of Health care facilities by municipality and facility type:

S.N	Municipality	Hospital	Health post	Total
1	Krishnanagar Urban Municipality	1	9	10
2	Shuddhodhan Rural Municipality	1	4	5
3	Lumbini Sanskritik Urban Municipality	1	7	8
4	Kotahimai Rural Municipality	1	5	6

3.2. Categorization of Primary Hospital and Health post based upon population served

The primary hospitals and health posts are categorized based on the population served by the health care facilities which are discussed in section 1.4.7.2.

The primary hospitals class A is divided into Type A1, Type A2, and Type A3. Similarly, the primary hospitals class B is divided into Type B1, Type B2, and Type B3. Finally, health posts were divided into Type 1 HP, Type 2 HP, Type 3 HP, and Type 4 HP.

In Krishnanagar Urban Municipality, 1 hospital of primary hospital class B3 type, 5 are Type 4 HP and 4 are Type 3 HP are presented as shown in Table 3.2 and Map 3.1.

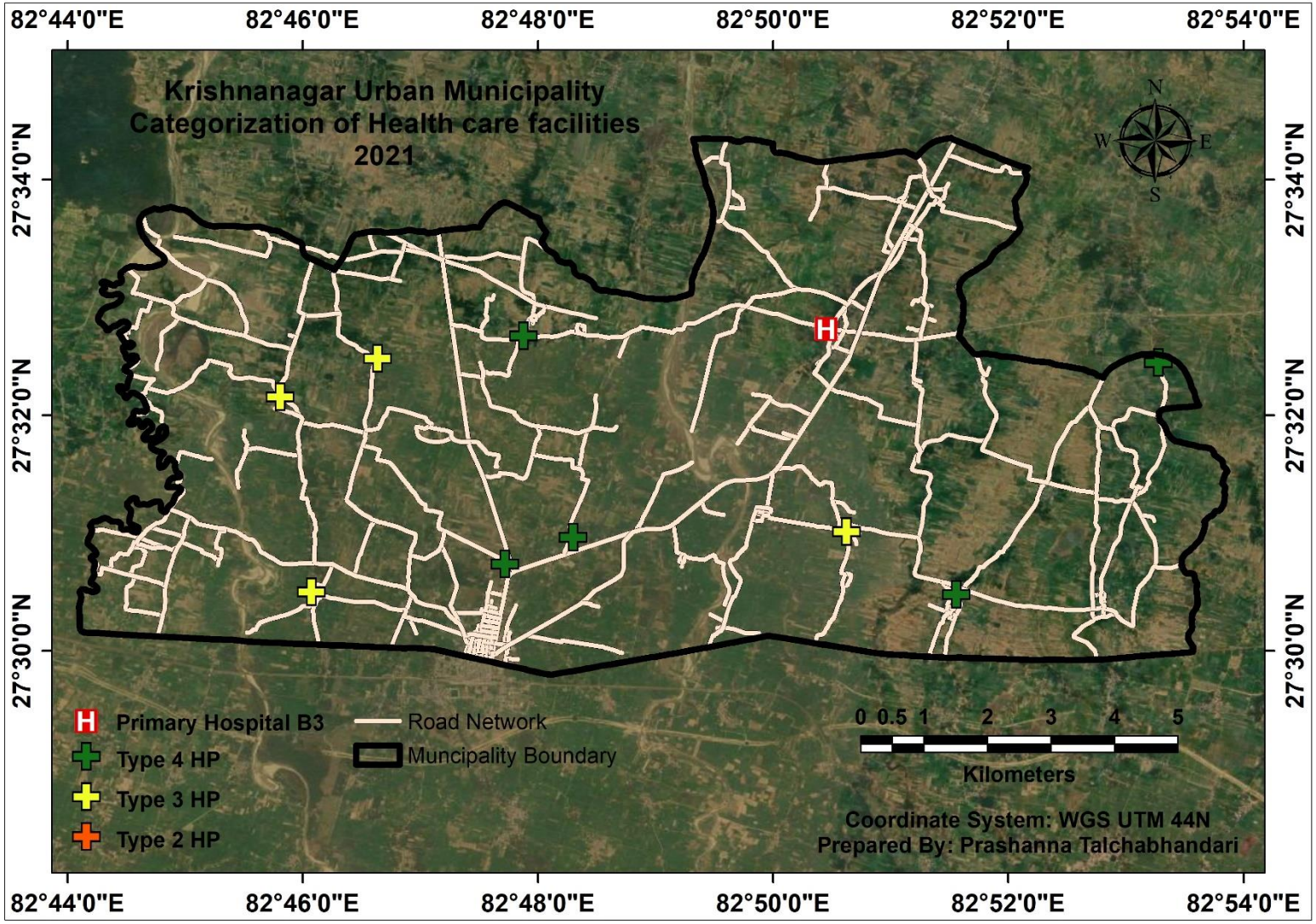
In Shuddhodhan Rural Municipality, 1 hospital of primary hospital class B3 type, 1 are Type 4 HP, 2 are Type 3 HP, and 1 is Type 2 HP are presented as shown in Table 3.2 and Map 3.2.

In Lumbini Sanskritik Urban Municipality, 1 hospital of primary hospital class A2 type, 4 are Type 3 HP, and 3 is Type 2 HP are presented as shown in Table 3.2 and Map 3.3.

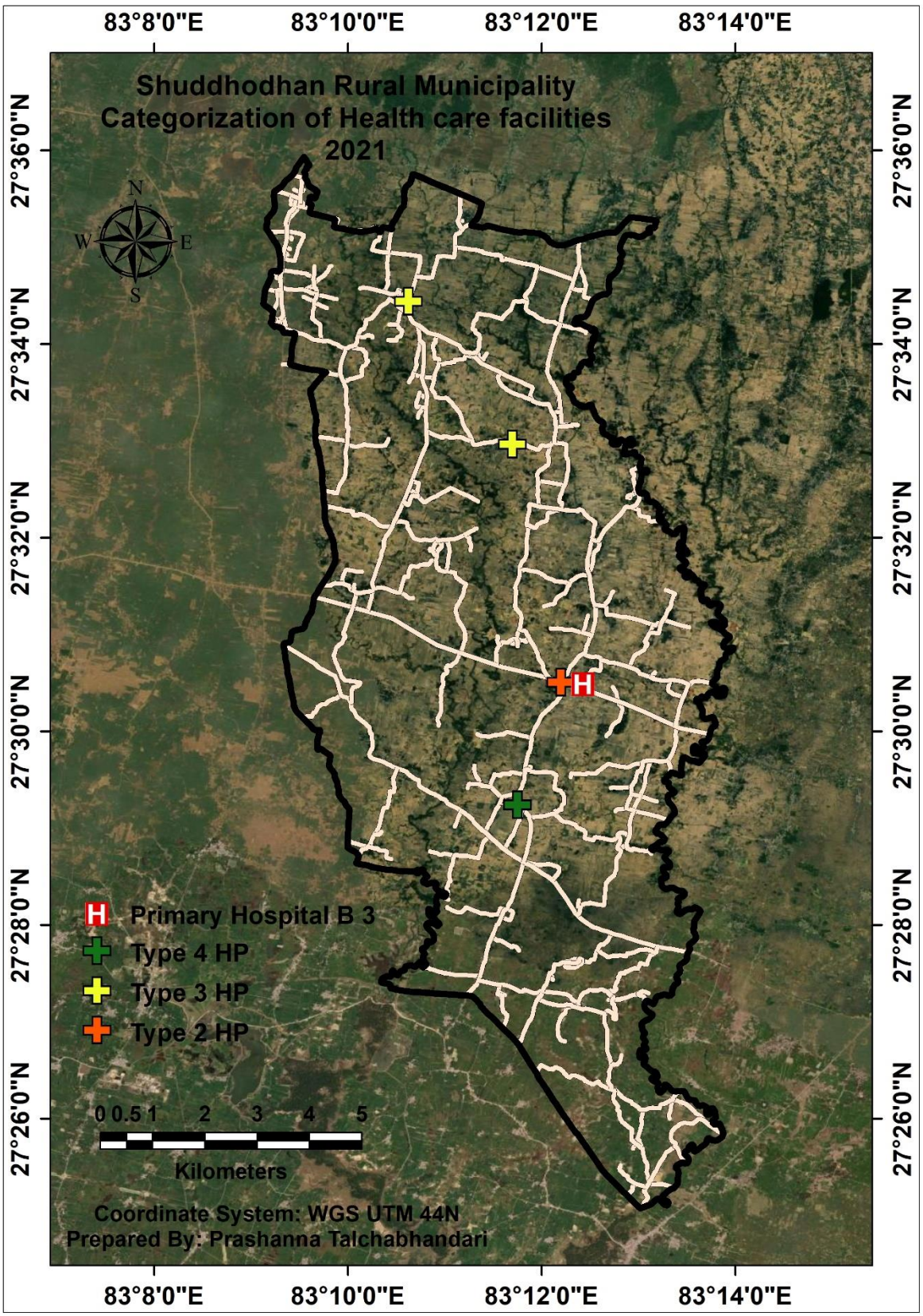
In Kotahimai Rural Municipality, 1 hospital of primary hospital class B3 type, 3 are Type 4 HP, 1 are Type 3 HP, and 1 is Type 2 HP are presented as shown in Table 3.2 and Map 3.4.

Table 3.2. Number of Primary Hospital B and Health Post by facility category

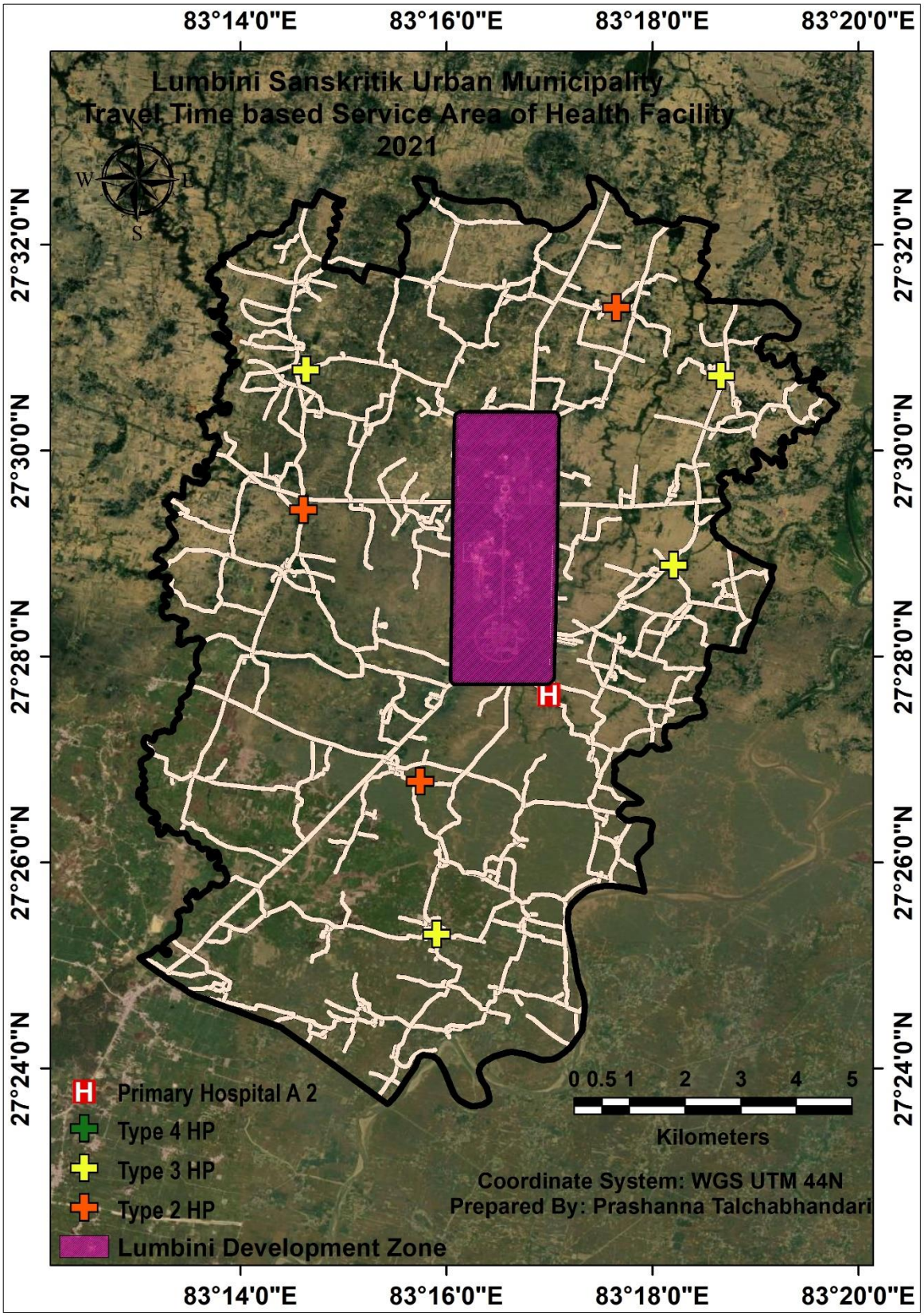
Type	**Category**	**Krishnanagar Urban Municipality**	**Shuddhodhan Rural Municipality**	**Lumbini Sanskritik Urban Municipality**	**Kotahimai Rural Municipality**
Hospital	Primary Hospital A2	-	-	1	-
Hospital	Primary Hospital B3	1	1	-	1
Health Post	Type 2 HP	-	1	3	1
Health Post	Type 3 HP	4	2	4	1
Health Post	Type 4 HP	5	1	-	3
Total		10	5	8	6



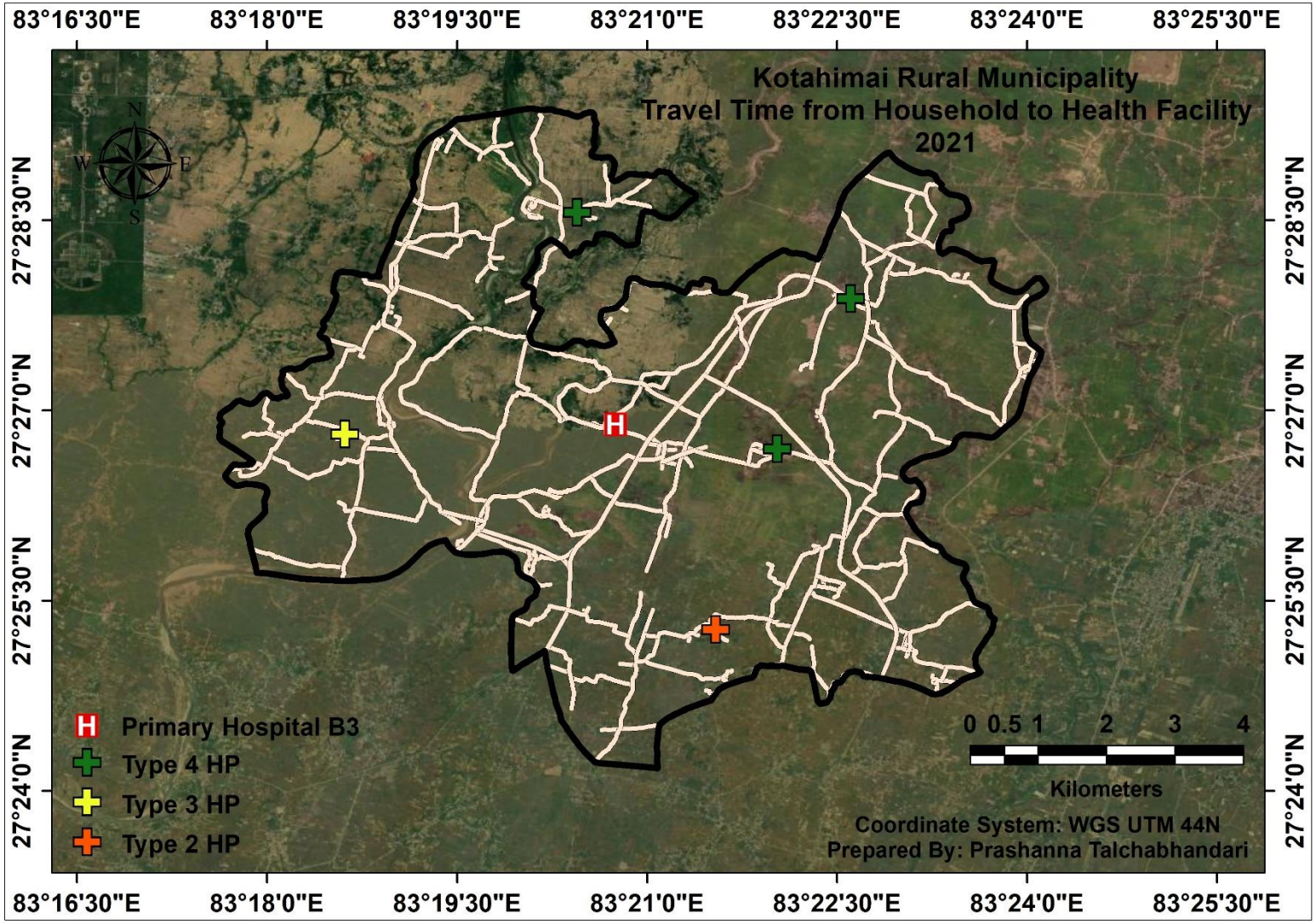
Map 3.1. Krishnanagar Urban Municipality: Categorization of Health care facilities



Map 3.2. Shuddhodhan Rural Municipality: Categorization of Health care facilities



Map 3.3. Lumbini Sanskritik Urban Municipality: Categorization of Health care facilities



Map 3.4. Kotahimai Rural Municipality: Categorization of Health care facilities

3.3. Household and Population Data

The ward-wise household and population data of the Krishnanagar Urban Municipality as shown in Table 3.3. The Krishnanagar Urban Municipality has 12 wards with 6743 households, a male population of 28062, a female population of 25458, and a total population of 53520. WN 1 has a maximum household and population with 946 households and 6983 populations. WN 5 has a minimum household and population with 277 households and 2297 populations.

Table 3.3. Household and Population data of Krishnanagar Urban Municipality

WN	Household	Male	Female	Total
1	946	3774	3209	6983
2	633	3154	2996	6150
3	357	1467	1352	2819
4	496	1969	1743	3712
5	277	1182	1115	2297
6	450	2034	2032	4066
7	586	2204	2078	4282
8	698	2941	2627	5568
9	512	2105	1785	3890
10	627	2783	2434	5217
11	625	2285	2055	4340
12	536	2164	2032	4196
Total	6743	28062	25458	53520

Similarly, the ward-wise household and population data of the Shuddhodhan Rural Municipality are shown in Table 3.4. The Shuddhodhan Rural Municipality has 6 wards with 6628 households, a male population of 30030, a female population of 26827, and a total population of 56857. WN 6 has a maximum household of 1484 and a population of 13143. WN 4 has a minimum household and population with 571 households and 5372 populations.

Table 3.4. Household and Population data of Shuddhodhan Rural Municipality

WN	Household	Male	Female	Total
1	1369	5206	4860	10066
2	1007	4286	4039	8325
3	1025	4469	4114	8583
4	571	2812	2560	5372
5	1172	6396	4972	11368
6	1484	6861	6282	13143
Total	6628	30030	26827	56857

Likewise, the ward-wise household and population data of the Lumbini Sanskritik Urban Municipality are shown in Table 3.5. The Lumbini Sanskritik Urban Municipality has 13 wards with 10114 households, a male population of 42547, a female population of 39541, and a total population of 82088. WN 6 has a maximum household of 1080 and a population of 9426. WN 8 has a minimum household and population with 419 households and 3721 populations.

Table 3.5. Household and Population data of Lumbini Sanskritik Urban Municipality

WN	Household	Male	Female	Total
1	553	2367	2208	4575
2	1021	3897	3571	7468
3	591	2712	2649	5361
4	898	4098	3846	7944
5	530	2255	2222	4477
6	1080	4873	4553	9426
7	656	2739	2606	5345
8	419	1895	1826	3721
9	692	3046	2697	5743
10	1024	3952	3467	7419
11	1015	4109	3850	7959
12	1058	3847	3589	7436
13	577	2757	2457	5214
Total	10114	42547	39541	82088

Also, the ward-wise household and population data of the Kotahimai Rural Municipality are shown in Table 3.6. The Kotahimai Rural Municipality has 7 wards with 6417 households, a male population of 24036, a female population of 21865, and a total population of 45901. WN 5 has a maximum household of 1569 and a population of 10387. WN 1 has a minimum household and population with 599 households and 4186 populations.

Table 3.6. Household and Population data of Kotahimai Rural Municipality

WN	Household	Male	Female	Total
1	599	2157	2029	4186
2	638	2759	2548	5307
3	965	3932	3563	7495
4	744	2517	2337	4854
5	1569	5438	4949	10387
6	753	2858	2535	5393
7	1149	4375	3904	8279
Total	6417	24036	21865	45901

3.4. Result of Raster Analysis and Overlay Analysis

People use public vehicles and private vehicles or by walking to reach health care facilities. For this study, Travel time is calculated taking into consideration that people reach health care facilities by using the local bus or private vehicle in normal driving. Health care facilities offered two types of services: basic service and medical service as in section 1.4.7. Hence, household and population access to health care facilities based on travel time to receive services provided by health care facilities are calculated under two scenarios: i) Travel time to Hospital only ii) Travel time to All Health care facilities.

3.4.1. Scenario 1: Travel time to Hospital only

One Primary Hospital class 'B' type of health care facility exists in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, and Kotahimai Rural Municipality whereas Primary Hospital class 'A' type of hospital exists in Lumbini Sanskritik Urban Municipality. Primary Hospital provided both basic and medical services. In this case, the least accumulative cost distance is calculated considering only Primary Hospital class 'B'. Cost distance on travel time's break values of 0 to 15, 15 to 30, 30 to 45, 45 to 60, and greater than 60 are calculated. Household and population covered by each break value were identified by overlay analysis. The spatial join tool for overlay analysis is applied to join cost distance of travel time generated by raster analysis and household points containing household data and population data then the Summary Statistic tool is used to calculate summary statistics for fields in a table.

In Krishnanagar Urban Municipality: Households situated within the 0 – 78 min travel time from the Hospital. 34.48% of households located on the travel time of 0 - 15 min, 46.34% of household settled on the travel time of 15 - 30 min, 18.00% of household settled on the travel time of 30 - 45 min, 0.74% of household settled on the travel time of 45 - 60 min, and 0.43% of household settled on the travel time of 60 - 78 region of Shiva Raj primary hospital class B3 of Krishnanagar Urban Municipality. 99.57% of households are inside a

one-hour travel time zone, while 0.43% of households are outside the hospital's one-hour travel time zone. The maximum household of 3125 is 46.34% situated on 15 - 30 min travel time zone and the minimum household of 29 that is 0.43% situated on 60 - 78 min travel time zone of the hospital as shown in Table 3.7, Map 3.5, Map 3.6 and Figure 3.1.

Table 3.7. Krishnanagar Urban Municipality: Household access to Primary Hospitals based on the travel time

Municipality	Hospital	Travel Time (minutes)	Household	
			N	%
Krishnanagar Urban Municipality	Shiva Raj Primary Hospital B3	0 - 15	2325	34.48%
		15 – 30	3125	46.34%
		30 - 45	1214	18.00%
		45 - 60	50	0.74%
		60 - 78	29	0.43%
		Total	6743	100%

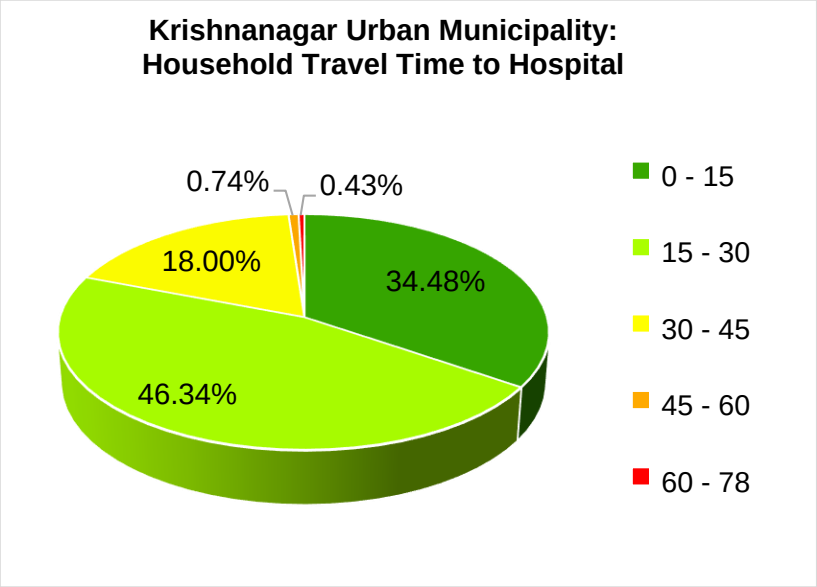


Figure 3.1. Krishnanagar Urban Municipality: Household Travel Time to Hospital

The population covered by the hospital of Krishnanager Urban Municipality is shown in Table 3.8 and Figure 3.2. 34.97% of the total population locates within 0 - 15 min travel time's zone, 46.96% of total population locates within 15 - 30 min travel time region, 16.94% of the total population locates within 30 – 45 min travel time's zone, 0.73% of the total

population locates within 45 - 60 min travel time's zone, and 0.40% of the total population locates within 60 -78 min travel time's zone of Shiva Raj primary hospital class B3. 99.60% of the total population locates in a one-hour service area of a hospital whereas 0.40% of households require more than one-hour travel time to reach Shiva Raj primary hospital class B3. Maximum of 25135 that is 46.96% of total population situated at 15 - 30 min travel time and minimum 214 that is 0.40% of population situated at 60 - 78 min travel time.

Table 3.8. Krishnanagar Urban Municipality: Population access to Primary Hospitals based on travel time

Municipality/ Hospital	Travel Time (minutes)	Population					
		Male		Female		Total	
		N	%	N	%	N	%
Krishnanagar Urban Municipality/ Shiva Raj Primary Hospital B3	0 - 15	9928	35.38%	8786	34.51%	18714	34.97%
	15 - 30	13121	46.76%	12014	47.19%	25135	46.96%
	30 - 45	4714	16.80%	4353	17.10%	9067	16.94%
	45 - 60	204	0.73%	186	0.73%	390	0.73%
	60 - 78	95	0.34%	119	0.47%	214	0.40%
	Total	28062	100%	25458	100%	53520	100%

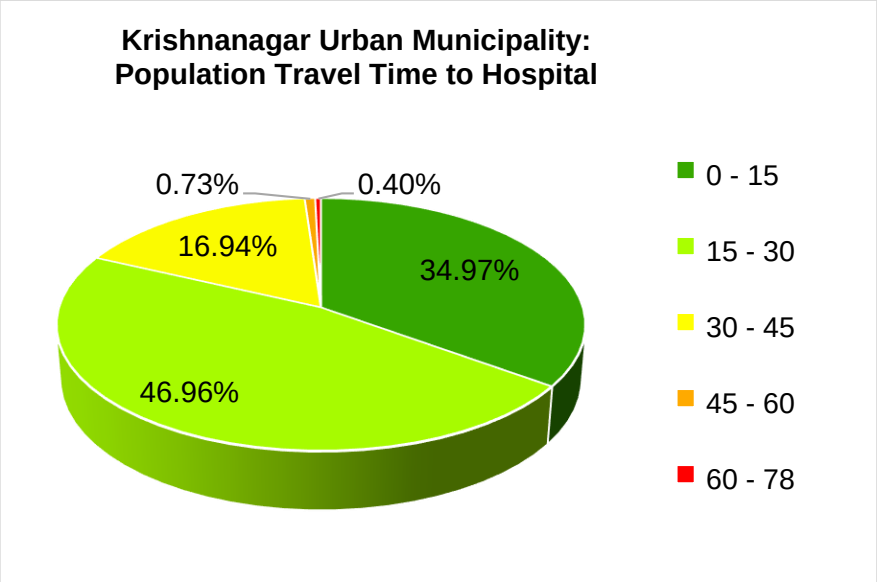
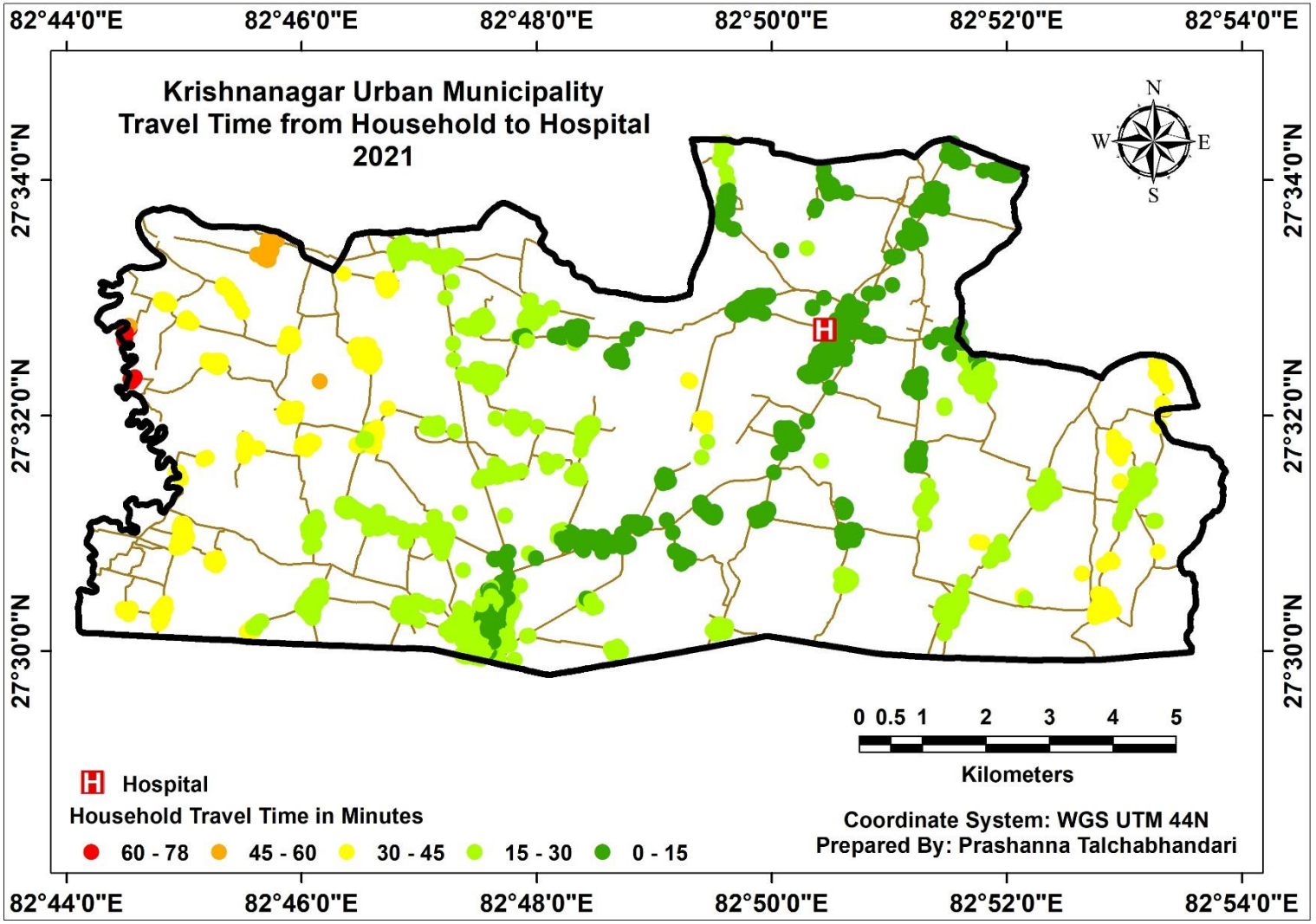
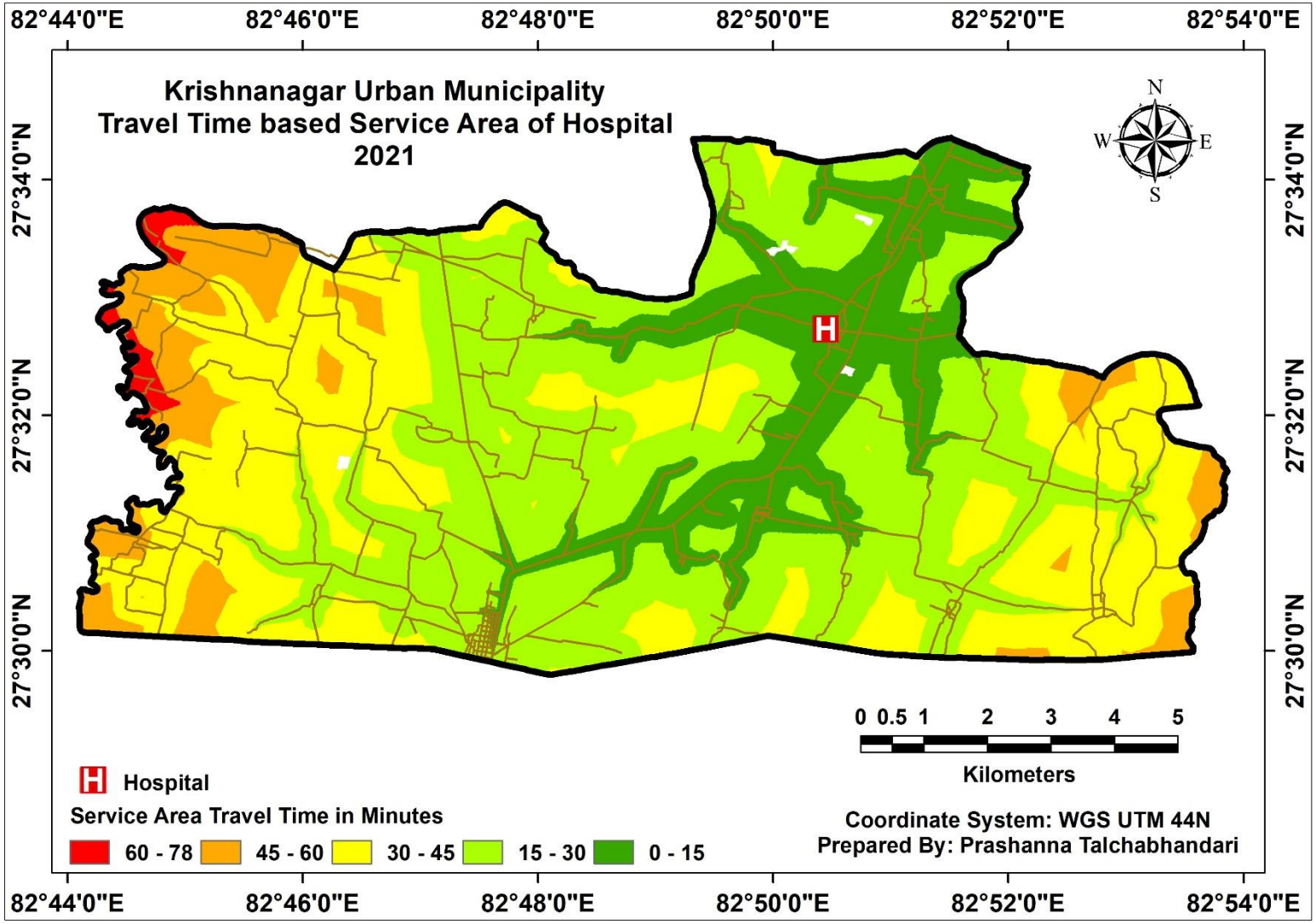


Figure 3.2. Krishnanagar Urban Municipality: Population Travel Time to Hospital



Map 3.5. Krishnanagar Urban Municipality: Travel time from household to Hospital



Map 3.6. Krishnanagar Urban Municipality: Travel time service area of Hospital

In Shuddhodhan Rural Municipality: The Households situated within the sector of 0 – 60 minutes' travel time from the Labani primary Hospital. 27.78% of households located on the 0 - 15 minutes' travel time zone, 37.52% of households settled on the 15 - 30 minutes' travel time zone, 25.63% of households settled on the 30 - 45 minutes' travel time zone, and 9.07% of household settled on the 45 - 60 minutes' on the travel time of Labani primary hospital class B3 of Shuddhodhan Rural Municipality. 100% of households are within a one-hour travel time zone of the hospital. The maximum household of 2487 is 37.52% situated on 15 - 30 min travel time zone and the minimum household of 601 that is 9.07% situated on 45 - 60 min travel time zone of the hospital as shown in Table 3.9, Map 3.7, Map 3.8 and Figure 3.3.

Table 3.9. Shuddhodhan Rural Municipality: Household access to Primary Hospitals based on the travel time

Municipality	Hospital	Travel Time (minutes)	Household	
			N	%
Shuddhodhan Rural Municipality	Labani Primary Hospital B3	0 - 15	1841	27.78%
		15 - 30	2487	37.52%
		30 - 45	1699	25.63%
		45 - 60	601	9.07%
		Total	6628	100%

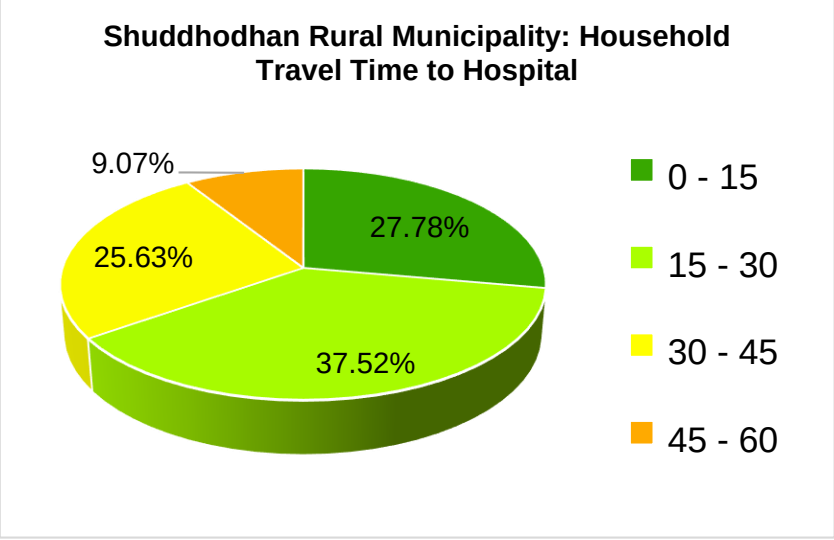


Figure 3.3. Shuddhodhan Rural Municipality: Household Travel Time to Hospital

Table 3.10 and Figure 3.4 shows the population covered by the Labani primary hospital of Shuddhodhan Rural Municipality. 27.48% of the total population locates within 0 - 15 min travel time's zone, 38.92% of total population locates within 15 - 30 min travel time region, 25.28% of the total population locates within 30 – 45 min travel time's zone, and 8.32% of the total population locates within 45 - 60 min travel time's zone of Labani primary hospital class B3. 100% of the total population can reach Labani primary hospital class B3 within a one-hour travel time. Maximum of 22129 that is 38.92% of total population situated at 15 - 30 min travel time's zone and minimum 4730 that is 8.32% of population situated at 45 - 60 min travel time's zone.

Table 3.10. Shuddhodhan Rural Municipality: Population access to Primary Hospitals based on travel time

Municipality/ Hospital	Travel Time (minutes)	Population					
		Male		Female		Total	
		N	%	N	%	N	%
Shuddhodhan Rural Municipality/ Labani Primary Hospital B3	0 - 15	8082	26.91%	7544	28.12%	15626	27.48%
	15 - 30	11791	39.26%	10338	38.54%	22129	38.92%
	30 - 45	7647	25.46%	6725	25.07%	14372	25.28%
	45 - 60	2510	8.36%	2220	8.28%	4730	8.32%
	Total	30030	100%	26827	100%	56857	100%

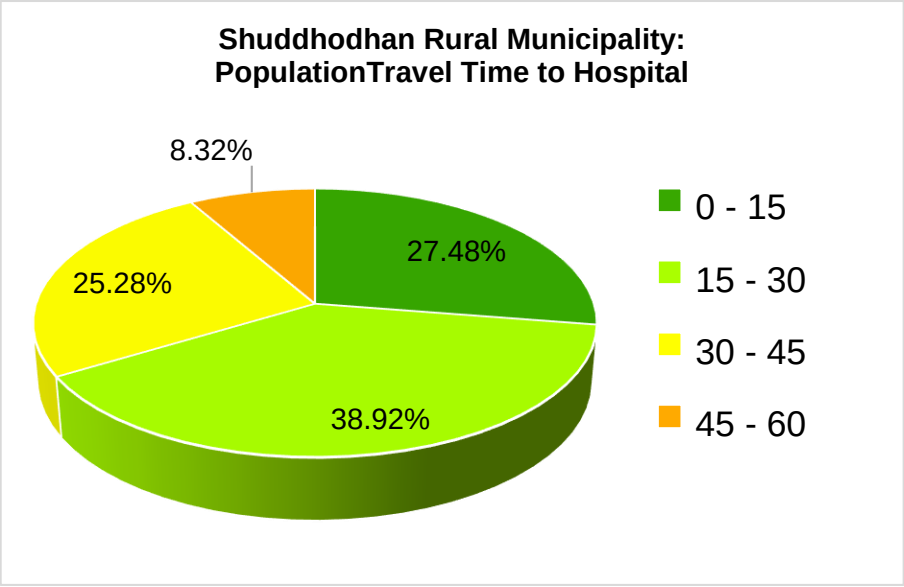
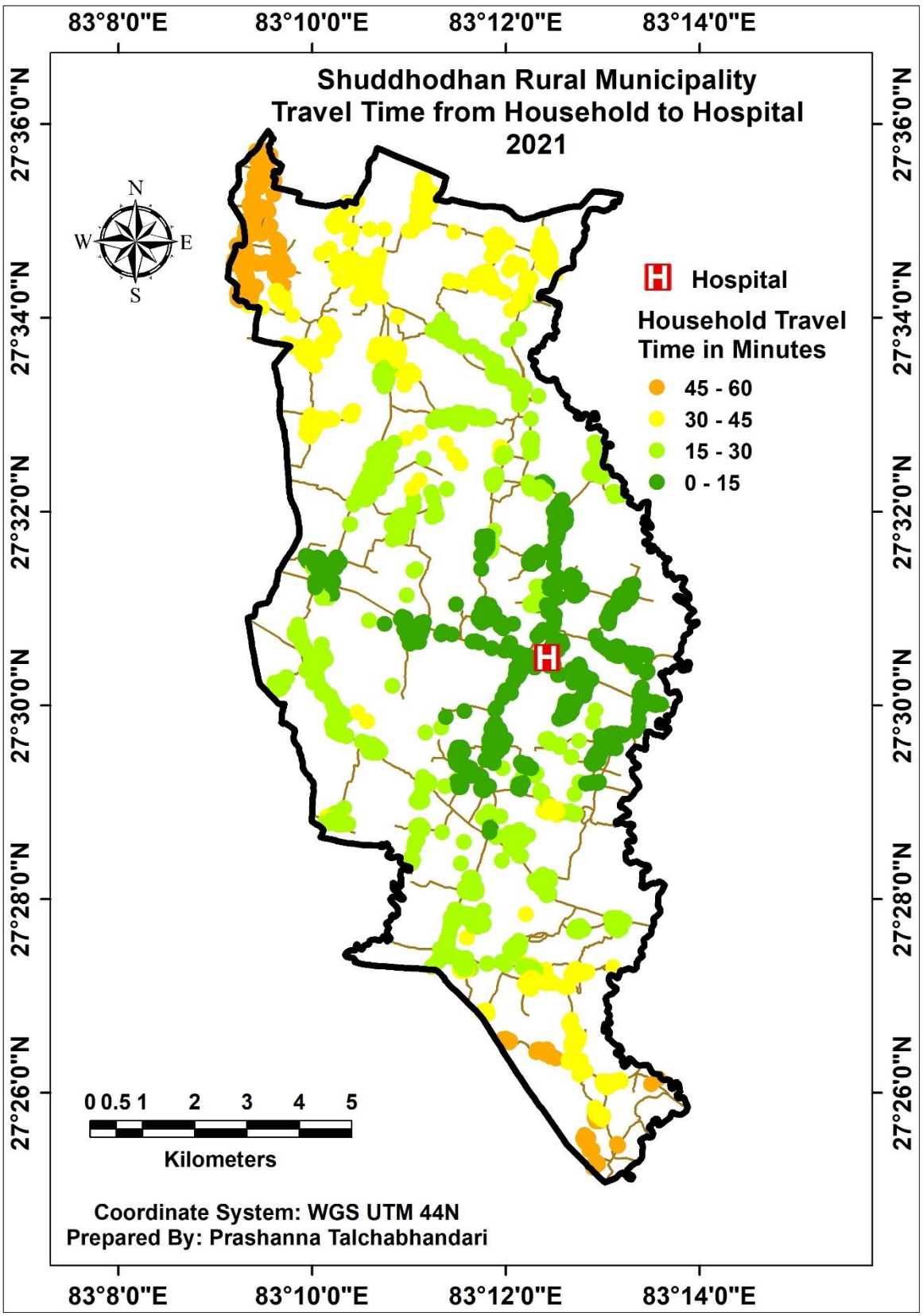
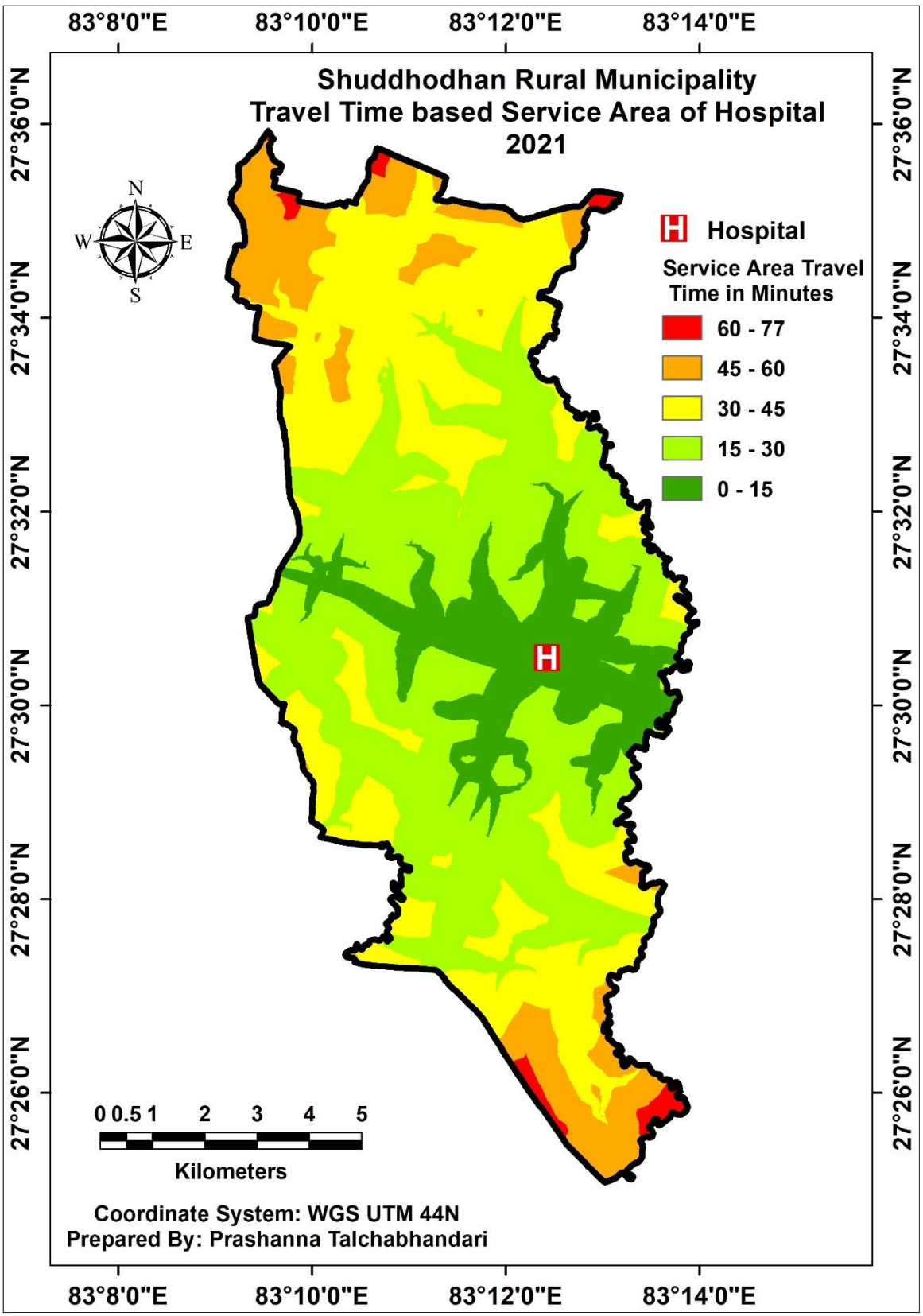


Figure 3.4. Shuddhodhan Rural Municipality: Population Travel Time to Hospital



Map 3.7. Shuddhodhan Rural Municipality: Travel time from household to Hospital



Map 3.8. Shuddhodhan Rural Municipality: Travel time service area of Hospital

In Lumbini Sanskritik Urban Municipality: The Households situated within the sector of 0 -108 min travel time from the Hospital. 2.82% of households located in the travel time zone of 0 - 15 min, 11.52% of households settled on the travel time region of 15 - 30 min, 32.07% of households settled on the travel time region of 30 - 45 min, 31.18% of household settled on the travel time region of 45 - 60 min and 22.42% of household settled on the travel time region of 60 - 108 min on travel time region of Lumbini Primary Hospital class A2 of Lumbini Sanskritik Urban Municipality. 77.58% of households are within a one-hour travel time zone of the hospital whereas 22.42% of households lie outside the one-hour travel time zone of the hospital. The maximum household of 3243 is 32.07% situated on 30 - 45 min travel time zone and the minimum household of 285 is 2.82% situated on 0 - 15 min travel time zone of the hospital as shown in Table 3.11, Map 3.9, Map 3.10, and Figure 3.5.

Table 3.11. Lumbini Sanskritik Urban Municipality: Household access to Primary Hospitals based on the travel time

Municipality	Hospital	Travel Time (minutes)	Household	
			N	%
Lumbini Sanskritik Urban Municipality	Lumbini Primary Hospital A3	0 - 15	285	2.82%
		15 - 30	1165	11.52%
		30 - 45	3243	32.07%
		45 - 60	3153	31.18%
		60 - 108	2267	22.42%
		Total	10113	100%

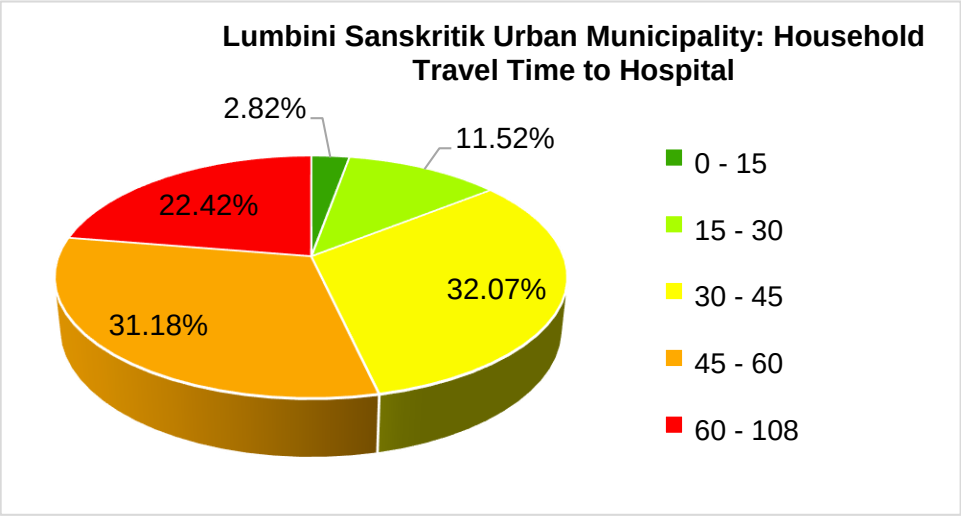


Figure 3.5. Lumbini Sanskritik Urban Municipality: Household Travel Time to Hospital

The 2.42% of the total population locates within 0 - 30 min travel time's zone, 9.92% of total population locates within 30 - 60 min travel time's zone, 32.87% of the total population locates within 60 – 120 min travel time's zone, 31.34% of the total population locates within 120 – 180 min travel time's zone, and 23.45% of the total population locates within 60 - 108 min travel time's zone to reach Lumbini Primary Hospital A2. 76.55% of the total population can reach in a one-hour travel time whereas 23.45% of households require more than one hour to reach Lumbini Primary Hospital A2. Maximum of 26982 that is 32.87% of total population situated at 30 - 45 min travel time's zone and minimum 1983 that is 2.42% of population situated at 0 - 15 min travel time's zone as shown in Table 3.12 and Figure 3.6.

Table 3.12. Lumbini Sanskritik Urban Municipality: Population access to Primary Hospitals based on travel time

Hospital	Travel Time (minutes)	Population					
		Male		Female		Total	
		N	%	N	%	N	%
Lumbini Primary Hospital A2	0 - 15	1050	2.47%	933	2.36%	1983	2.42%
	15 - 30	4268	10.03%	3871	9.79%	8139	9.92%
	30 - 45	14019	32.95%	12963	32.79%	26982	32.87%
	45 - 60	13290	31.24%	12438	31.46%	25728	31.34%
	60 - 108	9916	23.31%	9333	23.61%	19249	23.45%
	Total	42543	100%	39538	100%	82081	100%

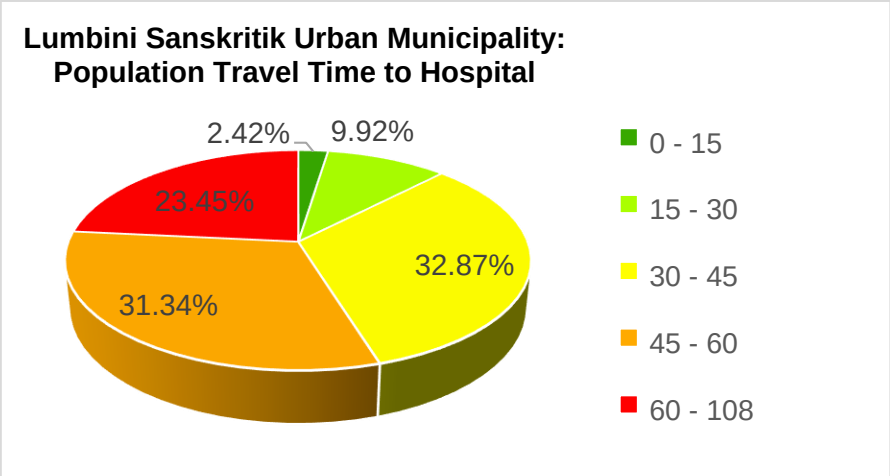
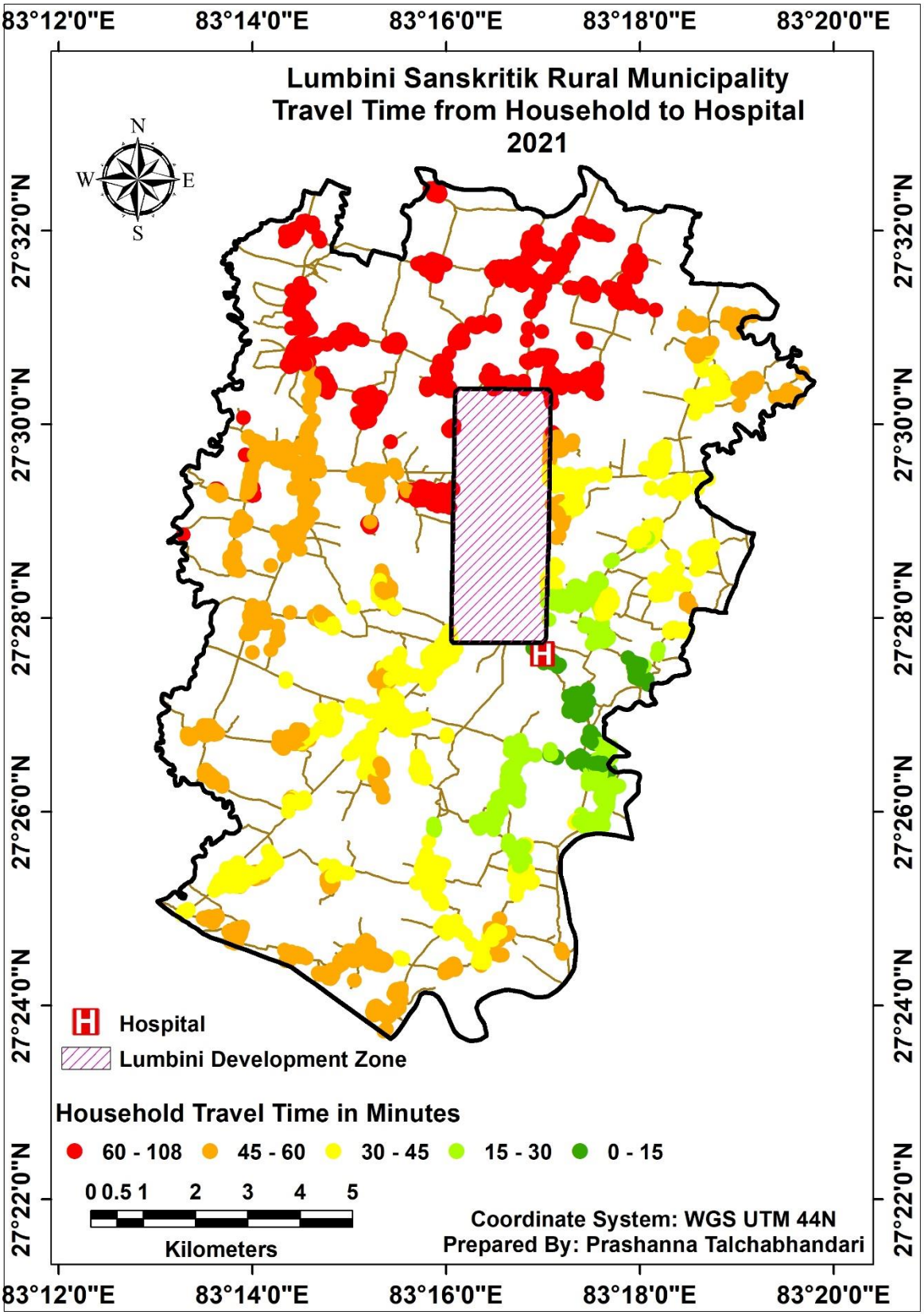
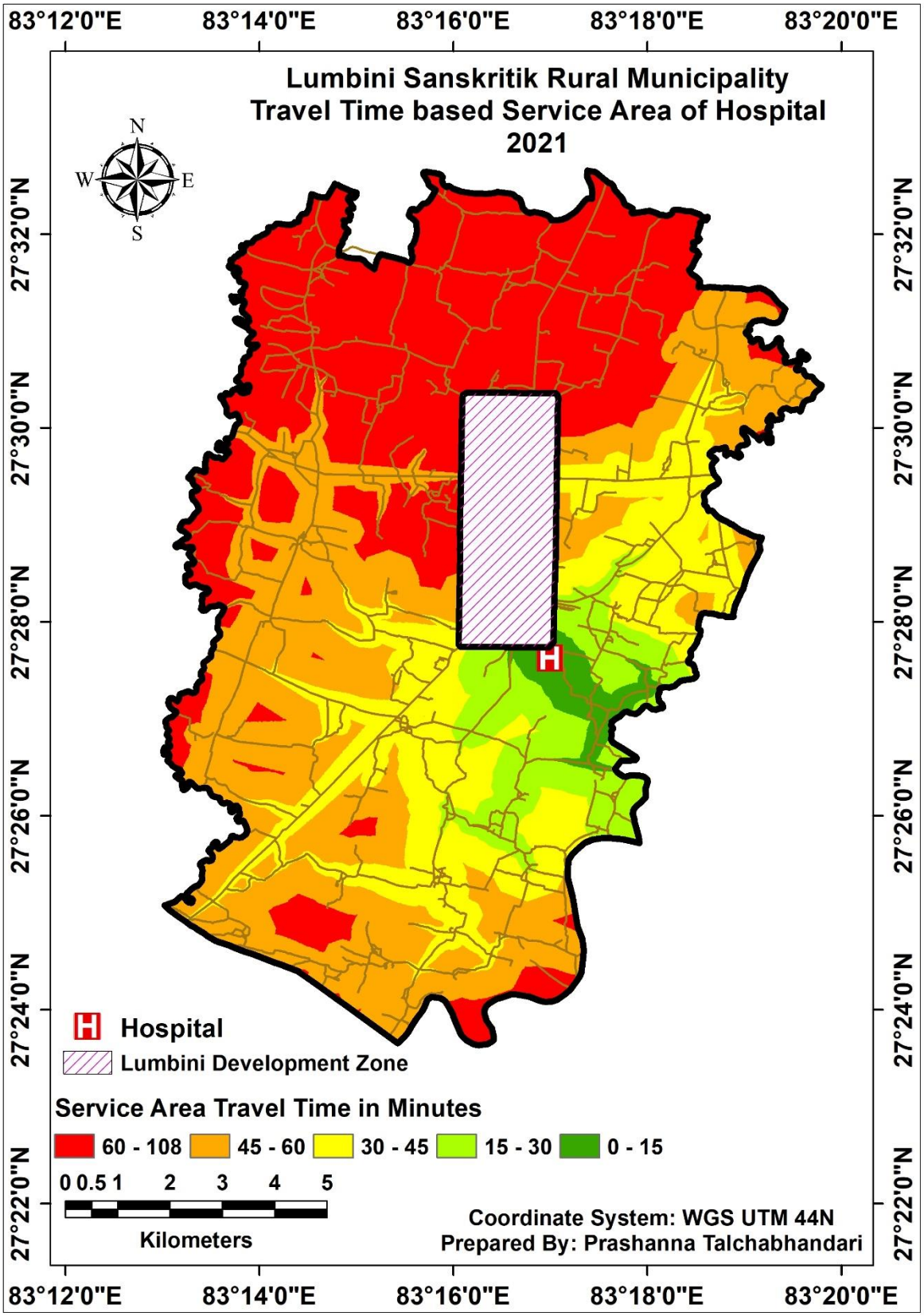


Figure 3.6. Lumbini Sanskritik Urban Municipality: Population Travel Time to Hospital



Map 3.9. Lumbini Sanskritik Urban Municipality: Travel time from household to Hospital



Map 3.10. Lumbini Sanskritik Urban Municipality: Travel time service area of Hospital

In Kotahimai Rural Municipality: The Households situated within the sector of 0 – 86 min travel time from the Hospital. 25.98% of households located in the travel time region of 0 - 15 min, 52.92% of households settled on 15 - 30 min the travel time, 9.41% of households settled on 30 - 45 min the travel time, 7.34% of households settled on the travel time region of 45 - 60 min and 4.35% of household settled on the travel time of 60 - 86 min on travel time region of Hospital. 95.65% of households are within a one-hour travel time of the hospital whereas only 4.35% of households lie outside the one-hour travel time zone of the hospital. The maximum household of 3396 is 52.92% situated on 15 - 30 min travel time zone and the minimum household of 279 that is 4.35% situated on 60 - 86 min travel time zone of the hospital as shown in Table 3.13, Map 3.11, Map 3.12 and Figure 3.7.

Table 3.13. Kotahimai Rural Municipality: Household access to Primary Hospitals based on the travel time

Municipality	Hospital	Travel Time (minutes)	Household	
			N	%
		Total	6743	100%
Kotahimai Municipality	Majhagawa Primary Hospital B2	0 - 15	1667	25.98%
		15 - 30	3396	52.92%
		30 - 45	604	9.41%
		45 -60	471	7.34%
		60 - 86	279	4.35%
		Total	6417	100%

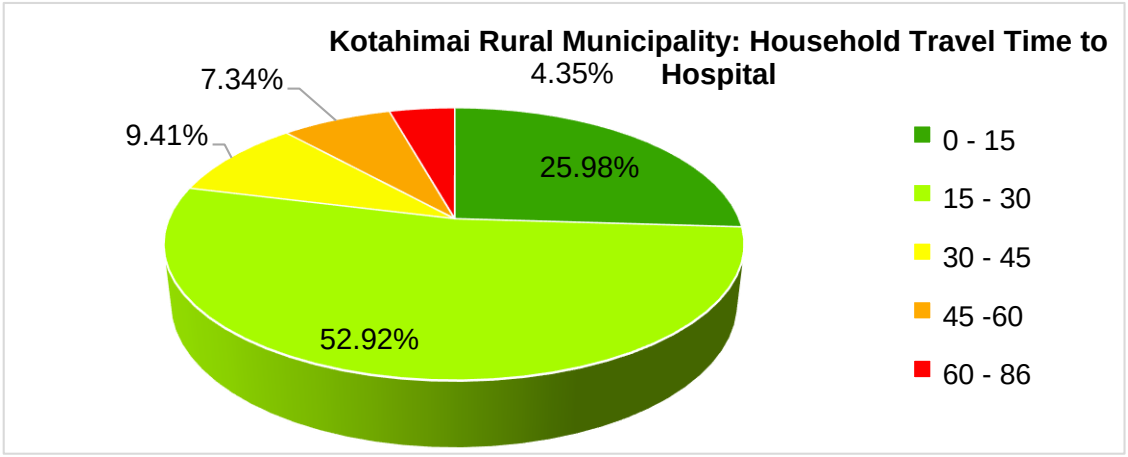


Figure 3.7. Kotahimai Rural Municipality: Household Travel Time to Hospital

The 24.59% of the total population locates within 0 - 15 min travel time's zone, 53.21% of total population locates within 15 - 30 min travel time's zone, 9.66% of the total population locates within 30 - 45 min travel time's zone, 7.56% of the total population locates within 45 - 60 min travel time's zone, and 4.97% of the total population locates within 60 - 86 min travel time's zone to reach Hospital. 95.03% of the total population needs one-hour travel time and 4.97% of households require more than one hour to reach Hospital. Maximum of 24425 that is 53.21% of total population situated at 15 - 30 min travel time's zone and minimum 2283 that is 4.97% of population situated at 60 - 86 min travel time as shown in Table 3.15 and Figure 3.8.

Table 3.14. Kotahimai Rural Municipality: Population access to Primary Hospitals based on travel time

Municipality/ Hospital	Travel Time (minutes)	Population					
		Male		Female		Total	
		N	%	N	%	N	%
Majhagawa Primary Hospital B2	0 - 15	5887	24.49%	5400	24.70%	11287	24.59%
	15 - 30	12852	53.47%	11573	52.93%	24425	53.21%
	30 - 45	2317	9.64%	2119	9.69%	4436	9.66%
	45 -60	1808	7.52%	1662	7.60%	3470	7.56%
	60 - 86	1172	4.88%	1111	5.08%	2283	4.97%
	Total	24036	100%	21865	100%	45901	100%

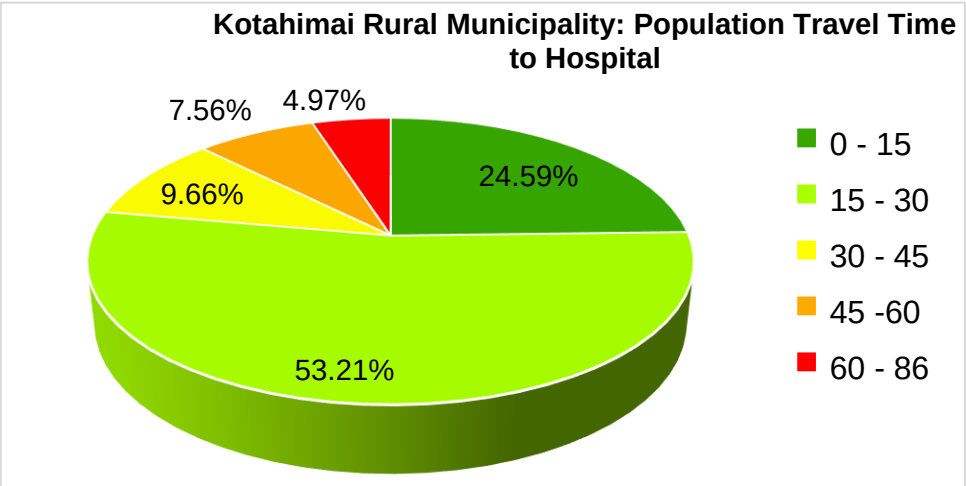
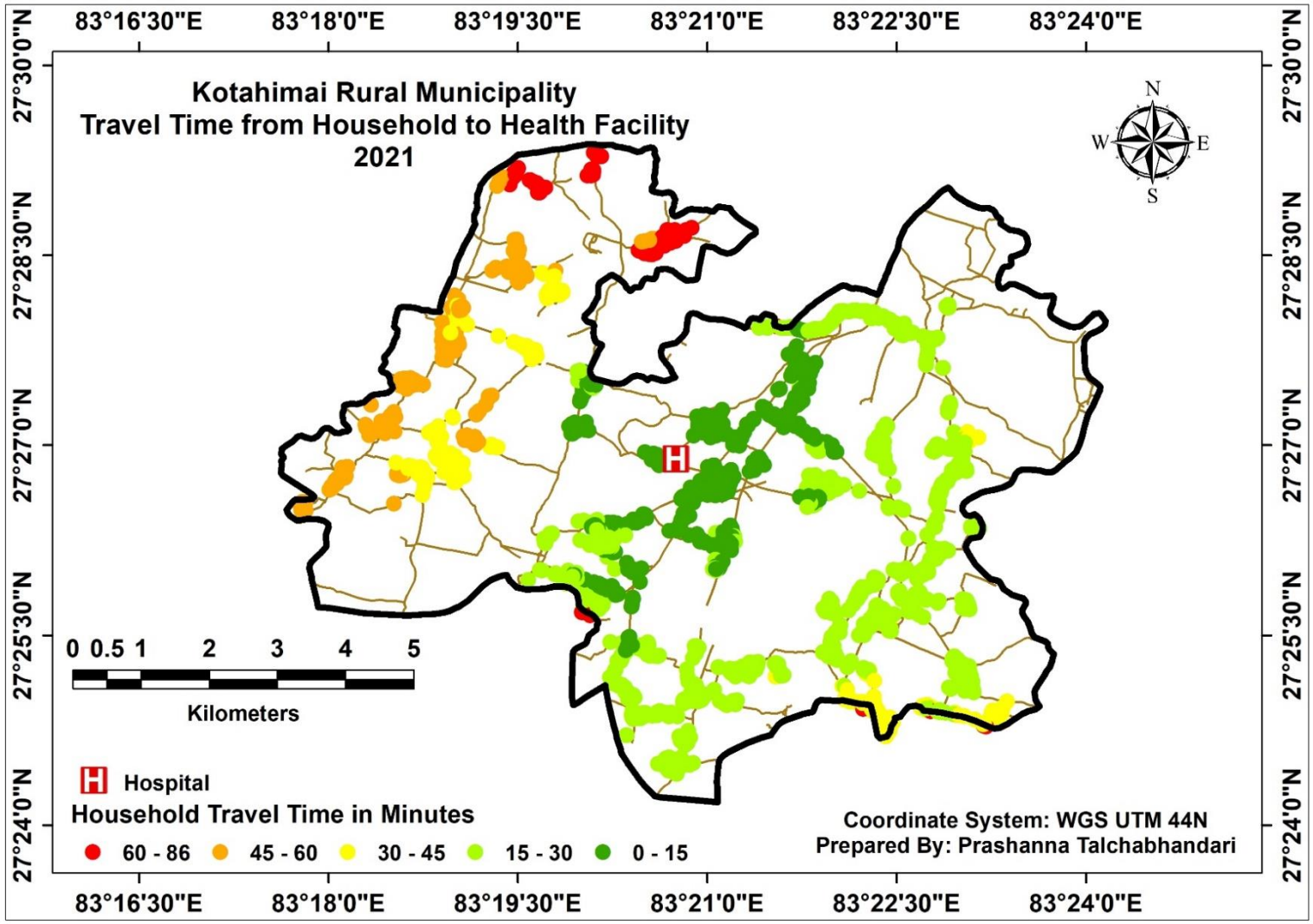
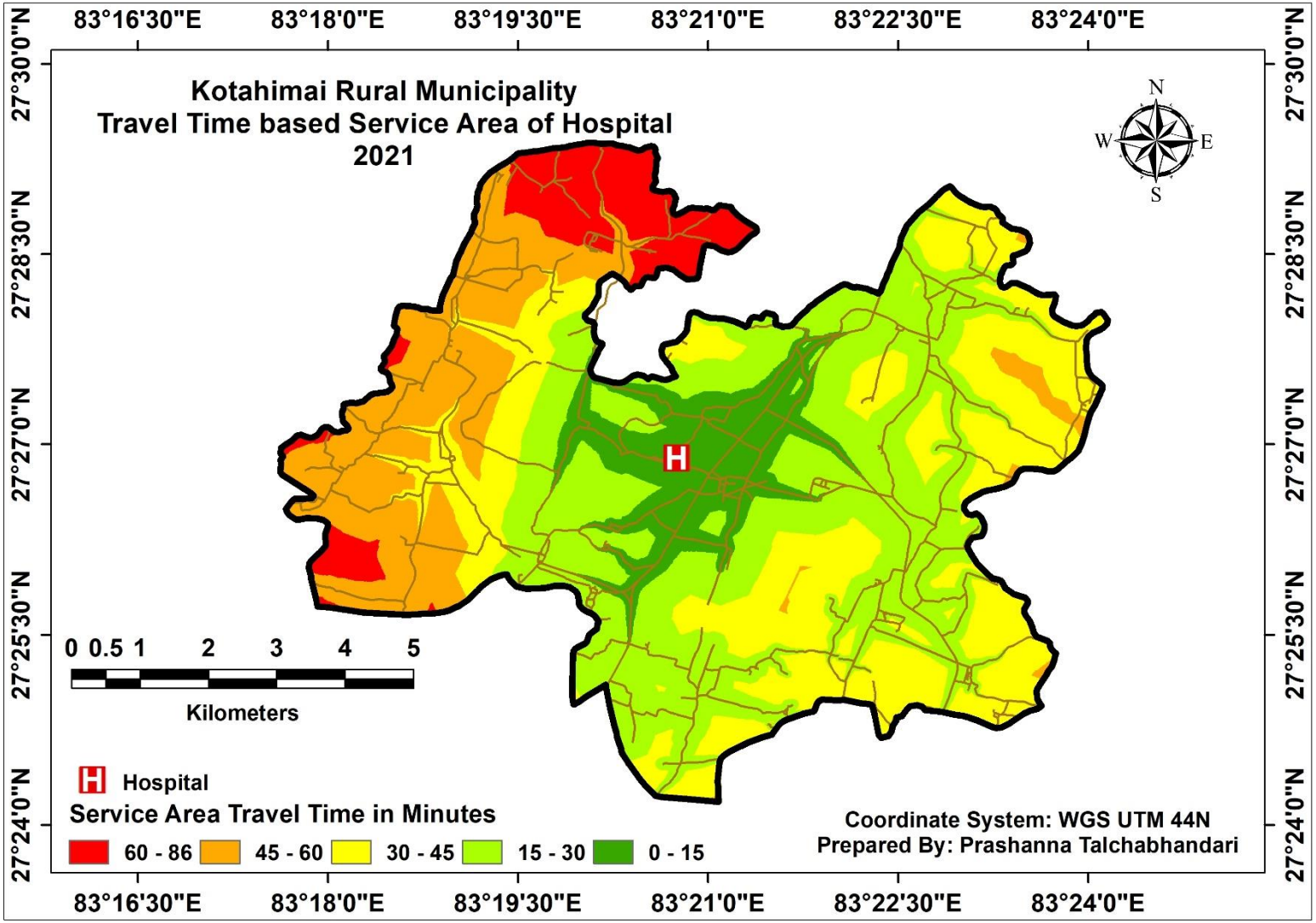


Figure 3.8. Kotahimai Rural Municipality: Population Travel Time to Hospital



Map 3.11. Kotahimai Rural Municipality: Travel time from household to Hospital



Map 3.12. Kotahimai Rural Municipality: Travel time service area of Hospital

3.4.2. Case 2: Travel time to All Health care facilities

In this case, travel time was calculated by raster analyses considering all health care facilities i.e. Primary Hospital class 'A', Primary Hospital class 'B', and health post. The cost distance area based on travel time break values of 0 to 15, 15 to 30, 30 to 45, 45 to 60, and greater than 60 minutes are calculated. The travel time of health care facilities is calculated by two types: a) Health care facilities in combine b) Health care facilities in individual. Then the household number, male population, female population, and total population covered by each break value were identified using the spatial join tool of overlay analysis.

3.4.2.1 Travel time of all Health care facilities in combine

In Krishnanagar Urban Municipality: The households of 91.38% i.e. 6162 number of households lies on the 0 - 15 min travel time's region, 8.19% of households i.e. 552 number of households lies on the region of travel time of 15 - 30 min, and 0.43% of households i.e. 29 number of households lies on the region of 30 - 45 min travel time.

Table 3.15. Household access to Health care facilities in combine

Municipality	Travel Time (minutes)	Household	
		N	%
Krishnanagar Urban Municipality	0 - 15	6162	91.38%
	15 - 30	552	8.19%
	30 - 45	29	0.43%
	Total	6743	100%

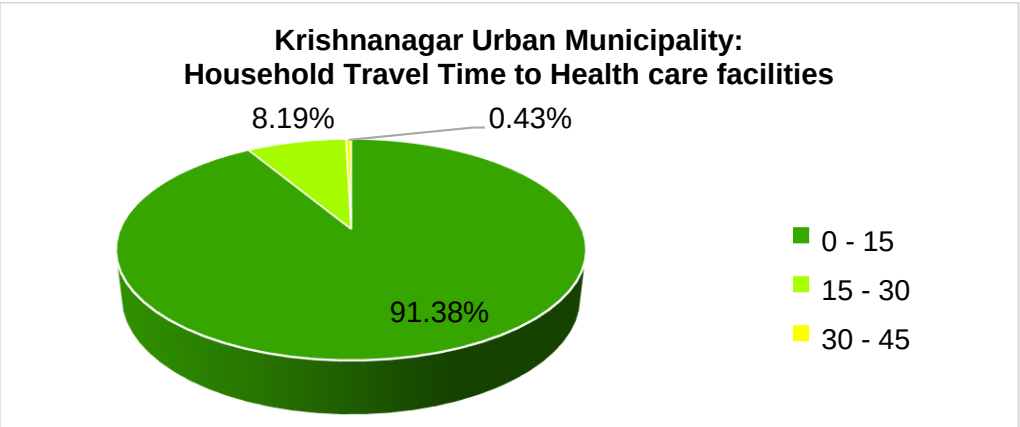


Figure 3.9. Krishnanagar Urban Municipality: Household Travel Time to Health care facilities

100% household i.e. 6743 number locate within one-hour travel time region of health care facilities. Maximum household of 6162 i.e. 91.38% lies in the region of 0 - 15 min travel time and minimum household of 29 i.e. 0.43% lies in the region of 30 – 45 min travel time as shown in Table 3.15, Map 3.13, and Map 3.14.

The 91.66% of the male population, 91.56% of female population, and 91.62% of the total population lie in the region of 0 - 15 min travel time; 7.99% of the male population, 7.99% of female population, and 7.99% of the total population lie on the region of 15 - 30 min travel time; 0.34% of the male population, 0.45% of the female, and 0.39% of the total population lie on the region of 30 - 45 min travel time. The 100% i.e. 53520 number of the population require one-hour travel time. Maximum 91.62% i.e. 49033 number of the total population lies in 0 - 15 min travel time's region and minimum 0.39% i.e. 210 number of the total population lies 30 - 45 travel time's region as shown in Table 3.16 and Figure 3.10.

Table 3.16. Krishnanagar Urban Municipality: Population access to Health care facilities

Municipality	Travel Time (min)	Population					
		Male	%	Female	%	Total	%
Krishnanagar Urban Municipality	0 - 15	25723	91.66%	23310	91.56%	49033	91.62%
	15 - 30	2243	7.99%	2034	7.99%	4277	7.99%
	30 - 45	96	0.34%	114	0.45%	210	0.39%
	Total	28062	100%	25458	100%	53520	100%

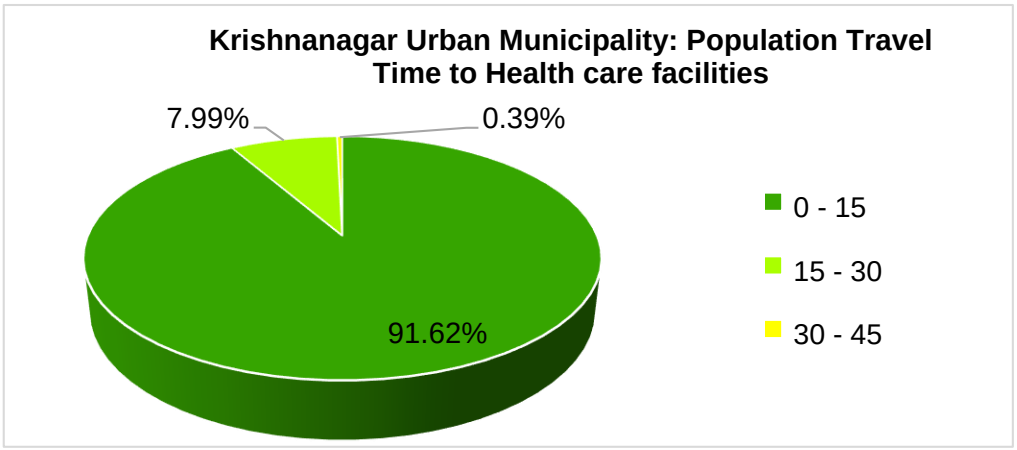
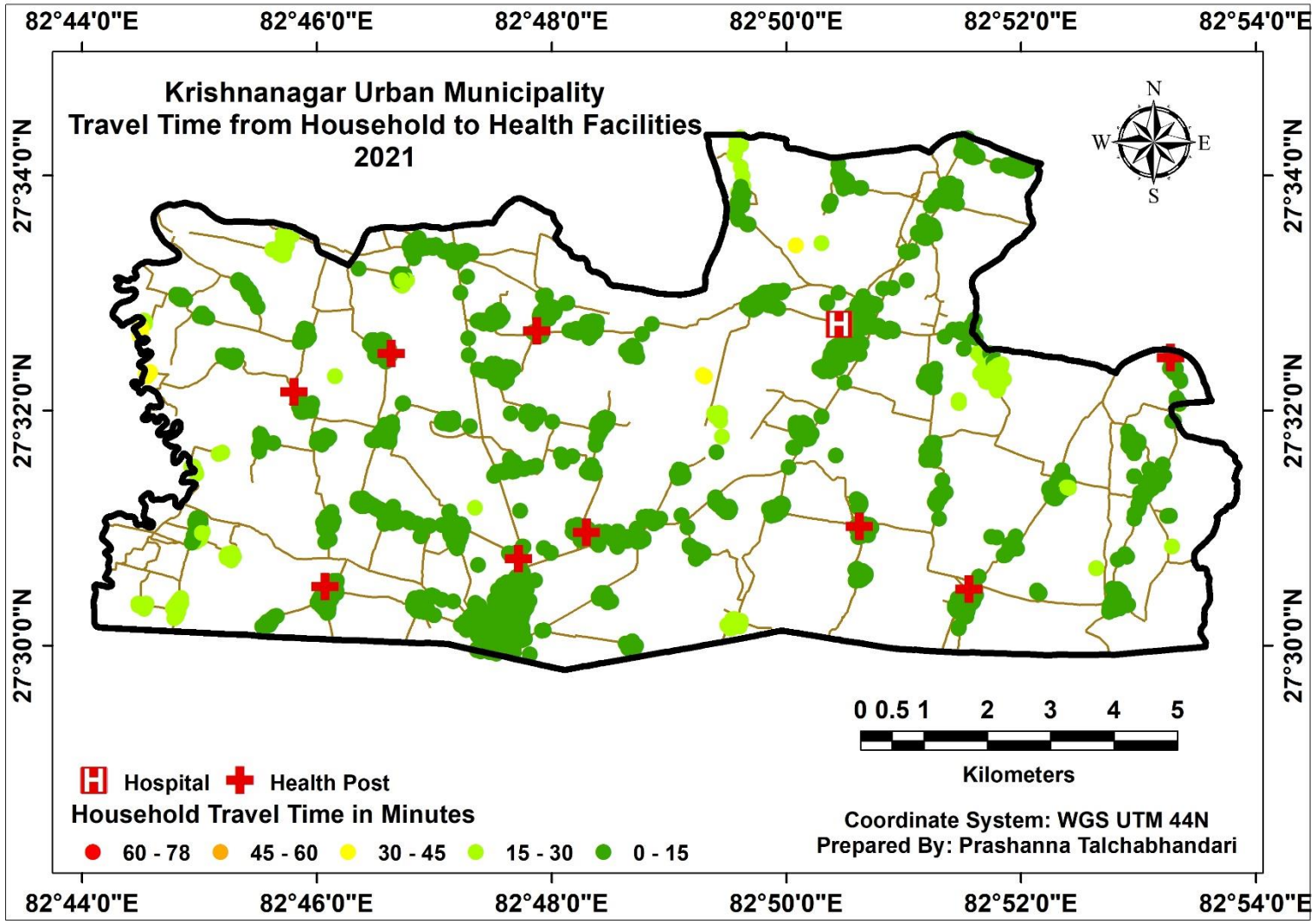
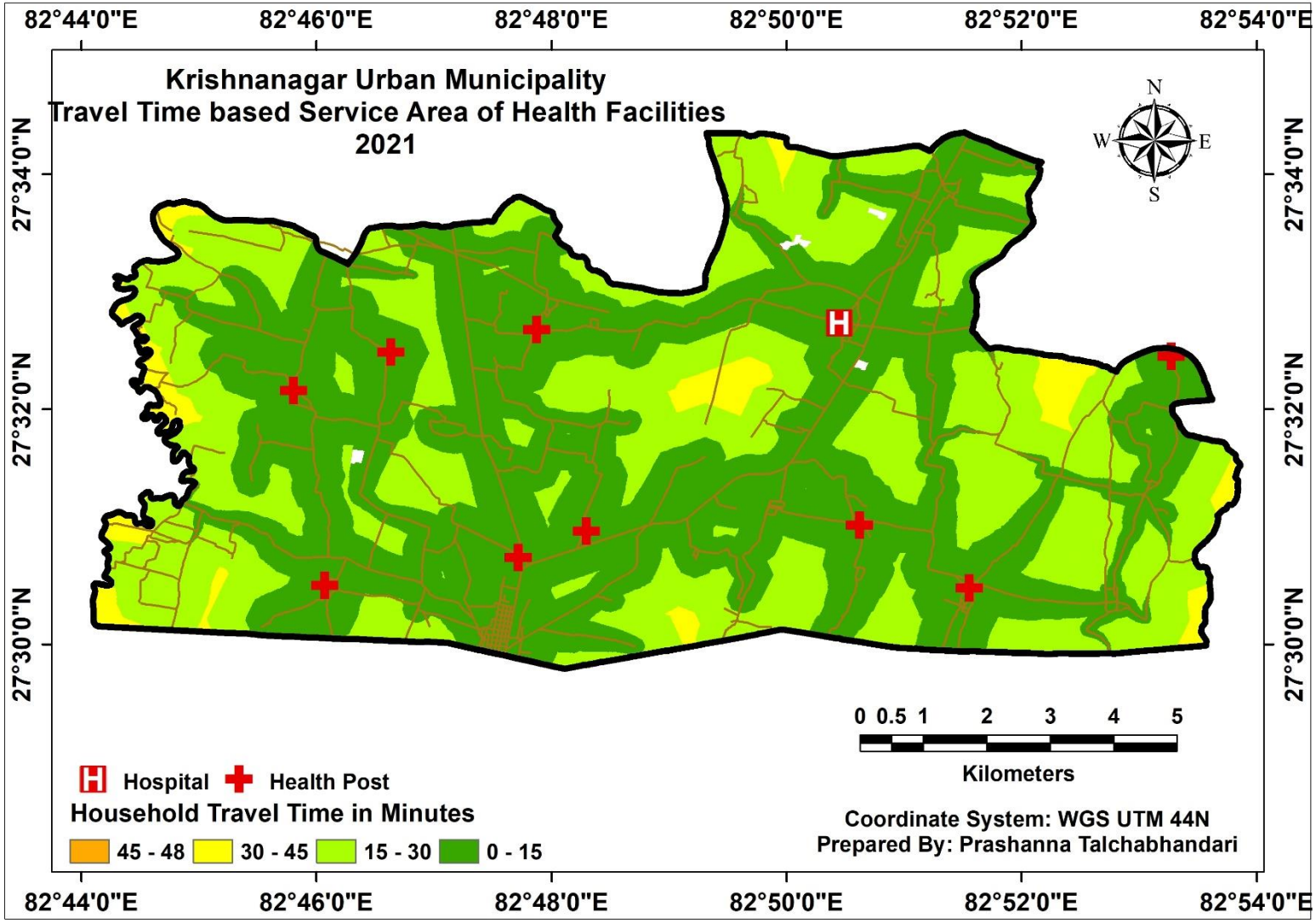


Figure 3.10. Krishnanagar Urban Municipality: Population Travel Time to Health care facilities



Map 3.13. Krishnanagar Urban Municipality: Travel time from household to Health care facilities



Map 3.14. Krishnanagar Urban Municipality: Travel time service area of Health care facilities

In Shuddhodhan Rural Municipality: The households of 69.18% i.e. 4585 number of households settled on the 0 - 15 min travel time's region, 27.25% of households i.e. 1806 number of households settled on the region of travel time of 15 - 30 min, and 3.58% of households i.e. 237 number of households settled on the region of travel time of 30 - 45 min. 100% household i.e. 6628 number locate within one-hour travel time region of health care facilities. Maximum household of 4585 i.e. 69.18% lies in the region of 0 - 15 min travel time and minimum household of 237 i.e. 3.58% lies in the region of 30 – 45 min travel time as shown in Table 3.17, Map 3.15, Map 3.16, and Figure 3.11.

Table 3.17. Household access to Health care facilities in combine

Municipality	Travel Time (minutes)	Household	
		N	%
Shuddhodhan Rural Municipality	0 - 15	4585	69.18%
	15 - 30	1806	27.25%
	30 - 45	237	3.58%
	Total	6628	100%

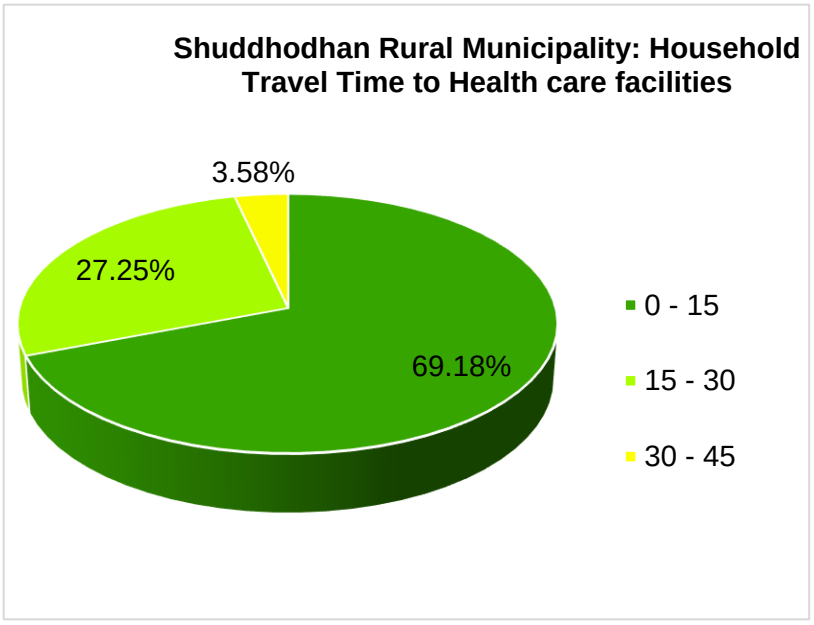


Figure 3.11. Shuddhodhan Rural Municipality: Household Travel Time to Health care facilities

The 67.86% of the male population, 69.31% of female population, and 68.55% of the total population lie in the region of 0 - 15 min travel time; 27.89% of the male population, 27.00% of female population, and 27.47% of the total population lies on the region of 15 - 30 min

travel time; 4.25% of the male population, 3.69% of the female, 3.98% of the total population lie on the region of 30 - 45 min travel time. 100% i.e. 56857 number of the population require one-hour travel time to reach health care facilities. Maximum 68.55% i.e. 38973 number of the total population lies in 0 - 15 min travel time's region and minimum 3.98% i.e. 2265 number of the total population lies 30 - 45 travel time's region as shown in Table 3.18 and Figure 3.12.

Table 3.18. Population access to Health care facilities in a combined

Municipality	Travel Time (min)	Population					
		Male	%	Female	%	Total	%
Shuddhodhan Rural Municipality	0 - 15	20379	67.86%	18594	69.31%	38973	68.55%
	15 - 30	8376	27.89%	7243	27.00%	15619	27.47%
	30 - 45	1275	4.25%	990	3.69%	2265	3.98%
	Total	30030	100%	26827	100%	56857	100%

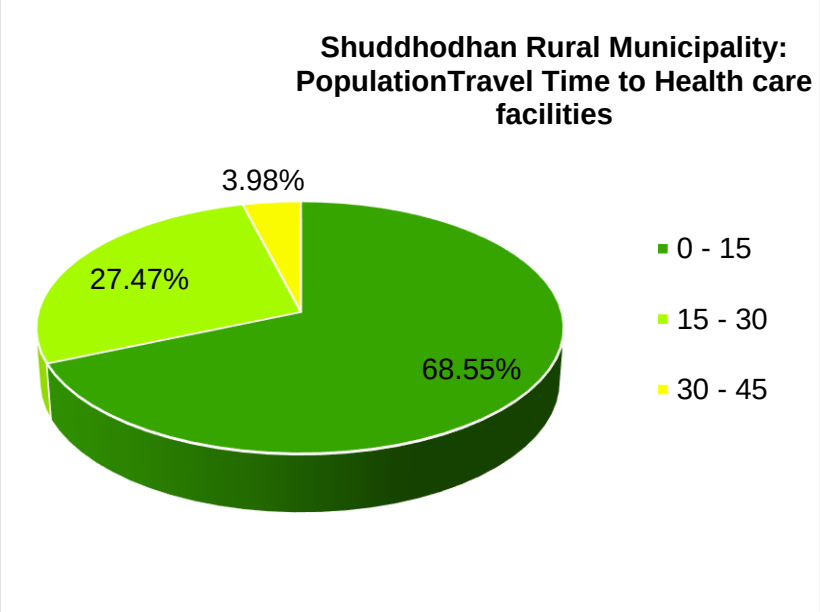
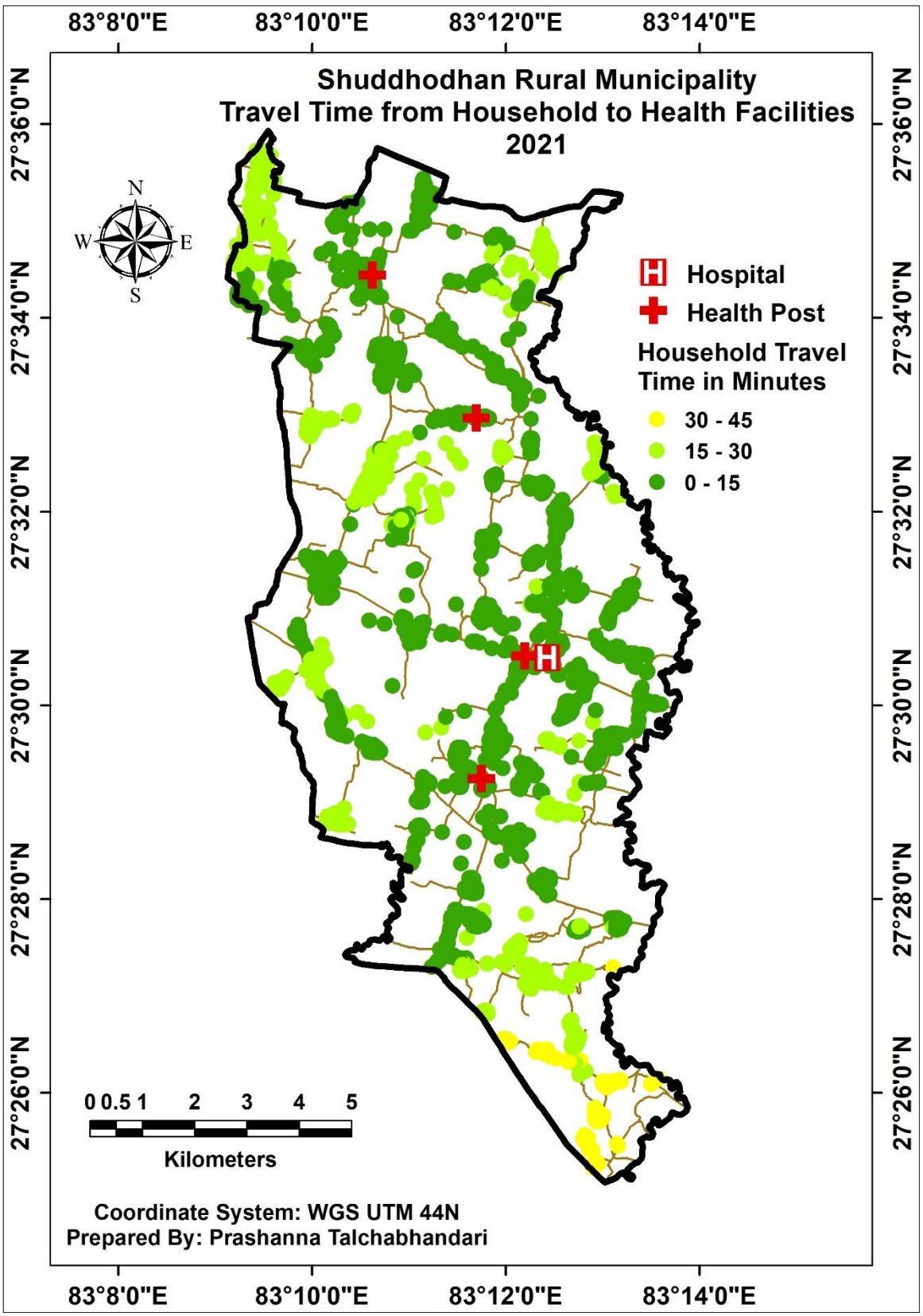
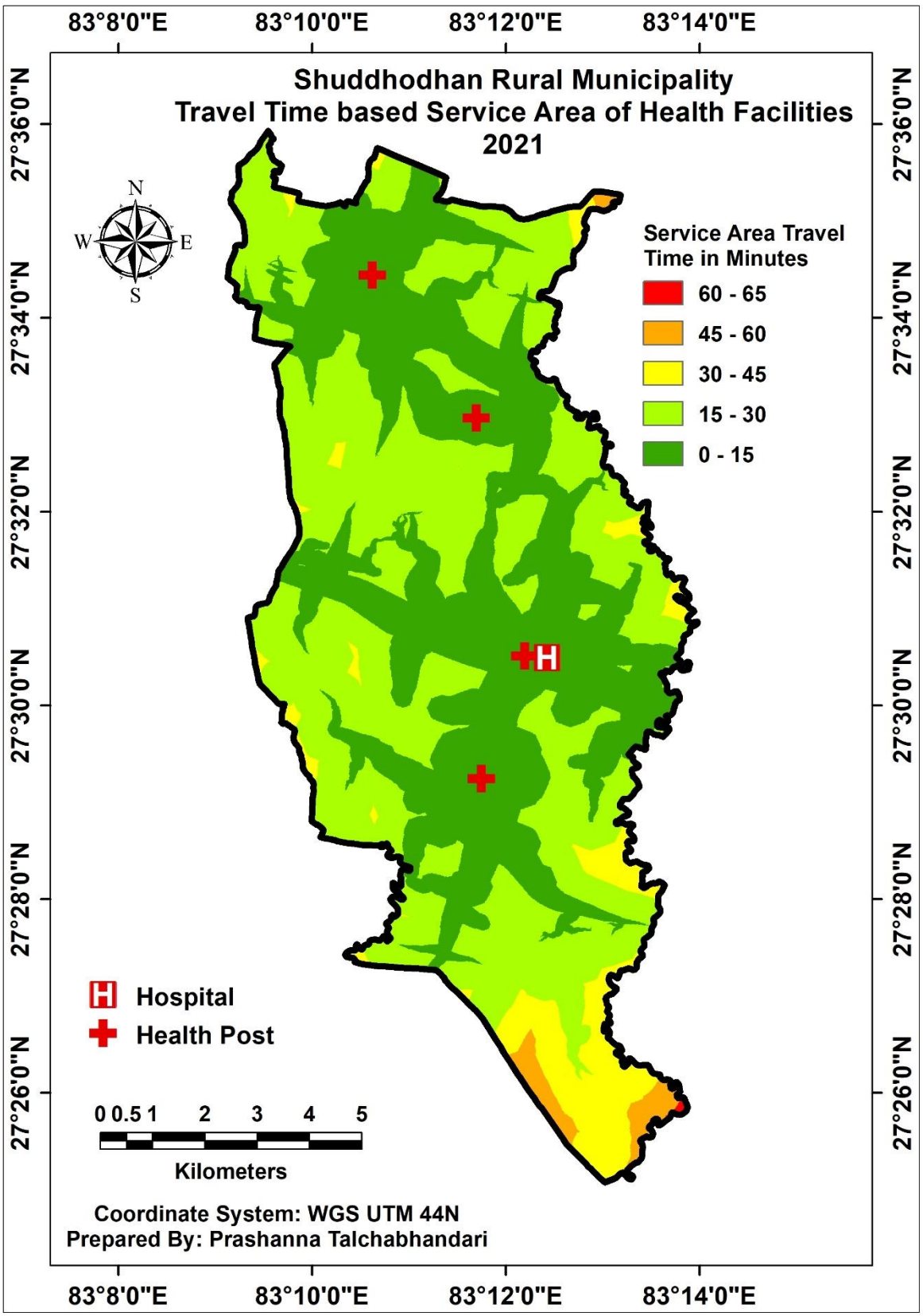


Figure 3.12. Shuddhodhan Rural Municipality: Population Travel Time to Health care facilities



Map 3.15. Shuddhodhan Rural Municipality: Travel time from household to Health care facilities



Map 3.16. Shuddhodhan Rural Municipality: Travel time service area of Health care facilities

In Lumbini Sanskritik Urban Municipality: The households of 72.09% i.e. 7290 number of households lies on the 0 - 15 min travel time's region, 27.30% of households i.e. 2761 number of households lies on the region of travel time of 15 - 30 min, and 0.61% of households i.e. 62 number of households lies on the region of travel time of 30 - 45 min. The household of 100% i.e. 10113 number situated within a one-hour travel time region of health care facilities. Maximum household of 7290 i.e. 72.09% lies in the region of 0 - 15 min travel time and minimum household of 62 i.e. 0.61% lies in the region of 30 – 45 min travel time as shown in Table 3.19, Map 3.17, Map 3.18, and Figure 3.13.

Table 3.19. Lumbini Sanskritik Urban Municipality: Household access to Health care facilities

Municipality	Travel Time (minutes)	Household	
		N	%
Lumbini Sanskritik Urban Municipality	0 - 15	7290	72.09%
	15 - 30	2761	27.30%
	30 - 45	62	0.61%
	Total	10113	100%

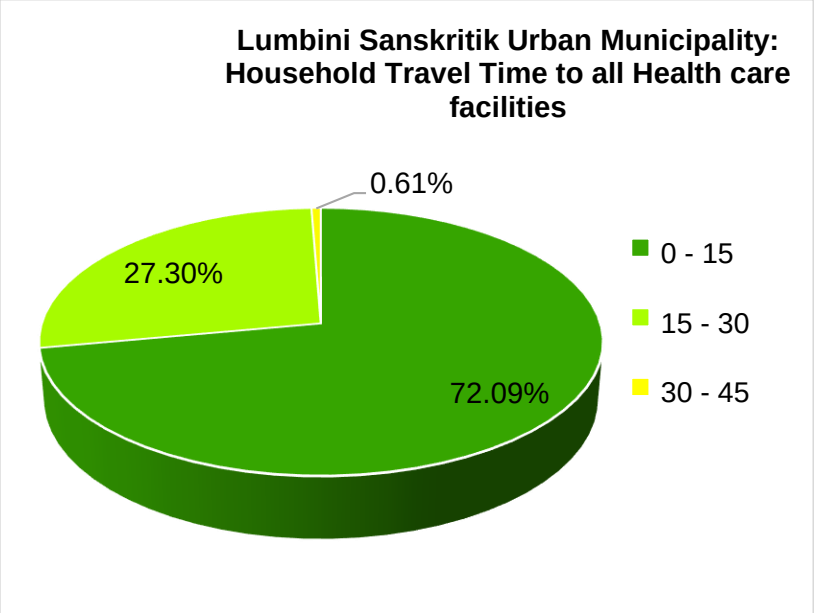


Figure 3.13. Lumbini Sanskritik Urban Municipality: Household Travel Time to Health care facilities

The 72.12% of the male population, 71.97% of female population, and 72.05% of the total population lie in the region of 0 - 15 min travel time; 27.31% of the male population, 27.48%

of female population, and 27.39% of the total population lies on the region of 15 - 30 min travel time; 0.58% of the male population, 0.55% of the female, 0.56% of the total population lie on the region of 30 - 45 min travel time. 100% i.e. 82081 number of the population required within one-hour travel time to reach health care facilities. Maximum 72.05% i.e. 5136 number of the total population lies in 0 - 15 min travel time's region and minimum 0.56% i.e. 462 number of the total population lies 30 - 45 travel time's region as shown in Table 3.20 and Figure 3.14.

Table 3.20. Lumbini Sanskritik Urban Municipality: Population access to Health care facilities

Municipality	Travel Time (min)	Population					
		Male	%	Female	%	Total	%
Lumbini Sanskritik Urban Municipality	0 - 15	30680	72.12%	28456	71.97%	59136	72.05%
	15 - 30	11617	27.31%	10866	27.48%	22483	27.39%
	30 - 45	246	0.58%	216	0.55%	462	0.56%
	Total	42543	100%	39538	100.0%	82081	100%

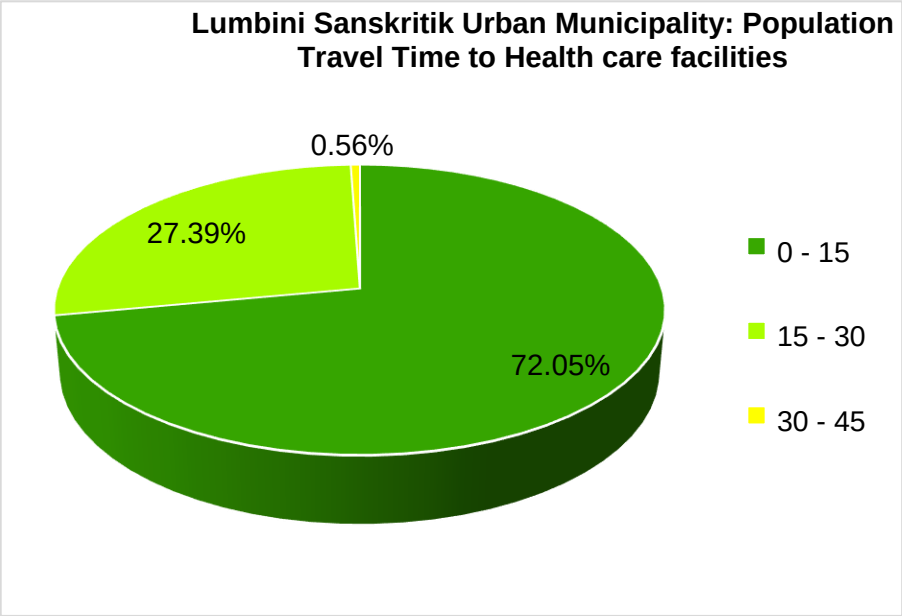
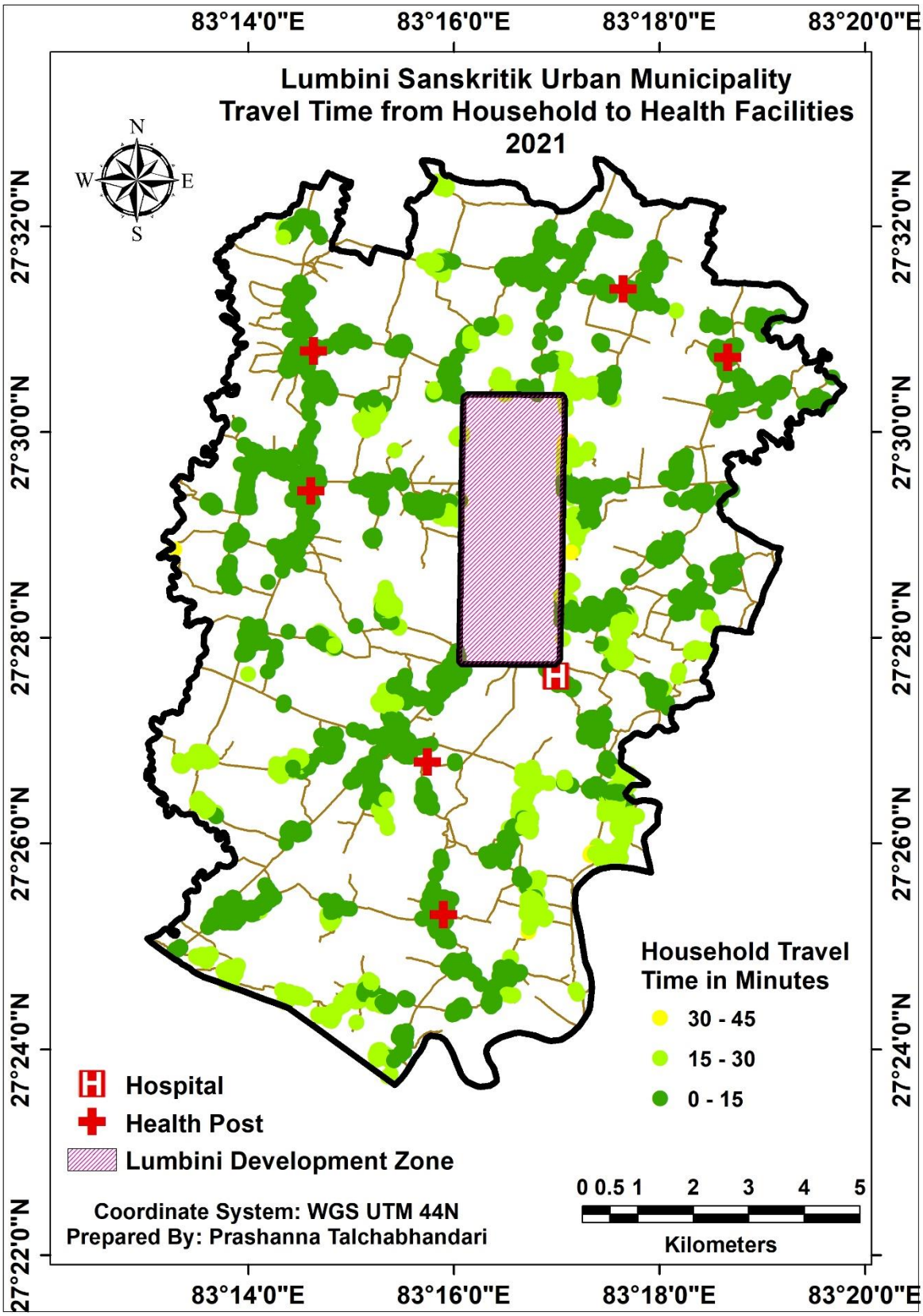
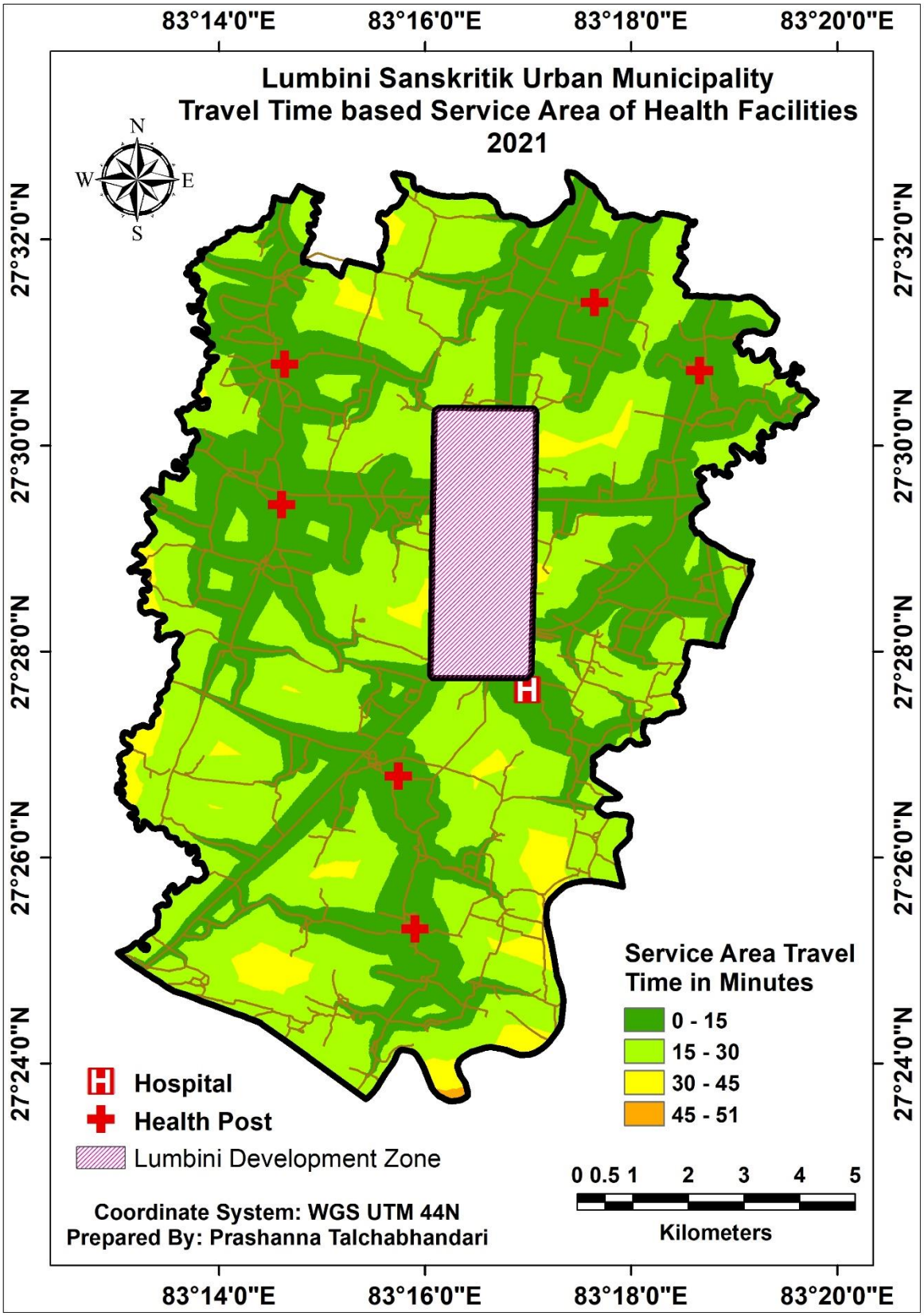


Figure 3.14. Lumbini Sanskritik Urban Municipality: Population Travel Time to Health care facilities



Map 3.17. Lumbini Sanskritik Urban Municipality: Travel time from household to Health care facilities



Map 3.18. Lumbini Sanskritik Urban Municipality: Travel time service area of Health care facilities

In Kotahimai Rural Municipality: the households of 79.02% i.e. 5071 number of households settled on the 0 - 15 min travel time's region, 20.76% of households i.e. 1332 number of households settled on the region of travel time of 15 - 30 min, 0.22% of households i.e.14 the number of households settled on the region of travel time of 30 - 37 min. The household of 100% i.e. 6417 number locates within a one-hour travel time's region of health. Maximum household of 5071 i.e. 79.02% lies in the region of 0 - 15 min travel time and minimum household of 14 i.e. 0.22% lies in the region of 30 - 37 min travel time as shown in Table 3.21, Map 3.19, Map 3.20, and Figure 3.15.

Table 3.21. Kotahimai Rural Municipality: Household access to Health care facilities

Municipality	Travel Time (minutes)	Household	
		N	%
Kotahimai Rural Municipality	0 - 15	5071	79.02%
	15 - 30	1332	20.76%
	30 - 37	14	0.22%
	Total	6417	100%

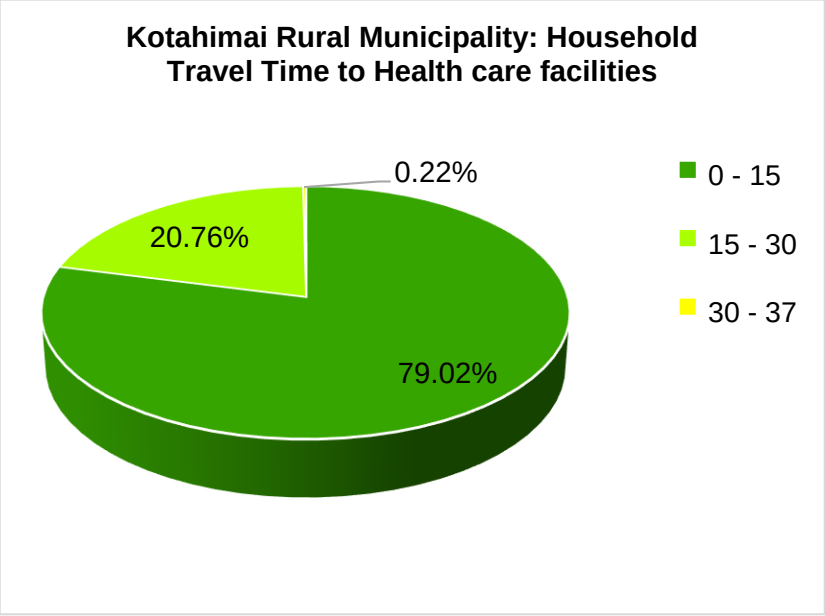


Figure 3.15. Kotahimai Rural Municipality: Household Travel Time to Health care facilities

The 78.03% of the male population, 78.38% of female population, and 78.20% of the total population lie in the region of 0 - 15 min travel time; 21.78% of the male population, 21.39% of female population, and 21.60% of the total population lie on the region of 15 - 30 min

travel time; 0.18% of the male population, 0.23% of the female, 0.20% of the total population lie on the region of 30 - 37 min travel time. 100% i.e. 45901 number of the population required within one-hour travel time to reach health care facilities. Maximum 78.20% i.e. 35894 number of the total population lies in 0 - 15 min travel time's region and minimum 0.20% i.e. 94 number of the total population lies 30 - 37 travel time's region as shown in Table 3.22 and Figure 3.16.

Table 3.22. Kotahimai Rural Municipality: Population access to Health care facilities

Municipality	Travel Time (min)	Population					
		Male	%	Female	%	Total	%
Kotahimai Rural Municipality	0 - 15	18756	78.03%	17138	78.38%	35894	78.20%
	15 - 30	5236	21.78%	4677	21.39%	9913	21.60%
	30 - 37	44	0.18%	50	0.23%	94	0.20%
	Total	24036	100%	21865	100%	45901	100%

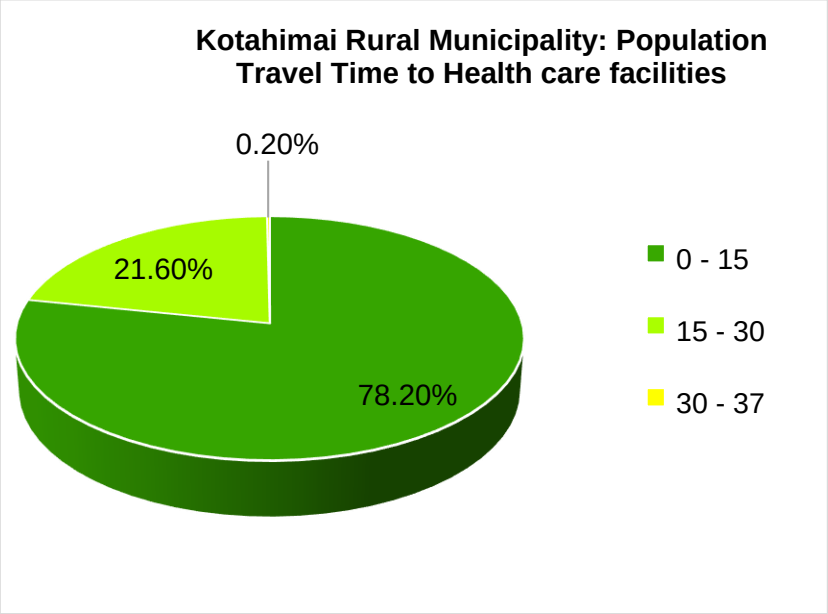
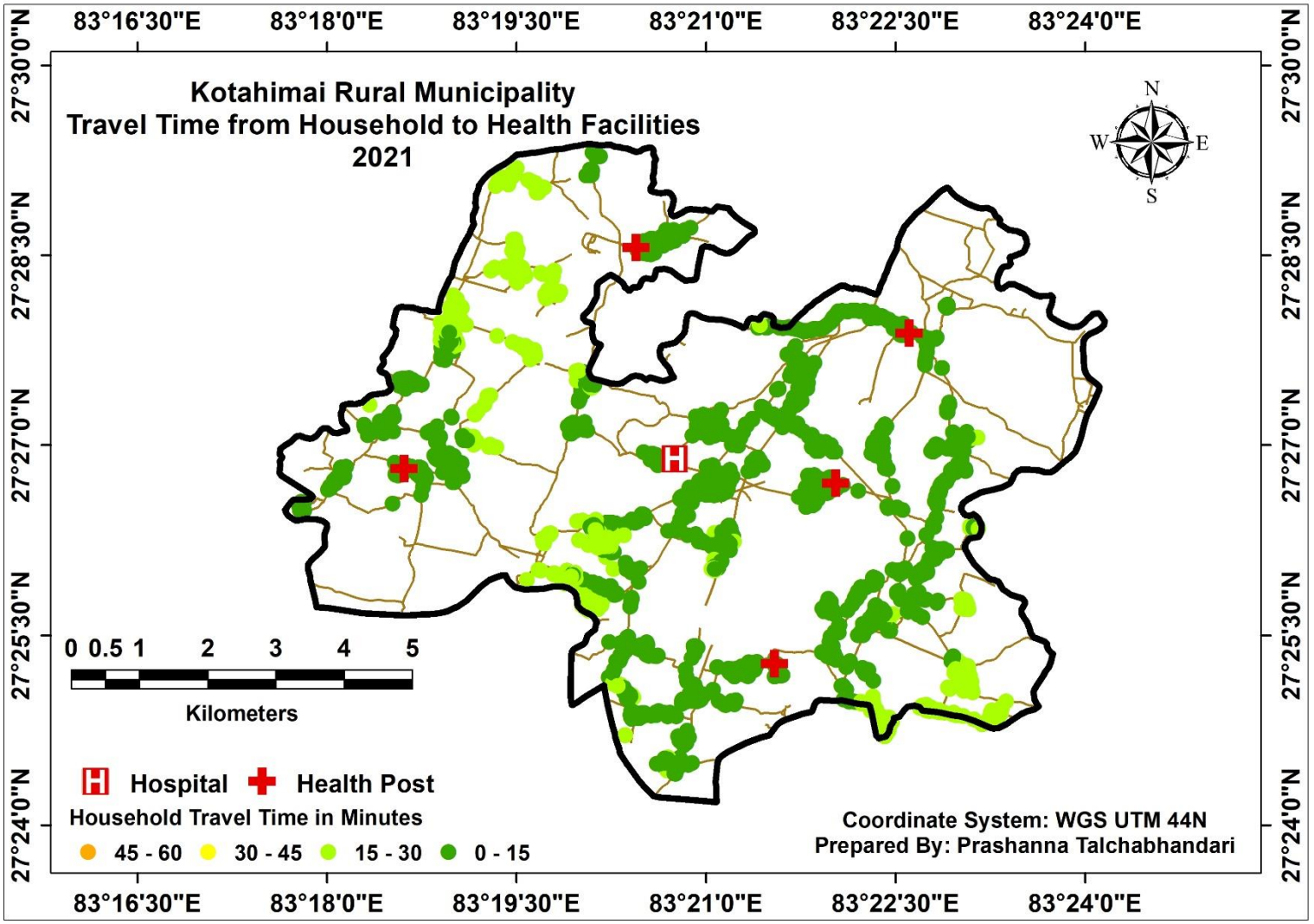
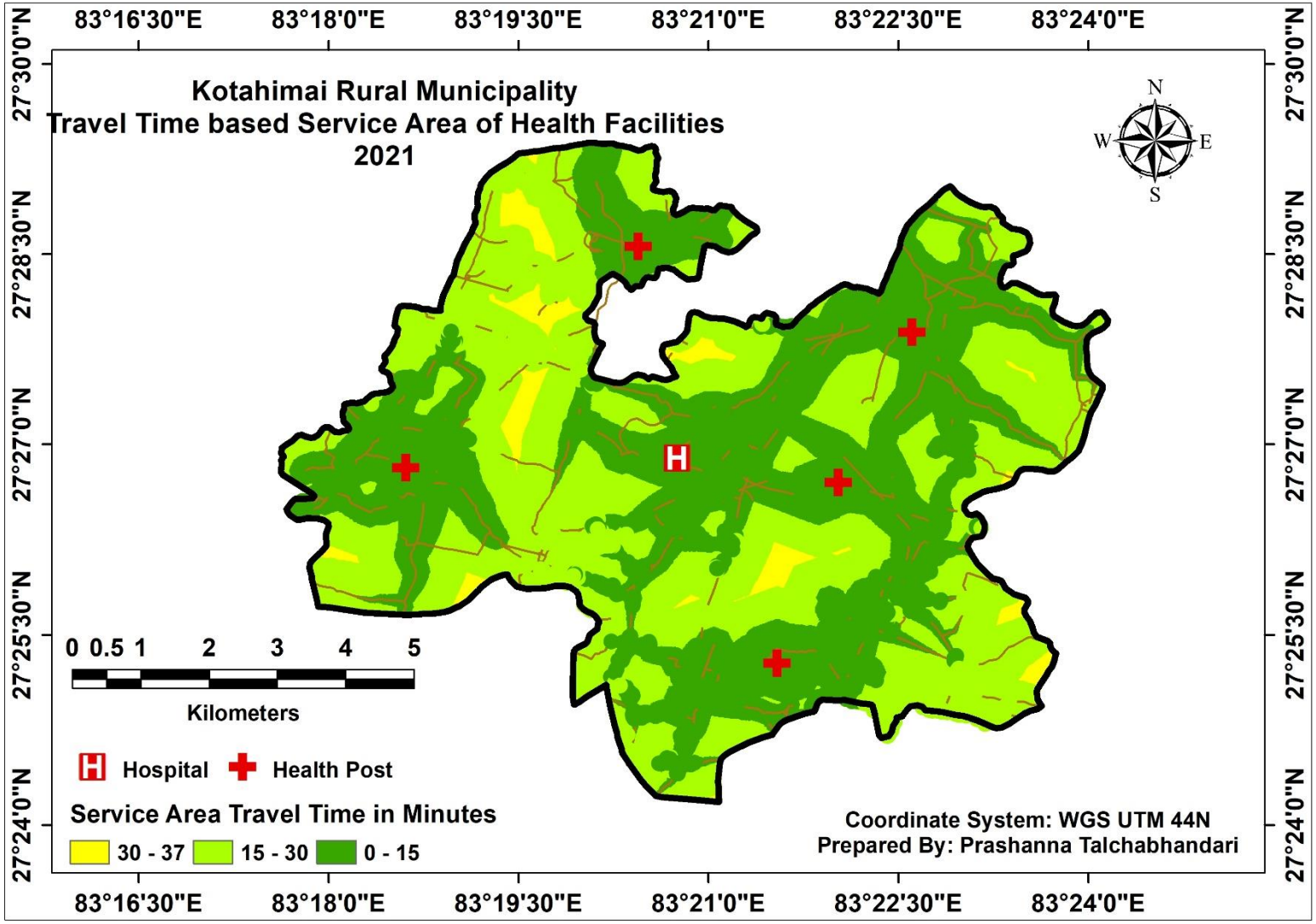


Figure 3.16. Kotahimai Rural Municipality: Population Travel Time to Health care facilities



Map 3.19. Kotahimai Rural Municipality: Travel time from household to Health care facilities



Map 3.20. Kotahimai Rural Municipality: Travel time service area of Health care facilities

3.4.2.2 The Traveltime of all Health care facilities in individual

Similarly, the household and population access to each health care facility separately based on travel time were analyzed for basic services as shown in Table 3.23.

Krishnanagar Urban Municipality: In travel time of 0 - 15 minutes, the household coverage stands at a maximum of 3406 number of Krishnanagar HP and a minimum of 283 number by Ajigara HP. The population coverage stands at a maximum of 27502 by Krishnanagar HP and a minimum of 2038 by Ajigara HP.

Similarly, in 15 – 30 minutes travel time, the household coverage stands at a maximum of 4023 number of Purusottampur HP and a minimum of 881 number by Ajigara HP. The population coverage stands at a maximum of 32595 by Purusottampur HP and a minimum of 7197 by Bhilmi HP.

Lastly, in 30 - 60 minutes travel time, the household coverage stands at a maximum of 4499 number of Ajigara HP and a minimum of 752 number by Krisnanagar HP. The population coverage stands at a maximum of 36281 by Ajigara HP and a minimum of 5651 by Krisnanagar HP.

Shuddhodhan Rural Municipality: In travel time of 0 - 15 minutes travel time, the household coverage stands at a maximum of 2155 number by Hathihawa HP and a minimum of 745 number by Nandanagar HP. The population coverage stands at a maximum of 18387 by Hathihawa HP and a minimum of 6237 by Nandanagar HP.

Similarly, for 15 – 30 minutes' travel time, the household coverage stands at a maximum of 2777 numbers by Nandanagar HP and a minimum of 1729 numbers by Patariya HP. The population coverage stands at a maximum of 24229 by Bithuwa HP and a minimum of 13980 by Patariya HP.

Lastly, for 30 - 60 minutes' travel time, the household coverage stands at a maximum of 3081 numbers by Patariya HP and a minimum of 1919 numbers by Hathihawa HP. The population coverage stands at a maximum of 27447 by Patariya HP and a minimum of 15647 by Hathihawa HP.

Lumbini Sankritik Municipality: In travel time of 0 - 15 minutes, the household coverage stands at a maximum of 2027 number by Tenuhawa HP and a minimum of 285 number by Lumbini PH A2. The population coverage stands at a maximum of 16501 by Tenuhawa HP and a minimum of 1983 by Lumbini PH A2.

Similarly, for 15 – 30 minutes' travel time, the household coverage stands at a maximum of 3518 numbers by Bhagawanpur HP and a minimum of 691 numbers by Ekala HP. The population coverage stands at a maximum of 27973 by Bhagawanpur HP and a minimum of 5908 by Ekala HP.

Lastly, for 30 - 60 minutes of travel time, the household coverage stands at a maximum of 6393 numbers by Lumbini PH A2 and a minimum of 1925 numbers by Madhubani HP. The population coverage stands at a maximum of 52710 by Lumbini PH A2 and a minimum of 14934 by Madhubani HP.

Kotahimai Rural Municipality: In travel time of 0 - 15 minutes, the household coverage stands at a maximum of 1831 number by Bairghat HP and a minimum of 215 number by Sakraun Pakadi HP. The population coverage stands at a maximum of 12218 by Bairghat HP and a minimum of 1766 by Sakraun Pakadi HP.

Similarly, for 15 – 30 minutes of travel time, the household coverage stands at a maximum of 3396 numbers by Majhawawa PH B2 and a minimum of 74 numbers by Sakraun Pakadi HP. The population coverage stands at a maximum of 24425 by Majhawawa PH B2 and a minimum of 623 by Sakraun Pakadi HP.

Lastly, for 30 - 60 minutes' travel time, the household coverage stands at a maximum of 4280 numbers by Sipawa HP and a minimum of 923 HP. The population coverage stands at a maximum of 30878 by Sipawa HP and a minimum of 6808 by Baighat HP.

Table 3.23: Household and Population access to each Health care facility

Travel Time (minutes)	Health care facilities	Household (N)	Population		
			Male	Female	Total
Krishnanagar Urban Municipality					
0 - 15	Shivanagar HP	3061	13095	11802	24897
	Krisnanagar HP	3406	14485	13017	27502
	Sirsihawa HP	1826	7900	7430	15330
	Purusottampur HP	1506	6297	5687	11984
	Bhilmi HP	760	3236	3159	6395
	Ajigara HP	283	1077	961	2038
	Shiva Raj PH B	2325	9928	8786	18714
	Vidhyanagar HP	1347	5863	5226	11089
	Ramnagar HP	711	2631	2453	5084
	Bhagawanpur HP	1162	4452	4060	8512
	Total	16387	68964	62581	131545
15 - 30	Shivanagar HP	2796	11518	10470	21988
	Krisnanagar HP	2577	10626	9678	20304
	Sirsihawa HP	3231	13280	11628	24908
	Purusottampur HP	4023	17086	15509	32595
	Bhilmi HP	3022	12817	11637	24454
	Ajigara HP	881	3617	3580	7197
	Shiva Raj PH B	3125	13121	12014	25135
	Vidhyanagar HP	3583	14894	13340	28234
	Ramnagar HP	2693	11389	10322	21711
	Bhagawanpur HP	2705	11554	10409	21963
	Total	28636	119902	108587	228489
30 - 60	Shivanagar HP	868	3391	3105	6496
	Krisnanagar HP	752	2924	2727	5651
	Sirsihawa HP	1680	6864	6381	13245
	Purusottampur HP	1182	4572	4133	8705
	Bhilmi HP	2885	11727	10374	22101
	Ajigara HP	4499	19207	17074	36281
	Shiva Raj PH B	1264	4918	4539	9457
	Vidhyanagar HP	1794	7244	6809	14053
	Ramnagar HP	3172	13406	12127	25533
	Bhagawanpur HP	2731	11496	10508	22004
	Total	20827	85749	77777	163526
Shuddhodhan Rural Municipality					
0 - 15	Patariya HP	1365	5676	5259	10935
	Nandanagar HP	745	3222	3015	6237
	Labani PH B	1841	8082	7544	15626
	Bithuwa HP	1622	7761	6900	14661
	Hathihawa HP	2155	9554	8833	18387
	Total	7728	34295	31551	65846

15 - 30	Patariya HP	1729	7269	6711	13980
	Nandanagar HP	2777	11865	10931	22796
	Labani PH B	2487	11791	10338	22129
	Bithuwa HP	2775	12842	11387	24229
	Hathihawa HP	2554	12193	10630	22823
	Total	12322	55960	49997	105957
30 - 60	Patariya HP	3081	14567	12880	27447
	Nandanagar HP	2883	13761	11957	25718
	Labani PH B	2300	10157	8945	19102
	Bithuwa HP	2206	9330	8463	17793
	Hathihawa HP	1919	8283	7364	15647
	Total	12389	56098	49609	105707
Lumbini Sanskritik Urban Municipality					
0 - 15	Bhagawanpur HP	1566	7129	6756	13885
	Lumbini PH A2	285	1050	933	1983
	Tenuhawa HP	2027	8490	8011	16501
	Ekala HP	773	3309	3187	6496
	Khudabagar HP	772	3379	2996	6375
	Madhubani HP	1156	4745	4198	8943
	Masina HP	1306	5440	5153	10593
	Aama HP	1101	4131	3820	7951
	Total	8986	37673	35054	72727
15 - 30	Bhagawanpur HP	3518	14450	13523	27973
	Lumbini PH A2	1165	4268	3871	8139
	Tenuhawa HP	2603	12056	11428	23484
	Ekala HP	691	3009	2899	5908
	Khudabagar HP	871	3468	3059	6527
	Madhubani HP	774	3168	2831	5999
	Masina HP	2104	9107	8522	17629
	Aama HP	3002	13122	12282	25404
	Total	14728	62648	58415	121063
30 - 60	Bhagawanpur HP	2962	11973	11046	23019
	Lumbini PH A2	6396	27309	25401	52710
	Tenuhawa HP	3446	13676	12684	26360
	Ekala HP	4866	20992	19320	40312
	Khudabagar HP	2165	8890	8428	17318
	Madhubani HP	1925	7717	7217	14934
	Masina HP	3908	16928	15936	32864
	Aama HP	3534	14478	13444	27922
	Total	29202	121963	113476	235439
Kotahimai Rural Municipality					
0 - 15	Sipawa HP	516	1835	1728	3563
	Sakraun Pakadi HP	215	913	853	1766
	Maryadpur HP	1589	5992	5503	11495
	Bairghat HP	1831	6351	5867	12218
	Majhagawa PH B2	1667	5887	5400	11287
	Bogadi HP	1056	4038	3539	7577
	Total	6874	25016	22890	47906
15 – 30	Sipawa HP	310	1316	1196	2512
	Sakraun Pakadi HP	74	317	306	623
	Maryadpur HP	2857	10501	9483	19984
	Bairghat HP	3280	12575	11257	23832
	Majhagawa PH B2	3396	12852	11573	24425

	Bogadi HP	3138	11105	10130	21235
	Total	13055	48666	43945	92611
30 - 60	Sipawa HP	4280	16206	14672	30878
	Sakraun Pakadi HP	1222	4481	4160	8641
	Maryadpur HP	1464	5528	4968	10496
	Bairghat HP	923	3544	3264	6808
	Majhagawa PH B2	1075	4125	3781	7906
	Bogadi HP	1730	6796	6252	13048
	Total	10694	40680	37097	77777

3.5. Service availability of Health care facilities

Service Availability refers to the physical presence of health service delivery components. It is one of the core SARA indicators and is calculated as a density of health services per unit population. Results are presented at the municipality level and ward level, as ward level is the smallest geographical unit for which population data are available. The Service Availability is calculated based on three main health service delivery components: health infrastructures, health workforce, and service utilization (Section 1.4.5.1).

3.5.1. Health Infrastructure Density

The Health Infrastructure Density consists of three components: (1) facility density per 10,000 populations, (2) inpatient bed density per 10,000 populations, and (3) maternity bed density per 1,000 pregnant women.

3.5.1.1 Facility numbers and density per 10,000 populations

Health care facility density is primarily an indicator of outpatient service access: Facility density per 10 000.

Using the total population of the municipality: The health care facility density of Krishnanagar Urban Municipality is 1.87, Shuddhodhan Rural Municipality is 0.88, Lumbini Sanskritik Urban Municipality is 0.97, and Kotahimai Rural Municipality is 1.31. The breakdown of health care facility density data by municipality indicates that Krishnanagar Urban Municipality has high target score than Shuddhodhan rural Municipality of Kapilbastu

district and Kotahimai Rural Municipality has a high target score than Lumbini Sanskritik Urban Municipality of Rupandehi District. All four municipalities don't meet the health care facility density target set by WHO (Table 3.24).

Table 3.24. Facility numbers and density per 10,000 populations

Municipality	Facility numbers			Population	Facility density	Target achievement Score
	Hospital	Health post	Total			
Considering the total population of Municipality						
Kapilbastu District						
Krishnanagar Urban Municipality	1	9	10	53520	1.87	93%
Shuddhodhan Rural Municipality	1	4	5	56857	0.88	44%
Rupandehi District						
Lumbini Sanskritik Urban Municipality	1	7	8	82081	0.97	49%
Kotahimai Rural Municipality	1	5	6	45901	1.31	65%
Considering the catchment population of the primary hospital in 60 minutes travel time						
Kapilbastu District						
Krishnanagar Urban Municipality	1	0	1	53306	1.88	94%
Shuddhodhan Rural Municipality	1	0	1	56857	0.88	44%
Rupandehi District						
Lumbini Sanskritik Urban Municipality	1	0	1	62832	1.27	64%
Kotahimai Rural Municipality	1	0	1	43618	1.38	69%
Considering the catchment population of all Health care facilities in 60 minutes travel time						
Kapilbastu District						
Krishnanagar Urban Municipality	1	9	10	53520	1.87	99%
Shuddhodhan Rural Municipality	1	4	5	56857	0.88	44%
Rupandehi District						
Lumbini Sankritik Municipality	1	7	8	82081	0.97	49%
Kotahimai Rural Municipality	5	5	6	45901	1.31	65%

Using the catchment population of the primary hospital in 60 minutes travel time: The health care facility density of Krishnanagar Urban Municipality is 1.88, Shuddhodhan Rural Municipality is 0.88, Lumbini Sanskritik Urban Municipality is 1.27, and Kotahimai Rural Municipality is 1.31. The health care facility density data by municipality indicates that Krishnanagar Urban Municipality has high target score than Shuddhodhan rural of Kapilbastu district and Kotahimai Rural Municipality has high target score than Lumbini Sanskritik Urban Municipality of Rupandehi District. All four municipalities don't meet the health care facility density target set by WHO (Table 3.24).

Using the catchment population of all Health care facilities in 60 minutes travel time: the health care facility density of Krishnanagar Urban Municipality is 1.87, Shuddhodhan Rural Municipality is 0.88, Lumbini Sanskritik Urban Municipality is 0.97, and Kotahimai Rural Municipality is 1.31. The health care facility density data by municipality indicates that Krishnanagar Urban Municipality has high target score than Shuddhodhan rural of Kapilbastu District and Kotahimai Rural Municipality has high target score than Lumbini Sanskritik Urban Municipality of Rupandehi District. All four municipalities don't meet the health care facility density target set by WHO (Table 3.24).

3.5.1.2 Inpatient bed density per 10,000 populations

Inpatient bed density is an indicator of inpatient service access. The bed counts include pediatric beds but exclude maternity beds as these are calculated separately. The target for this indicator is 25 beds per 10,000 populations.

Table 3.25 shows that the functional inpatient bed density in all four municipalities is 1 bed per 10,000 populations which is significantly below the target value of 25 beds per 10,000 populations or does not meet the target set by WHO in all three conditions.

Using the total population of the municipality: the inpatient bed density was found 1 bed per 10,000 populations in all four Municipalities which are significantly below the target

value of 25 beds per 10,000 populations or do not meet the target set by WHO. The inpatient beds of 2%, 2%, 5%, and 2% target achievement scores can be found in the Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively.

Using the catchment population of the primary hospital in 60 minutes travel time: The inpatient bed density was found 1 bed per 10,000 populations in three Municipalities and 2 beds per 10,000 in Lumbini Sanskritik Urban Municipality which are significantly below the target value of 25 beds per 10,000 populations or do not meet the target set by WHO. The inpatient beds of 2%, 2%, 6%, and 3% target achievement scores can be found in the Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively.

Using the catchment population of all Health care facilities in 60 minutes travel time: The inpatient bed density was found 1 bed per 10,000 populations in all four Municipalities which are significantly below the target value of 25 beds per 10,000 populations or do not meet the target set by WHO. The inpatient beds of 2%, 2%, 5%, and 3% target achievement scores can be found in the Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively.

Table 3.25. Inpatient bed density per 10,000 populations by the municipality

Municipality	Inpatient Beds			Population	Inpatient Bed Density per 10000 population	Target achievement Score
	Hospital	Health post	Total			
Considering the total population of Municipality						
Kapilbastu District						
Krishnanagar Urban Municipality	3	0	3	53520	1	2%
Shuddhodhan Rural Municipality	3	0	3	56857	1	2%

Rupandehi District						
Lumbini Sanskritik Urban Municipality	10	0	10	82081	1	5%
Kotahimai Rural Municipality	3	0	10	45901	1	3%
Considering the catchment population of the primary hospital in 60 minutes travel time						
Kapilbastu District						
Krishnanagar Urban Municipality	3	0	3	53306	1	2%
Shuddhodhan Rural Municipality	3	0	3	56857	1	2%
Rupandehi District						
Lumbini Sanskritik Urban Municipality	10	0	10	62832	2	6%
Kotahimai Rural Municipality	3	0	10	43618	1	3%
Considering the catchment population of all Health care facilities in 60 minutes travel time						
Kapilbastu District						
Krishnanagar Urban Municipality	3	0	3	50638	1	2%
Shuddhodhan Rural Municipality	3	0	3	56736	1	2%
Rupandehi District						
Lumbini Sankritik Municipality	10	0	10	82081	1	5%
Kotahimai Rural Municipality	3	0	10	45901	1	3%

3.5.1.3 Maternity bed density per 10,000 populations

Maternity beds are inpatient beds that are used exclusively by pregnant women before and after delivery. Maternity bed density provides an indicator of access to delivery services. The indicator does not include delivery beds. The target is 10 maternity beds per 1,000 pregnant women. The score target of Maternity bed density of all four municipalities in three different options is below the target set by WHO (Table 3.26).

Using the total population of the municipality: the maternity bed density was found 1, 4, 6, 2 maternity beds for 1,000 pregnant women in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively which are significantly below the target value of 10 beds per 1,000 populations or do not meet the target set by WHO. The maternity beds of 10%, 40%, 60%, and 20% target achievement scores can be found in the Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively.

Table 3.26. Maternity bed density per 1000 pregnant women by the municipality

Municipality	Maternity Beds			Maternity inpatient	Maternity Bed Density per 1000 population	Target achievement Score
	Hospital	Health post	Total			
Considering the total population of Municipality						
Kapilbastu District						
Krishnanagar Urban Municipality	2	0	2	1940	1	10%
Shuddhodhan Rural Municipality	2	0	2	433	4	40%
Rupandehi District						
Lumbini Sanskritik Urban Municipality	5	0	5	732	6	60%
Kotahimai Rural Municipality	2	0	2	750	2	20%
Considering the catchment population of the primary hospital in 60 minutes travel time						
Kapilbastu District						
Krishnanagar Urban Municipality	2	0	2	1940	1	10%
Shuddhodhan Rural Municipality	2	0	2	433	4	40%
Rupandehi District						
Lumbini Sanskritik Urban Municipality	5	0	5	732	6	60%
Kotahimai Rural Municipality	2	0	2	750	2	20%
Considering the catchment population of all Health care facilities in 60 minutes travel time						
Kapilbastu District						

Krishnanagar Urban Municipality	2	0	2	1940	1	10%
Shuddhodhan Rural Municipality	2	0	2	433	4	40%
Rupandehi District						
Lumbini Sanskritik Urban Municipality	5	0	5	732	6	60%
Kotahimai Rural Municipality	2	0	2	750	2	20%

Using the catchment population of the primary hospital in 60 minutes travel time: the maternity bed density was found 2, 2, 5, and 2 maternity beds for 1,000 pregnant women in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively which is significantly below the target value of 10 beds per 1,000 populations or does not meet the target set by WHO. The maternity beds of 10%, 40%, 60%, and 20% can be found in the Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively.

Using the catchment population of all Health care facilities in 60 minutes travel time: the maternity bed density was found 1, 4, 6, and 2 maternity beds for 1,000 pregnant women in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively which is significantly below the target value of 10 beds per 1,000 populations or does not meet the target set by WHO. The maternity beds of a 10%, 40%, 60%, and 20% target achievement score can be found in the Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively.

3.5.2. Health workforce density

The core health workforce density indicator focuses on the core medical professionals: physicians, medical licentiates, clinical officers, registered nurses ad midwives. The target

is 23 core heath workers per 10,000 populations. The health workforce density was calculated using the population of three types of catchment.

Using the total population of the municipality: the core health worker density was found 16, 8, 8, and 11 health workforce density per 10,000 populations respectively in Krishnanagar Urban Municipality, Shuddhodhan rural municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality which is significantly below the target value of 23 health workforce density per 10,000 populations or does not meet the target set by WHO. The health workforce density of 70%, 35%, 35%, and 48% target achievement score in Krishnanagar Urban Municipality, Shuddhodhan rural municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively (Table 3.27).

Using the total catchment population of the primary hospital in 60 minutes travel time: the core health worker density was found 2, 2, 2, and 3 health workforce density per 10,000 populations respectively in Krishnanagar Urban Municipality Shuddhodhan rural municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality which is significantly below the target value of 23 health workforce density per 10,000 populations or does not meet the target set by WHO. The health workforce density of 9%, 9%, 9%, and 13% target achievement score in Krishnanagar Urban Municipality, Shuddhodhan rural municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively (Table 3.27).

Using the catchment population of all Health care facilities in 60 minutes travel time: the core health worker density was found with 16, 8, 8, and 11 health workforce density per 10,000 populations respectively in Krishnanagar Urban Municipality Shuddhodhan rural municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively which is significantly below the target value of 23 health workforce density per 10,000 populations, or does not meet the target set by WHO. The health workforce density of 70%, 35%, 35%, 48% target achievement score in Krishnanagar Urban Municipality,

Shuddhodhan rural municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively (Table 3.27).

Table 3.27. Health workforce density per 10,000 populations by the municipality

Municipality	Health care facility			Population	Health Worker Density per 10,000 population	Target achievement Score
	Hospital	Health post	Total			
Considering the total population of Municipality						
Kapilbastu District						
Krishnanagar Urban Municipality	15	72	87	53520	16	70%
Shuddhodhan Rural Municipality	15	32	47	56857	8	35%
Rupandehi District						
Lumbini Sanskritik Urban Municipality	15	56	71	82081	8	35%
Kotahimai Rural Municipality	15	40	55	45901	11	48%
Considering the catchment population of the primary hospital in 60 minutes travel time						
Kapilbastu District						
Krishnanagar Urban Municipality	15	0	15	53306	2	9%
Shuddhodhan Rural Municipality	15	0	15	56857	2	9%
Rupandehi District						
Lumbini Sanskritik Urban Municipality	15	0	15	62832	2	9%
Kotahimai Rural Municipality	15	0	15	43618	3	13%
Considering the catchment population of all Health care facilities in 60 minutes travel time						
Kapilbastu District						
Krishnanagar Urban Municipality	15	72	87	53520	16	70%
Shuddhodhan Rural Municipality	15	32	47	56857	8	35%

Rupandehi District						
Lumbini Sanskritik Urban Municipality	15	56	71	82081	8	35%
Kotahimai Rural Municipality	15	40	55	45901	11	48%

3.5.3. Service utilization

The third component of service availability is service utilization, which is measured by the number of outpatient visits per capita. The target is 5 visitors per capita per annum.

Using the total population of the municipality: The core outpatient service utilization by the municipality with 0.58, 0.52, 0.48, and 0.48 respectively in Krishnanagar Urban Municipality, Shuddhodhan rural municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality which is very low than the target value of 5 visitors per capita per annum or does not meet the target set by WHO. The service utilization score of 12%, 10%, 10%, and 10% in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively (Table 3.28).

Using the total catchment population of the primary hospital in 60 minutes travel time: the core outpatient service utilization by the municipality with 0.58, 0.52, 0.62, and 0.51 respectively in Krishnanagar Urban Municipality, Shuddhodhan rural municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality which is very low than the target value of 5 visitors per capita per annum, or does not meet the target set by WHO. The service utilization score of 12%, 10%, 12%, and 10% in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively (Table 3.28).

Using the catchment population of all Health care facilities in 60 minutes travel time: the core outpatient service utilization by the municipality with 0.58, 0.52, and 0.52

respectively in Krishnanagar Urban Municipality and Shuddhodhan rural municipality which is very low than the target value of 5 visitors per capita per annum, or does not meet the target set by WHO. The service utilization score of 12%, 10%, 10%, and 10% in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively (Table 3.28).

Table 3.28. Outpatient visits per capita per year by the municipality

Municipality	Number of outpatient visits	Population	Outpatient service utilization	Service utilization Score
Considering the total population of Municipality				
Kapilbastu District				
Krishnanagar Urban Municipality	31001	53520	0.58	12%
Shuddhodhan Rural Municipality	29634	56857	0.52	10%
Rupandehi District				
Lumbini Sanskritik Urban Municipality	39253	82081	0.48	10%
Kotahimai Rural Municipality	22040	45901	0.48	10%
Considering the catchment population of the primary hospital in 60 minutes travel time				
Kapilbastu District				
Krishnanagar Urban Municipality	31001	53306	0.58	12%
Shuddhodhan Rural Municipality	29364	56857	0.52	10%
Rupandehi District				
Lumbini Sanskritik Urban Municipality	39253	62832	0.62	12%
Kotahimai Rural Municipality	22040	43618	0.51	10%
Considering the catchment population of all Health care facilities in 60 minutes travel time				
Kapilbastu District				
Krishnanagar Urban Municipality	31001	53520	0.58	12%
Shuddhodhan Rural Municipality	29634	56857	0.52	10%
Rupandehi District				
Lumbini Sanskritik Urban Municipality	39253	82081	0.48	10%
Kotahimai Rural Municipality	22040	45901	0.48	10%

3.5.4. Hospital Inpatient Utilization Index

The Hospital inpatient utilization index is the number of discharges per 100 populations per year. The target is 10 discharges (admissions) per 100 populations.

Using the total population of the municipality: the hospital admission per year by the municipality with 9.06, 1.90, 2.23, and 4.08 respectively in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively which is very low than the target value of 10 visitors per capita per annum, or does not meet the target set by WHO. The hospital utilization score of 91%, 19%, 22%, and 41% in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively (Table 3.29).

Using the total catchment population of the primary hospital in 60 minutes travel time: the hospital admission per year by the municipality with 11.71, 7.24, 9.01, and 8.30 respectively in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively. The value of 11.74 of Krishnanagar Urban Municipality is higher than the target value of 10 visitors per capita per annum and the other three municipalities have very low than the target value of 10 visitors per capita per annum or do not meet the target set by WHO. The hospital utilization score of 117%, 72%, 90%, and 83% in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively (Table 3.29).

Using the catchment population of all Health care facilities in 60 minutes travel time: the hospital admission per year by the municipality with 11.66, 7.24, 6.90, and 7.89 respectively in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively where Krishnanagar Urban Municipality has a higher target value of 10 visitors per capita and other

three municipalities has low than the target value of 10 visitors per capita per annum or does not meet the target set by WHO. The hospital utilization score of 117%, 72%, 69%, 79% in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality respectively (Table 3.29).

Table 3.29. Hospital inpatient service utilization per 1000 populations per year by the municipality

Municipality	Number of Hospital admissions	Population	Hospital admission per year	Hospital utilization Score
Considering the total population of Municipality				
Kapilbastu District				
Krishnanagar Urban Municipality	4850	53520	9.06	91%
Shuddhodhan Rural Municipality	1083	56857	1.90	19%
Rupandehi District				
Lumbini Sanskritik Urban Municipality	1830	82081	2.23	22%
Kotahimai Rural Municipality	1875	45901	4.08	41%
Considering the catchment population of the primary hospital in 60 minutes travel time				
Kapilbastu District				
Krishnanagar Urban Municipality	6242	53306	11.71	117%
Shuddhodhan Rural Municipality	4119	56857	7.24	72%
Rupandehi District				
Lumbini Sanskritik Urban Municipality	5662	62832	9.01	90%
Kotahimai Rural Municipality	3620	43618	8.30	83%
Considering the catchment population of all Health care facilities in 60 minutes travel time				
Kapilbastu District				
Krishnanagar Urban Municipality	6242	53520	11.66	117%
Shuddhodhan Rural Municipality	4119	56857	7.24	72%
Rupandehi District				
Lumbini Sanskritik Urban Municipality	5662	82081	6.90	69%
Kotahimai Rural Municipality	3620	45901	7.89	79%

3.5.5. Service Availability Index

The service availability index is a reflection of the availability of health services and is calculated as the unweighted average of the three areas described in the previous three sections: infrastructure, workforce, and utilization (Table 3.30).

Table 3.30. Service Availability summary index by the municipality

Municipality	Health Infrastructure Density Index				Health Workforce Density Index	Service Utilization Index			Service availability index
	Facility density	Inpatient bed density	Maternity bed density	Average score		Outpatient visits per person/ year	Hospitals admission per 100/year	Average score	
Considering the total population of Municipality									
Kapilbastu District									
Krishnanagar Urban Municipality	93%	2%	10%	35%	70%	12%	91%	51%	52%
Shuddhodhan Rural Municipality	44%	2%	40%	29%	35%	10%	19%	15%	26%
Rupandehi District									
Lumbini Sanskritik Urban Municipality	49%	5%	60%	38%	35%	10%	22%	16%	30%
Kotahimai Rural Municipality	65%	3%	20%	29%	48%	10%	41%	25%	34%
Considering the catchment population of the primary hospital in 60 min travel time									
Kapilbastu District									
Krishnanagar Urban Municipality	94%	2%	10%	35%	9%	12%	117%	64%	36%
Shuddhodhan Rural Municipality	44%	2%	40%	29%	9%	10%	72%	41%	26%
Rupandehi District									
Lumbini Sanskritik Urban Municipality	64%	6%	60%	43%	9%	12%	90%	51%	34%
Kotahimai Rural Municipality	69%	3%	20%	31%	13%	10%	83%	47%	30%
Considering the catchment population of all Health care facilities in 60 min travel time									
Kapilbastu District									
Krishnanagar Urban Municipality	93%	2%	10%	35%	70%	12%	117%	64%	56%
Shuddhodhan Rural Municipality	44%	2%	40%	29%	35%	10%	72%	41%	35%
Rupandehi District									

Lumbini Sanskritik Urban Municipality	49%	5%	60%	38%	35%	10%	69%	39%	37%
Kotahimai Rural Municipality	65%	3%	20%	29%	48%	10%	79%	44%	40%

Using the total population of the municipality:

In Krishnanagar Urban Municipality, facility density was 93%, inpatient bed density was 2%, maternity bed density was 10% and total health infrastructure density index was 35%, whereas health workforce density index was 70%, service utilization index was 12%, hospital utilization score was 91% and overall service availability index was 52%. All index value was very low than the target value of 100% set by WHO. In Shuddhodhan Rural Municipality, facility density was 44%, inpatient bed density was 2%, maternity bed density was 40% and total health infrastructure density index was 29%. The health workforce density index was 35%, the service utilization index was 10%, the hospital utilization score was 19% and the overall service availability index was 26%. All index was below the target value of 100% set by WHO.

In Lumbini Sanskritik Urban Municipality, facility density was 49%, inpatient bed density was 5%, maternity bed density was 60% and total health infrastructure density index was 38%. The health workforce density index was 35%, the service utilization index was 10%, the hospital utilization score was 22% and the overall service availability index was 30%. All index was below the target value of 100% set by WHO. In Kotahimai Rural Municipality, facility density was 29%, inpatient bed density was 3%, maternity bed density was 20% and total health infrastructure density index was 29%. The health workforce density index was 48%, the service utilization index was 10%, the hospital utilization score was 41% and the overall service availability index was 34%. All index was below the target value of 100% set by WHO. (Figure 3.17 and Table 3.30).

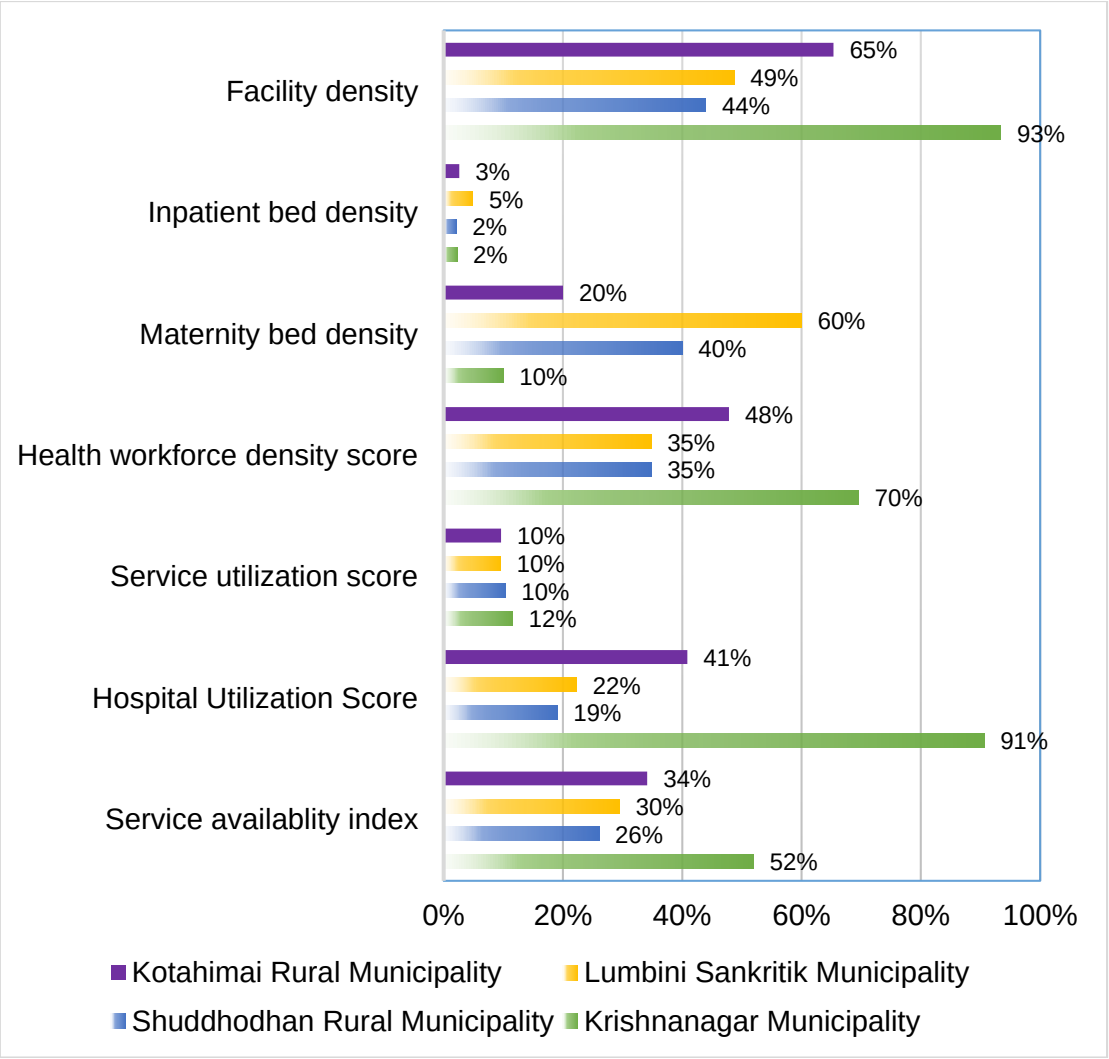


Figure 3.17. Individual components of the service availability index by the municipalities

Using the total catchment population of the primary hospital in 60 minutes travel time: In Krishnanagar Urban Municipality, facility density was 94%, inpatient bed density was 2%, maternity bed density was 10% and total health infrastructure density index was 35%, whereas health workforce density index was 9%, service utilization index was 12%, hospital utilization score was 117% and overall service availability index was 36%. All index value was very low than the target value of 100% set by WHO except hospital utilization score had high value than the target. In Shuddhodhan Rural Municipality, facility density was 44%, inpatient bed density was 2%, maternity bed density was 40% and total health infrastructure density index was 29%. The health workforce density index was 9%, the service utilization index was 10%, the hospital utilization score was 72% and the overall

service availability index was 26%. All index was below the target value of 100% set by WHO.

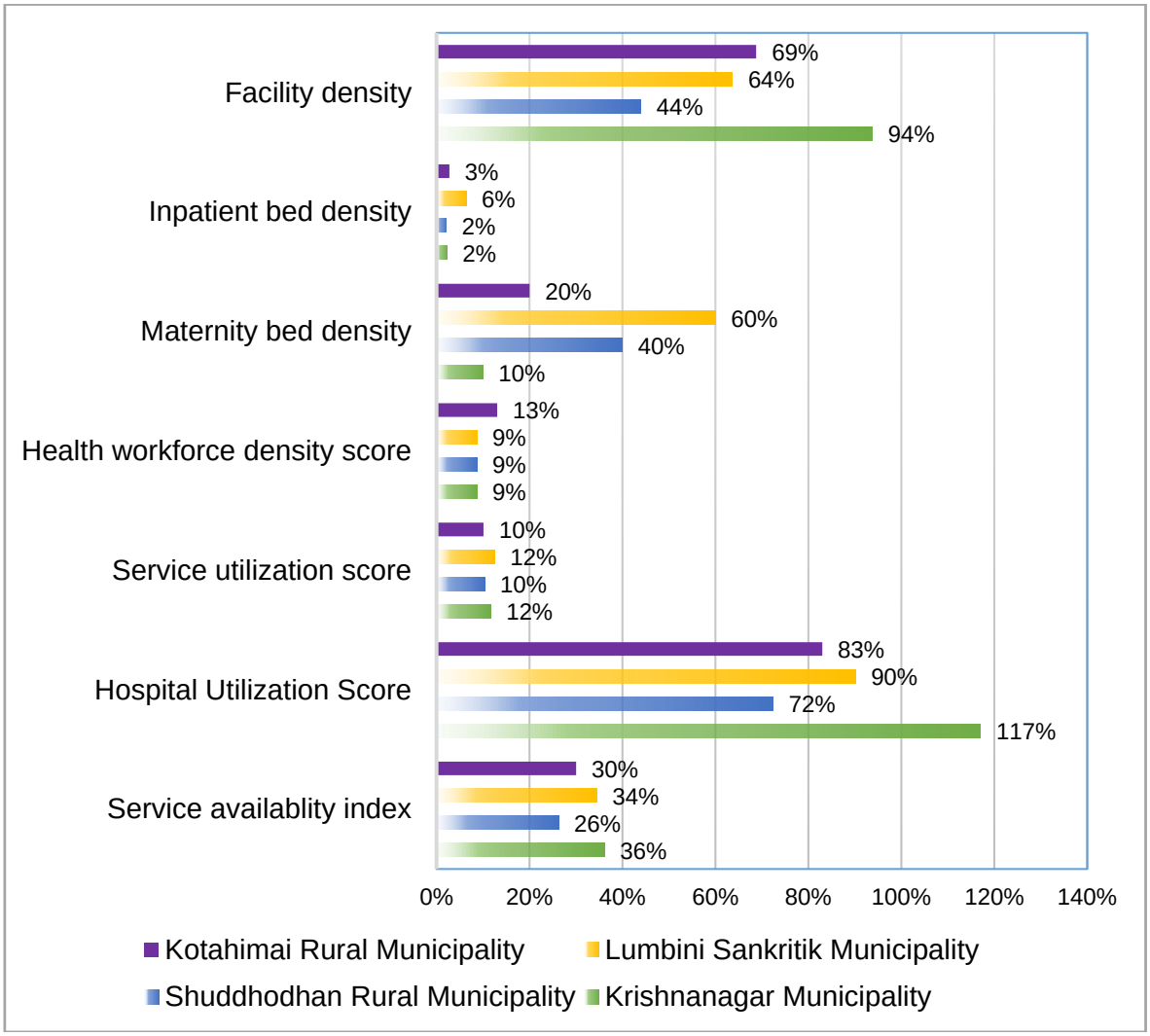


Figure 3.18. Individual components of the service availability index by primary hospital

In Lumbini Sanskritik Urban Municipality, facility density was 43%, inpatient bed density was 64%, maternity bed density was 60% and total health infrastructure density index was 43%. The health workforce density index was 9%, the service utilization index was 12%, the hospital utilization score was 90% and the overall service availability index was 34%. All index was below the target value of 100% set by WHO. In Kotahimai Rural Municipality, facility density was 31%, inpatient bed density was 69%, maternity bed density was 3% and total health infrastructure density index was 31%. The health workforce density index was

13%, the service utilization index was 10%, the hospital utilization score was 83% and the overall service availability index was 30%. All index was below than the target value of 100% set by WHO (Figure 3.18 and Table 3.30).

Using the catchment population of all Health care facilities in 60 minutes travel time:
In Krishnanagar Urban Municipality, facility density was 93%, inpatient bed density was 2%, maternity bed density was 10% and total health infrastructure density index was 35%, whereas health workforce density index was 70%, service utilization index was 12%, hospital utilization score was 117% and overall service availability index was 56%. All index value was very low than the target value of 100% set by WHO except hospital utilization score had high value than the target. In Shuddhodhan Rural Municipality, facility density was 44%, inpatient bed density was 2%, maternity bed density was 40% and total health infrastructure density index was 29%. The health workforce density index was 35%, the service utilization index was 10%, the hospital utilization score was 72% and the overall service availability index was 35%. All index was below the target value of 100% set by WHO.

In Lumbini Sanskritik Urban Municipality, facility density was 49%, inpatient bed density was 5%, maternity bed density was 50% and total health infrastructure density index was 38%. The health workforce density index was 35%, the service utilization index was 10%, the hospital utilization score was 69% and the overall service availability index was 37%. All index was below the target value of 100% set by WHO. In Kotahimai Rural Municipality, facility density was 29%, inpatient bed density was 65%, maternity bed density was 20% and total health infrastructure density index was 29%. The health workforce density index was 48%, the service utilization index was 10%, the hospital utilization score was 79% and the overall service availability index was 40%. All index was below than the target value of 100% set by WHO (Figure 3.19 and Table 3.30).

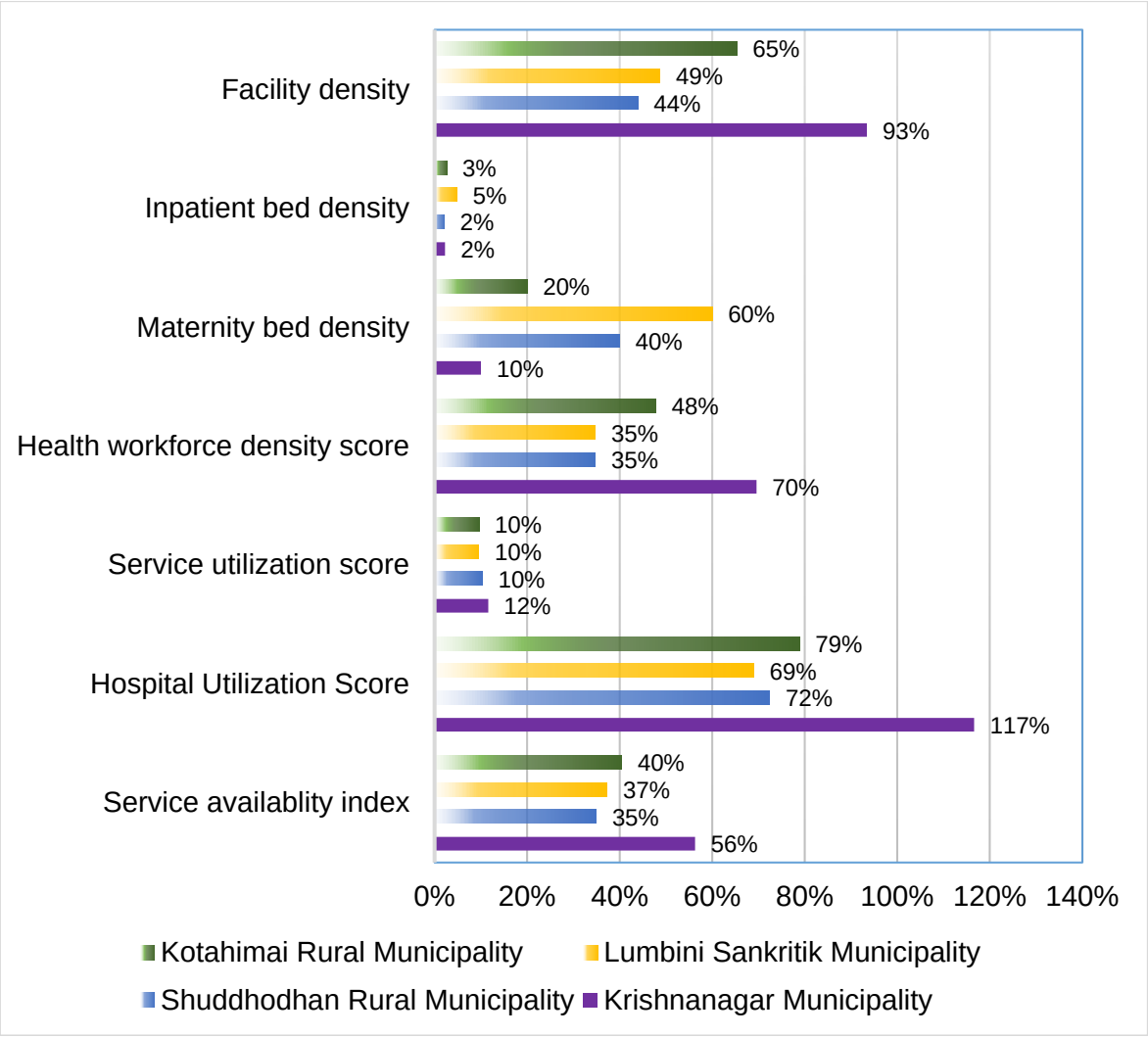


Figure 3.19. Individual components of the service availability index by all Health care facilities

3.6. The ratio of Service Availability Index to the population

A ratio shows the relative sizes of two or more values that indicated their sizes with each other. In this project ratio between the Service Availability Index and the population covered by the health care facilities. The ratio of the Service Availability Index to the population was calculated by considering three types of population catchment. 1) Total population 2) Catchment population of primary hospital 3) Catchment population of all health care facilities.

Considering the total population of the municipality: As shown in Table 3.31 the ratio between the Service Availability Index and the Population of municipality hospital in

Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality is 0.52, 0.26, 0.30, and 0.34 respectively. Hence, in this case, the Service Availability Index of the Krishnanagar Urban Municipality is higher than the Shuddhodhan Rural Municipality.

Considering Catchment population of the primary hospital in 60 minutes travel time: In the second case, the ratio between the Service Availability Index and the Population covered by the service area of the primary hospital in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality is 0.36, 0.26, 0.44 and 0.32 respectively. The Service Availability Index of the Krishnanagar Urban Municipality is higher than the Shuddhodhan Rural Municipality.

Considering Catchment population of all health care facilities in 60 minutes travels time: In the third case, the ratio between the Service Availability Index and the Population covered by the service area of all health care facilities in Krishnanagar Urban Municipality, Shuddhodhan Rural Municipality, Lumbini Sanskritik Urban Municipality, and Kotahimai Rural Municipality is 0.56, 0.35, 0.37 and 0.40 respectively. The Service Availability Index of the Krishnanagar Urban Municipality is higher than the Shuddhodhan Rural Municipality.

Table 3.31. The ratio of Service Availability Index and population

Municipality	Population (%)	Service Availability Index(%)	Service Availability Index/Population
Considering the total population of Municipality			
Krishnanagar Urban Municipality	100	52	0.52
Shuddhodhan Rural Municipality	100	26	0.26
Lumbini Sanskritik Urban Municipality	100	30	0.30
Kotahimai Rural Municipality	100	34	0.34
Considering the catchment population of the primary hospital in 60 minutes travel time			
Krishnanagar Urban Municipality	100	36	0.36

Shuddhodhan Rural Municipality	100	26	0.26
Lumbini Sanskritik Urban Municipality	77	34	0.44
Kotahimai Rural Municipality	95	30	0.32
Considering the catchment population of all health care facilities in 60 minutes travel time			
Krishnanagar Urban Municipality	100	56	0.56
Shuddhodhan Rural Municipality	100	35	0.35
Lumbini Sanskritik Urban Municipality	100	37	0.37
Kotahimai Rural Municipality	100	40	0.40

In this section, the accessibility of the hospital and all health care facilities of all four municipalities is calculated by considering three types of population. Similarly, the service availability of the hospital and all health care facilities of all four municipalities is calculated by considering three types of population. Compare the result score with the target set by WHO. Finally, the ratio of service availability to population is calculated using the same three options of catchment population.

Chapter-4. Discussion and Conclusion

Accessibility to the health care facilities of Krishnanagar Urban Municipality and Shuddhodhan Rural Municipality show satisfactory. According to (CBS, 2011), about 86% of urban households in the country reach Health care facilities are within 30 minutes but only 21% of rural households can reach Health care facilities. The method used in the CBS report was visiting selected households and interviewed and access is measured in terms of time taken for one-way travel to a Health care facility using foot or vehicle transport mode but in this project, the GIS-based method is applied and the time taken health care facilities is considered travel time. The survey was carried out in the whole country and the sample base in the CBS report but in this project, the study was carried out at the municipality level. Therefore, it is not comparable to the CBS report.

From this study, results show that in Krishnanagar Urban Municipality to receive the services provided by the primary hospital can be accessed by 80.82% of households and 81.93% of the population within 30 minutes travel time while 19.18% of households and 18.07% population need more than 30 minutes travel time. 99.57% of households and 99.61% of the population can access the health care facilities to get services within 30 minutes travel time and 0.43% of households and 0.39% of the population required more than 30 minutes travel time. Shuddhodhan Rural Municipality to receive the services provided by the primary hospital can be accessed by 65.30% of households and 66.40% of the population within 30 minutes travel time while 34.70% of households and 33.60% population need more than 30 minutes travel time. 96.42% of households and 96.02% of the population can access the health care facilities within 30 minutes travel time and 3.58% of households and 3.98% of the population required more than 30 minutes travel time. Lumbini Sanskritik Urban Municipality to receive the services provided by the primary hospital can be accessed by 14.34% of households and 12.33% of the population within 30 minutes travel time while 85.66% of households and 87.67% population need more than 30 minutes travel time. 99.39% of households and 99.44% of the population can access the

health care facilities within 30 minutes travel time and 0.61% of households and 0.56% of the population required more than 30 minutes travel time. Kotahimai Rural Municipality to receive the services provided by the primary hospital can be accessed by 78.90% of households and 77.80% of the population within 30 minutes travel time while 21.10% of households and 22.20% of the population need more than 30 minutes travel time. 99.78% of households and 99.80% of the population can access the health care facilities within 30 minutes travel time and 0.22% of households and 0.20% of the population required more than 30 minutes travel time.

When comparing the urban and rural municipality of Kapilbastu District shows that the accessibility of the primary hospital of Krishnanagar Urban Municipality is better than Shuddhodhan Rural Municipality and the accessibility of all Health care facilities of Krishnanagar Urban Municipality is nearly the same as that of Shuddhodhan Rural Municipality.

When comparing the urban and rural municipality of Rupandehi District show that the accessibility of the primary hospital of Kotahimai Rural Municipality is better than Lumbini Sanskritik Urban Municipality and the accessibility of all Health care facilities of Kotahimai Rural Municipality is nearly the same as that of Lumbini Sanskritik Urban Municipality.

Comparing the two urban municipalities show the accessibility of the primary hospital of Krishnanagar Urban Municipality is better than Lumbini Sanskritik Urban Municipality and the accessibility all health care facility of Krishnanagar Urban Municipality is nearly same as Lumbini Sanskritik Urban Municipality.

Comparing the two rural municipality show that the accessibility of primary hospital of Kotahimai Rural Municipality is better than Shuddhodhan Rural Municipality and the accessibility of all health care facility of Kotahimai Rural Municipality is nearly same as Shuddhodhan Rural Municipality.

When considering the population of the municipality: The service availability to health care facilities of all four municipalities indicated inadequately. The service availability index of all four municipalities was determined by taking into consideration of total population of the municipality. The service availability index of all municipalities was below the target set by the WHO. Hence the service availability index of four municipalities is in poor condition. The service availability index of Krishnanager Urban Municipality was found 52% Whereas, the service availability index of Shuddhodhan Rural Municipality was 26%. Similarly, the service availability index of Lumbini Sanskritik Urban Municipality was found at 30% Whereas, the service availability index of Kotahimai Rural Municipality was 34%. Compare between the urban and rural municipality of Kapilbastu District, the service availability index of the urban municipality i.e. Krishnanager Urban Municipality is Higher than that of rural municipality i.e. Shuddhodhan Rural Municipality. In the same way, the service availability index of Lumbini Sanskritik Urban Municipality was 37% and 40% was of Kotahimai Rural Municipality. Compare between the urban and rural municipality of Rupandehi District, the service availability index of Rural Municipality i.e. Kotahimai Rural Municipality is higher than Urban Municipality i.e. Lumbini Sanskritik Urban Municipality. Likewise, comparing urban municipality of two District (Kapilbastu and Rupandehi), the service availability index of the urban municipality of Kapilbastu District is higher than of Rupandehi District and collating rural municipality of two District, the service availability index of the rural municipality of Kapilbastu District is lower than the Rupandehi District.

When considering the population catchment of the primary hospital of 60 minutes travel time, the service availability index of all four municipalities was below the target set by the WHO. Hence the service availability index of all four municipalities is in poor condition. The service availability index of Krishnanager Urban Municipality was found 36% Whereas the service availability index of Shuddhodhan rural municipality was found 26%. Similarly, the service availability index of Lumbini Sanskritik Urban Municipality was found 34% Whereas, the service availability index of Kotahimai Rural Municipality was 30%. Compare between

the urban and rural municipality of Kapilbastu District, the service availability index of the urban municipality i.e. Krishnanager Urban Municipality is Higher than that of rural municipality i.e. Shuddhodhan Rural Municipality. In the same way, compare between the urban and rural municipality of Rupandehi District, the service availability index of urban Municipality i.e. Lumbini Sanskritik Urban Municipality is higher than rural Municipality i.e. Kotahimai Rural Municipality. Likewise, comparing urban municipality of two District (Kapilbastu and Rupandehi), the service availability index of the urban municipality of Kapilbastu District is higher than of Rupandehi District and collating rural municipality of two District, the service availability index of the rural municipality of Kapilbastu District is higher than the Rupandehi District.

When considering the population catchment of all health care facilities of 60 minutes travel time, the service availability index of all four municipalities was below the target set by the WHO. Hence the service availability index of all four municipalities is in poor condition. for Krishnanager Urban Municipality, the service availability index was 56% Whereas for Shuddhodhan rural municipality, the service availability index was 35%. Similarly, the service availability index of Lumbini Sanskritik Urban Municipality was found at 37% Whereas, the service availability index of Kotahimai Rural Municipality was 40%. Compare between the urban and rural municipality of Kapilbastu District, the service availability index of the urban municipality i.e. Krishnanager Urban Municipality is Higher than that of rural municipality i.e. Shuddhodhan Rural Municipality. In the same way, compare between the urban and rural municipality of Rupandehi District, the service availability index of urban Municipality i.e. Lumbini Sanskritik Urban Municipality is lesser than Rural Municipality i.e. Kotahimai Rural Municipality. Likewise, comparing urban municipality of two District (Kapilbastu and Rupandehi), the service availability index of the urban municipality of Kapilbastu District is higher than of Rupandehi District and collating rural municipality of two District, the service availability index of the rural municipality of Kapilbastu District is lesser than the Rupandehi District.

Thus, Overall accessibility to health care facilities in all four municipalities is much better. The majority of the population of all four municipalities can be reached to health care facilities within 30 minutes travel time but the service availability of all four municipalities is under target set by WHO which required improvement. Comparatively, the Krishnanagar Urban Municipality has improved service availability compared to the other three municipalities. Mainly population growth, better public transportation, and economic activities were a major factor which affects the accessibility of health care facilities, on the other hand, number of the facility, inpatient, outpatient, hospital admission rate, number of beds, and health worker in the hospital was the factor effect the service availability of municipality. It is very important to balance the population, accessibility, and service availability of the health care facility.

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