Jimma University

Jimma Institute of Technology

School of Graduate Studies

Faculty of Civil and Environmental Engineering

Highway Engineering Stream

A Correlation Analysis of the Effects of Roadside Activities on the Traffic Flow Characteristics: A Case Study in Nekemte City

A Thesis Submitted to the School of Graduate Studies of Jimma University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering (Highway Engineering Stream)

By:

Dabala Misgana

August 2020

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DECLARATION

I, the undersigned, declare that this thesis entitled "**A Correlation Analysis of the Effects of Roadside Activities on the Traffic Flow Characteristics: A Case Study in Nekemte**" is my original work and has not been presented by any other person for an award of a degree in this or any other University, and all sources of material used for this thesis duly acknowledged.

Candidate:

Mr. Dabala Misgana _____ 02/17/2020

Signature Date

As Master's Research Advisors, I hereby certify that I have read and evaluated this MSc Thesis prepared under my guidance by **Mr. Dabala Misgana** entitled: "**A Correlation Analysis of the Effects of Roadside Activities on the Traffic Flow Characteristics: A Case Study in Nekemte**".

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ACKNOWLEDGMENT

First, I would like to thank the Almighty of God for his endless mercy and support throughout my life.

Next, my very appreciation goes to Professor Emer T. Quezon for his great advice and kindness from start to the end of my work.

Also, my gratitude is hot for Engineer Oluma Gudina who supports me through my work.

Moreover, I would say thank you to all Jimma Institute of Technology instructors and guest professors, who taught me to grasp the basic knowledge of Highway Engineering.

Finally, I say be grateful to all those behind me while I do this research.

ABSTRACT

The effectiveness of the road does not only depend on the roadway condition. Roadside activities rolling along and/or on the arterial road: roadside vendor, on-road parking vehicle, cart, and non-motorized vehicle, dumping of construction materials, and pedestrians related to major problems incurred by the motorists in Nekemte city. The existing roadside activities considerably influenced the drivers' conditions that lead them to irritate, disturb, worry, and even enforced changing the route. Hence, this study focused on the correlation analysis of the effect of roadside activities on traffic flow characteristics. In this research data collection methods: field observation, interviews, questioners, and literature reviews used to get relevant information about the problem and effects of roadside activities in Nekemte city as per their significance. The correlation analysis studied considering traffic flow characteristics as a dependent variable and roadside activities as the independent variable. Speed data with the number of roadside activities' stakeholders recorded at different times in the specified place locally called Board. Examination of the effect of selective roadside activities on traffic flow characteristics, using regression analysis, showed that existing roadside activities adversely influence traffic flow characteristics by reducing the speed. The analysis of this study demonstrates the speed reduction was 83.6%, 81.3%, 55.2%, and 62.9% correlated with the existing pedestrians, roadside vendors, parking vehicles, and carts along and/or on the road. On the other hand, the developed model indicated the speed on the arterial road with roadside activities such as pedestrian, roadside vendor, parked vehicle, and carts will predict as $V = 34.6 - 0.273P - 0.326RV - 0.5C - 0.099PV$. *Generally, the negative coefficient with the model confirms the activities running along and/or on travel way obstruct traffic flow characteristics and the motorists' condition. Finally, major roadside activities that obstructing the driver's condition and traffic flow characteristics need attention and further studies to quantify the effects, validate the equation, and lower the adverse impact of the activities.*

Keywords: Correlation, Motorist, Roadside activity, Traffic flow

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

AASHTO	American Association of State Highway Transportation Official
DRIPs	Dynamic road information panels
ERA	Ethiopian Road Authority
HCM	Highway Capacity Manual
IHCM	Indonesian Highway Capacity Manual
ITS	Intelligent Transportation System
LOS	Level of Service
PCU	Passenger Car Unit
RII	Relative Importance Index
RAs	Roadside Activities
RSFI	Roadside Friction Index
SMV	Non-motorized and slow-moving vehicles
TDM	Transportation Demand Management
VMS	Variables Message Signs

CHAPTER ONE

INTRODUCTION

1.1. Background

The urban transportation system has a significant contribution to a country's development. The quality of the urban transportation scheme plays a great responsibility in the socio-economic of society. Hence, in an urban area giving attention to factors influencing traffic flow characteristics is crucial. AASHTO stated that the amount of roadside obstruction could govern travel speed. The real travel speed on a street generally reveals a combination of the physical characteristics of the highway, the amount of roadside interference, the weather, the occurrence of other vehicles, and the speed limits (established either by law or by traffic control devices) [1]. Also, HCM identifies that street environment, interaction among vehicles, and traffic controls are the three main factors limiting the speed of vehicles, and the quality of services on urban streets. Where the street environment includes the geometric characteristics of the feature of roadside activity and adjacent land uses [2]. Therefore, it is crucial to assess and analyze the reason that influences traffic characteristics. This research considered the effects of roadside activities (RAs) and their problem to offer a valid remedial measure that improves the transportation system.

In an urban area, the roadside serves a different purpose. Public recreational spaces for residents and visitors are among that purpose. Besides, the roadside placed for people to shop, entertain, interact, and normally engage in a different array of social, recreational, and most non-motorized activities in addition to acting as main roads for motorists. This makes urban living enjoyable [3,4]. Besides making urban living enjoyable, RAs possibly will be considered as factors obstruct the motorists since the RAs share road environments with vehicles. Accordingly, on the subject of this, the valuable concern was desired to find the major problems incurred by the motorists from the RAs in Nekemte city.

Most of the RAs overcrowd the majority of main roads in the main cities in Ethiopia. As well the street vendors are blamed for problems created in sidewalks in streets [5]. In Nekemte city the current roadside is encroached either by vendors, utility poles, parking carts, or illegal construction materials in different places[6]. Therefore, the major factors mostly affecting the traffic flow characteristics according to the effect of RAs assessed in this study.

To sum up, RAs have undoubting effects on traffic flow characteristics. Studying different variables of RAs that affecting traffic flow characteristics and modeling the suited relationships by regression analysis was the aim of this research and this was what makes the researcher motivated to conduct studies about the Correlation Analysis of the Effect of Roadside Activities on Traffic Flow Characteristics and progressed and discussed in this study.

1.2. Statement of Problem

To get better facilities of road, investigating and analyzing the condition of the roadside beside roadway characteristics is essential. The efficiency of the road does not measure only the characteristics of the roadway but also depends on the situation of the roadside. The study conducted in India said that several projects for widening and strengthening of roads taken up, the surface condition improved, but capacity and LOS not enhanced as expected because of abutting land use along the road alignment. The presence of RAs is among the cause of not improving the LOS [7]. This point to the effects of RAs is as great as to reduce capacity and LOS. Therefore, a lack of understanding about the roadside conditions in the transportation system mainly in a developing country would create an occasion for the reduction of efficiency of the roadway facilities.

Ethiopia is a developing country that has limited access to the road. The government is allocating huge capital per year in the road construction sector to develop the road network. Although the government gave attention to road networks, there are inadequate studies that assess the effect of RAs on traffic flow characteristics that may influence the performance of road access in urban areas. Failure in the quality of transportation also results from factors like RAs that sway traffic flow characteristics. The study shows that activities like street vendors overcrowd the mass of major roads in main cities in Ethiopia. As well the street vendors are blamed for the problem created in sidewalks in streets[5]. And as reported earlier also Nekemte city experienced this case: the current sidewalk is encroached either by vendors, parking carts, utility poles, or dumping construction materials [6]. These RAs need proper investigation for their problems and effects on drivers and traffic flow characteristics. That was what attempted to address in the conducted research.

A roadside activity with a lack of good management, wrong location, poor arrangement, and obstructing motorists has unhesitant problems and effects on drivers and traffic flow

characteristics. The problem with RAs is crowding sidewalks and disturbing, irritating, and worrying pedestrians and motorists that displace pedestrians onto pavements and obstruct motorist's sightlines. And delay traffic flows, increase travel time, cause of traffic accidents, make motorists preferring to change the location from disturbing RAs, and increases the intensity of vehicle-generated air pollution are among the effects of RAs. Consequently, identifying different factors related to major problems of RAs and their effects on traffic flow characteristics assessed in this study, to analyze the correlations between the effect of roadside activities and traffic flow characteristics. Therefore, a roadside activity has undoubting problems and effects on drivers and traffic flow characteristics in Nekemte city. This case is the required point and studied in this research.

Figure 1.1. Roadside Activities

1.3. Research questions

The research questions that answered through the conducted research are the following:

1. What are the factors related to major problems incurred the motorists from the roadside activities?
2. Which factors, mostly affecting the traffic flow characteristics according to the effects of roadside activities?
3. What model suited the relationships of the different variables affecting the traffic flow characteristics due to roadside activities in the study road section?

1.4. Objectives

1.4.1. General Objective

The general objective of this research is to analyze the correlation between the effects of roadside activities on traffic flow characteristics.

1.4.2. Specific Objectives

The following specific objectives were set to deal with the objective of this research.

- To identify the roadside activities relating to major problems incurred the motorists from the roadside activities.
- To prioritize the roadside activities as their effects on traffic flow characteristics.
- To develop a correlation model using regression analysis relating the different variables affecting the traffic flow characteristics due to roadside activities.

1.5. Scope of the study

This study considered the existing arterial road and actual RAs in Nekemte city. The activities relating to major problems incurred the motorists from roadside identified. The effects and problems of RAs examined through the observation, interviewing related government sectors, and questioning the driver on the issue. The effects of RAs on traffic flow characteristics ranked by considering their effects and drivers' responses (RII). In this research volume, speed, density, and capacity were deliberated traffic flow characteristics. Finally, regression analysis was done by SPSS to correlate different variables of RAs affecting traffic flow characteristics to model speed prediction on the arterial road.

1.6. Significance of the study

This study has analyzed the correlation of the effect of RAs on traffic flow characteristics that evaluate the setting of RAs effects with contiguous traffic flow conditions. More the study was conducted to aware of the concerning transportation offices of the area about the problem and effect of RAs on traffic flow. From the finding of this study, Nekemte city municipality benefit to manage and arrange market area and appropriate strategic location for RAs along main roads to minimize or eliminate their adverse impact on traffic flow. Finally, the researcher will use the findings as input for further investigation of this area.

1.7. Justification of the study

Nekemte city is one of a well-known market city in western Ethiopia, and different trade activities take place in this city. The reason for conducting this research is to identify the problem with RAs on driver and traffic flow characteristics in Nekemte city and assessing its effects on the transportation system. Generally by conducting this research adverse impact of RAs on the transportation system will be minimized or eliminate and make the transportation system more efficient and suitable in Nekemte city.

1.8. Limitation of the Study

The condition and the time in which this study conducted was not comfortable for the researcher to collect the necessary data freely. Besides, the data gained from the corresponding office was rough; even they agreed with the existence of a problem but there was not documented data and detailed information on the issues or RAs in Nekemte city.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1. Introduction

This chapter provides reviews of the literature on the road, roadside environment, roadside friction, roadside activities, problem and effect of roadside activities, and traffic flow characteristics. The purpose of this section is to gather relevant information regarding the objective and subjective of the topic studied.

2.2. Road

Transportation facilities are major infrastructure elements of current cities, and actions by transportation designers and planners have a considerable influence on social ecology and community [8]. That confirms road alignment, construction, and operation are anxious tasks. In Ethiopia for road design and construction, an alternative of design controls and criteria is influenced by the volume of traffic, design vehicle, the practical classification of the road, type of terrain, the design speed, the density and feature of the adjoining land use, and environmental and economic concerns [9].

The road network is a structure that consists of interconnected routes designed to carry different categories of vehicles and allow smooth travel for facility users. The road network usually forms the most critical level of transportation infrastructure and associate with all other areas both inside and outside the borders of the urban.

A road network divided into parts such as:

- Intersections
  - Controlled or uncontrolled intersections
  - Roundabouts
- Motorways
- Bicycle lanes
- Pedestrian crossings
- Footpaths and pedestrian areas
- Urban roads
- Rural roads
- Bridges, tunnels

Moreover, some roadside systems (or Intelligent Transportation System, ITS) and monitoring systems used to make trouble-free and manage the traffic, such as:

- Variables Message Signs (VMS)
- Intersection control with traffic lights
- Dynamic road information panels (DRIPs)
- Loop detectors

2.2.1. Functions of Road Network

i. Social

The road network enables the easy movement of people consenting for social interaction. A high-quality road network is essential not only for connecting main urban centers but for improving connecting of more isolated local communities for whom many public transport options are limited or not available. Roads connect inaccessible communities with the areas where employment opportunities are more concentrated and services and facilities more readily available[10]. Commonly, road transportation is the major method of conveying which connects the cities, towns, metropolitan regions, villages, states, and the whole country into the system creating an advanced announcement. Also, it improves the entire country's development, environment, and socio-economic civilization's growth. Still, the special benefits of the highway transport individual have been facing rare troubles owing to the need for its suitable organization, modernize & preservation [11].

ii. Economic

Road networks cover a crucial role in the economic development of the 20th century, allowing relatively fast individual transportation for the masses from the second part of the 20thcentury[12]. By relating geographic locations, road networks simplify the transport and movement of people, goods, and services, creating welfare. Investments in road networks decrease the travel time between two locations increases the robustness of the transportation network, therefore, improving factors relating to transportation makes to reduce the travel costs. These kinds of effects are referred to as direct effects of road networks. The economic impacts of road networks extend in most cases beyond these direct effects due to the further rounds of economic activity as a result of the efficient transportation of goods, skills, and persons, the supposed indirect economic effects[10].

Therefore, transportation and economic growth go parallel, and a well-organized road facility has a significant advantage in the economic development of a country.

iii. Mobility

The main purpose of a road network is to facilitate movement from one area to another. Consequently, it has an important role to play in the urban environment to facilitate mobility. It also determines the accessibility of an urban area organized with public transport options[10]. In the urban area, many RAs challenge the mobility of the road. Therefore studying these factors has a significant role to increase the efficiency of the road.

iv. Safety

The safety of road users typically depends on road safety (prevention of accidents through speed control, seatbelt enforcement, roadside conditions management, etc.). Appropriate development is critical in ensuring road safety: in the case of national roads, where the speed limit can exceed 50-60 km per hour the rise of roadside development is not recommended. For this reason, the development of new access to national routes can generate additional safety risks to road users. The layout of the road should help to improve traffic safety, for example by providing separate bicycle lanes and physically separated driving directions for motorways and larger urban roads[10].

v. Security Issues

The presence or absence of routes from one place to another not only influences the mobility of the public but also of criminals. This can have a direct effect on the perceived attractiveness of a location to criminals. Security issues are influenced by the pervasiveness of the road network because an easy escape adds to the attractiveness of targets are burglary, robbery, raid, vehicle theft. Generally, the function of a road is more than what is discussed in this section so to achieve the maximum utilization of the road for the required purpose it is mandatory to deal with all factors and parameters that persuade the facilities [10].

For road design, considering influencing factors only at the preconstruction stage does not result in satisfactory service. To be fully beneficiaries of the road network more it is better to follow up and assess further influencing factors of traffic flow characteristics after

construction through operation time. This indicates that on behalf of a user to have better access and quality of services on the road all transportation-influencing factors should be considered from the preliminary of the design to the end of service life.

2.2.2. Functional classification of road

According to Ethiopian Road authorities, the functional classification of road includes five functional classes. Trunk Roads (Class I) Centers of international importance and roads terminating at international boundaries are linked with Addis Ababa by trunk roads. Trunk roads have a present AADT ≥1000, although they can have volumes as low as 100 AADT. Link Roads (Class II) Centers of national or international importance, such as principal towns and urban centers, must be linked with each other by link roads. A typical link road has over 400 - 1000 first year AADT, although values can range between 50-10,000 AADT. Main Access Roads (Class III) Centers of provincial importance must be linked with each other by main access roads. The first-year AADTs are between 30 -1,000. Collector Roads (Class IV) Roads linking locally important centers to each other, to a more important center, or higher class roads must be linked by a collector road. Feeder Roads (Class V) any road link to a minor center such as market and local locations is served by a feeder road. First-year AADTs are between 0-100. Roads of the highest classes, trunk and link roads have, as their major function to provide mobility, while the primary function of lower-class roads is to provide access. The roads of intermediate classes have, for all practical purposes, to provide both mobility and access[9].

Depending on motor vehicle travel characteristics and degree of access provided to adjacent properties AASHTO classifies the urban highway system into four functional highway systems: urban principal arterials (streets), minor arterials (streets), collectors (streets), and local streets. According to this classification, the urban principal arterial structure serves the major centers of activity of urbanized areas, the longest trip needs, and the highest traffic volume corridors. The second classification is an urban minor arterial street system and this arterial interconnects with and augments the urban principal arterial system. Such a facility may carry local bus routes and offer intercommunity continuity but ideally does not go through identifiable neighborhoods. The next is an urban collector street system provides both land access service and traffic circulation within residential neighborhoods and commercial and industrial areas. On the other hand, the urban collector street also

collects traffic from local streets in residential areas and channels it into the arterial system. The final urban local street system offers the lowest level of mobility and usually contains no bus routes. Service to through-traffic movement usually is deliberately discouraged [1].

2.2.3. Street Environment

Street environment, interaction among vehicles, and traffic controls are the three main factors influencing the speed of vehicles, and the quality of services on urban streets. The street environment takes account of the geometric characteristics of the street, the feature of roadside activity and adjacent land uses. The interaction between vehicles is defined by traffic density, the proportion of trucks and buses, and turning movements. Where traffic control, (including signals and signs) forces a portion of all vehicles to slow or stop[2].

The expression "clear zone" used to assign the unobstructed, traversable area provided further than the border of the travel way for the improvement of the errant vehicle. Shoulders, bicycle lanes, and any additional space, if available are included in a clear zone [13]. However, in urban areas, different activities take place in a clear zone and occupy the roadside for another purpose. To have better road access and a quality transportation system we should have to pay attention to roadsides particularly in urban where the roadside provides different activities.

Public recreational spaces for urban residents and visitors are among the service of the roadside in urban areas. Urban roadsides are also places for people to shop, socialize, interact, and depend on engaging in the different collection of social, recreational, and most non-motorized activities in addition to acting as main roads for motorists. This makes urban living enjoyable[3][4]. On the contrary, RAs can influence traffic flow by obstructing the motorists since the activities share the road environment with the vehicles. Therefore, factors influencing/impacting traffic flow characteristics need logical management.

2.3. Roadside Friction

Most developing countries have heterogeneous traffic flow. This means in characteristics of heterogeneous traffic there are many kinds of vehicles on every roadside, the dynamic characteristic of vehicle composition, and complex behavior of undisciplined road users. The roadside activity factor is one of the side friction affecting traffic characteristics in the

urban area in developing countries separately from mixed traffic, public transportation the undisciplined driving behavior. Side friction has great impacts on capacity performance. The great number of side friction caused by RAs causes a traffic jam. Side frictions are defines as all those actions related to the activities taking place by the sides of the road and sometimes within the road, which obstruct the traffic flow on the traveled way [14].

As a research review spell out Side friction is defined as a composite variable describing the degree of interaction between the traffic flow and activities along the side(s) and sometimes across or within the traveled way. Besides, variables on behalf of activities going on or along the carriageway can define the side friction. Various activities representing side friction are grouped as follows: [15].

A. Reduction in a traveled way which includes:
    i. Vehicles stopping for pick up and set down of passengers
    ii. Pedestrians crossing or moving along the roadside
    iii. Non-motorized and slow-moving vehicles (SMV)
    iv. On-road parking
    v. Improper coordination and lack of multimodal terminals
B. Shoulder activities include:
    i. Parking and unparking activities
    ii. Pedestrian and non-motorized vehicles moving along shoulders
C. Roadside activities include:
    i. Vehicles entering and leaving the road
    ii. Food stalls vendors etc.

The existence of friction creators such as bus stops, intersections, petrol pumps, and pedestrian crossings, etc. much influences the traffic flow characteristics. As research conducted indicates, the average speed of motorized vehicles in the influenced region reduced by 26-38% of the free-flow speed in developing countries. These findings can better notify planners about the speeds used in traffic flow and travel demand modeling under heterogeneous conditions by helping them in accounting for the speed-reducing impacts of roadside friction. Moreover, transit planners may also consider the magnitudes and characteristics of the influenced regions and locations along the corridor to minimize their unhelpful impacts on the speed of other motorized vehicles[16].

Organizing on-street parking demand is an important subject in transportation planning, especially for metropolitan cities. Parking on the street is among the significant aspect of the transportation system. Another roadside friction is on-street parking. Every car owner prefers to park their vehicle as close as likely to the destination to reduce the walking distance, leading to overcrowded [17].

The study conducted on the parking challenges in urban cities of Tanzania to provide effective suggestions to overcome the challenges indicates, it is an explicit reality that the effectiveness of the parking policies is compromised with the perceived tension of three objectives which are governed by parking including; regeneration, restraint, and revenue. Also, the study suggests that municipalities and council authorities must provide awareness to people on the cost of driving within the city and encourage the non-motorized system to road users such as walking, cycling, etc. Further to ensure that any additional parking revenues are invested in developing the infrastructures; provide reliable information to inform people where they are allowed to park; to employ professionalism particularly parking attendants, applying friendly technology to charge parked cars and the cost of doing business within the city center should be elaborated to the population [18]. Normally this study informs those alerting road users in addition to managing parking facilities minimize parking challenges and improve the transportation system in urban areas.

2.3.1. Roadside and shoulder Activities

AASHTO stated that the amount of roadside obstruction could govern travel speed. The actual travel speed on a street usually reveals a combination of the highway physical characteristics, the amount of roadside interference, the weather, the existence of other vehicles, and the speed restrictions (established either by law or by traffic control devices)[1]. Because the amount of roadside obstruction can govern travel speed in urban transportation systems, it is very crucial to consider activities that progressed at the roadside and shoulders for their effects on traffic flow characteristics.

With the case of RAs, the study indicates that comparative risk assessment outcomes show village sites to be not as hazardous as residential and shopping sites. Village sites, which are different from residential and shopping locations, reside in single-purpose, land use zones consisting mostly of the single-family house and roadside shopping units with

sufficient off-street parking. Residential and shopping areas are characterized by multi-purpose, land-use zones permitting a combination of activities found in residential, shopping, and commercial areas. Village sites are sound for pedestrians, which is, have sidewalks and crosswalks, permit on-street parking, have speed limits, and other facilities that support walking[19]. This makes the urban street to investigated and analyzed for their efficiency beside the existing conditions. On the subject of RAs, helpful care should be needed to identify the major problems incurred by motorists from RAs.

Traffic congestion generates by roadside activities encroaching travel way disrupts business activities and reduces the productivity level, costs the lives of the people, and damages the environment in the form of pollution all over the world. Research indicates that it may also be a symbol of the growth of the economy. The economy grows and the real income of household increases creates the vehicle population increases, contributing to traffic congestion within cities. Given the critical importance of productivity on growth, the cost of treating people involved in accidents and compensation, the cost of travel time per year as a result of congestion delays, and finally the social cost of polluting the environment, this impedes economic growth and development of the country [20].

2.3.2. The problem of Roadside Friction

To improve transportation quality and efficiency, it is necessary to research the problem with RAs and their effects on traffic flow characteristics. The study conducted by Sudipta Pal and Sudip Kumar (2017) said that some projects for widening and strengthening of roads had been taken up, the surface condition has been improved, but capacity and LOS has not been enhanced as estimated because of adjoining land use along the road alignment and presences of roadside activities are also among the cause for not improving the LOS[7]. This study confirms that the effectiveness of the road does not depend only on the characteristics of the roadway but also depends on the conditions of the roadside.

Research conducted in Dhaka city indicates the reduction of roadway width due to side friction is the main problem for the people transportation. The pedestrian face several challenges to walk on footpath due to roadside activities. When the pathway is blocked for various side friction likes tea stall, shirt pant stall, paper stall, fruit stall, etc. the pedestrian tense to sufficient roadway width which results in the traffic jam [21].

Among roadside activities, the study shows that street vendors overcrowd the majority of main roads in main cities in Ethiopia. As well the street vendors are blamed for problems created in sidewalks in streets [5]. And as reported earlier the current sidewalk is influenced either by vendors, utility poles, parking carts, or prohibited construction materials at diverse places in Nekemte city [6].

Traffic congestion is the existence of delays by the side of a substantial lane owing to the existence of additional road users. This is the most important problem of transportation in developing nation cities. Because of this, each cause is delaying: be short of services on the period public requires, road user insincerity achieves to the intention, be short of services scheduled for the routes public to necessitate. Owing to the traffic, overcrowding in the unusual intersections the liberated stream of the vehicle's speed slow compares to the design speed. This will affect the socio-economic development of the country. Environmental pollution increases due to traffic delays and overcrowding. The imbalance of the physiological behavior of the road user may lead to the risk generation further it may lead to the accident[11].

Further than reducing capacity and LOS roadside activities like street vending often produce more hazardous traffic conditions than comparable traditional commercial developments. If access and parking facilities are poor, or if traffic conditions vary, then street selling can lead to unexpected traffic maneuvers and increased crash risk. Therefore, RAs need close investigation for their problems and effects individually on driver and traffic flow characteristics.

2.3.3. Effects of Roadside Activity

Although it is widely appreciated that events at the roadside affect the operation of the traffic stream and may cause delay, there are few references which try to quantify their effects directly especially for developing country where their outcome is likely to be high [22], [23]. This specifies dealing with the effect of RAs is an interesting research area especially for developing countries.

Commonly street vendors studied with numerous Economists in economic point-of-view in Ethiopia. Moreover, some of the Economic researchers said that the following effect of street vendors on the transportation system is an argument. Through vendors in the roadway

and the lively activity of street sales, crowded sidewalks, and pedestrians displaced onto the road may block motorist's sightlines at intersections and may distract drivers from their driving. Then street vendors may cause traffic accidents, increase the levels of vehicle generated air pollution, and delay the flow of vehicles. A road may generate a lot of noise with their announcements, and they and their customers often leave garbage on the streets[24]. All these effects need assessment by concerning professionals because of them have their role in reducing facilities performance in addition to making conditions discomfort for road users.

2.4. Correlation of traffic flow characteristics and roadside friction

2.4.1. Traffic flow characteristics

In general, the conventional major street is a multilane two-way facility with an equal number of lanes for traffic in all directions of travel. The conditions under which the operation is most suitable depend largely on traffic flow characteristics, the street pattern, and geometric features of the particular street. Traffic flow conditions on roadways can be characterized and expressed by the Speed (Km/hr.), volume flow rate (Veh/hr.), and density (Veh/Km). These three variables volume, speed, and density are interrelated and have predictable relationships [1]. The knowledge of traffic is an essential input in the geometric design of roads, regulation, and control of traffic operations, accident analysis, before and after studies of road improvement schemes, assessing journey times, and congestion on roads, and in correlating capacity with speeds.

2.4.1.1. Speed

Speed defined as the rate of motion in distance per unit of time; mathematically speed given by,

$$v = \frac{d}{t} \qquad \text{…….……. } \textit{Eq. 1}$$

Where,

v = speed of vehicle (m/s, km/h),

d = distance travel in m, and t = time t is seconds

Speed is the essential measure of the traffic performance of a highway. It designates the quality of service practiced by the traffic stream. Speed is one of the necessary components in the relationships of traffic flow theory other than density and volume. The speeds of single vehicles have to be specific in the form of an appropriate mathematical form for predicting the speed of the next vehicle in the case of the simulation run. Speed has also been renowned as one of the measures that designers can use to study road consistency and driver expectancy on roadways [25].

Speed data is an essential measure in determining the safety of a road network. The data collected in spot speed studies used to decide vehicle speed percentile that is useful in making speed-related conclusions. Space Mean Speed, as well as Time Mean Speed, are the two types of speeds. Time Mean Speed (spot speed) is measured by taking a reference area on a roadway over a fixed time.

$$Vt = (1/m) \sum_{i}^{m}{}_{=1}(V_i) \qquad \text{…….……. Eq. 2}$$

Where m represents the number of vehicles passing the fixed point. Space Mean Speed is calculated by considering the total roadway section.

$$Vs = n \left(\sum_{i}^{n}{}_{=1}(1/V_i)^{-1}\right) \qquad \text{…….……. Eq. 3}$$

Where n stands for the number of vehicles passing the roadway segment. The time means speed is never less than space mean speed. $V_t = V_s + a^2/V$. where $\mathbf{a^2}$ is the variance of space mean speed[26].

There are numerous commercial portable speed measurement devices (traffic speed detectors) existing for measuring the speeds. Intrusive devices, non-intrusive devices, and off-roadway are among vehicle detector technology.

Table 2. 1. Vehicle Detector Technology

Intrusive	**Non-intrusive devices**	**Off roadway**
Inductive Loops	Sonic and Ultrasonic	Probe Vehicle
Pneumatic Tubes	Doppler	Laser Gun
Piezoelectric Tubes	Passive Infrared	Radar Gun
Bending Plates	Active Infrared	
Magnetic Detector	Microwave Detector Video	

Source[27]

A research review by Adnan et al. concluded that based on the research it observed that the automated traffic classifiers have a higher accuracy when compared to the V-BOX GPS. Table 2.2. Shows the summary that can be made from the study in the development of the advantages and disadvantages of each device.

Table 2. 2. Advantages and Disadvantages of Each Device

Speed Measurement Device	Advantages	Disadvantages
Automated Traffic Classifiers	• Quick and easy to install for permanent and temporary recording of data • Use low power • Road tube sensors are usually low cost and easy to maintain	• Wet pavement prohibits the use of road tubes • Inaccurate axle counting when truck and bus volumes are high • Cut tubes resulting from vandalism and wear produced by truck tires
Laser Gun	• Laser speed guns can target ONE specific vehicle	• Not every vehicle could be captured when the traffic is high • Some data were lost even while using the laser gun as well • Data have to be captured within a certain distance as the average operating range is about 800 feet
Manual Count	• Accurate on a low speed due to human perception reaction time	• Errors from the human when high speed • Accuracy of data depends on the individual

Radar Gun	• Portable and easy to use	• Data may be biased due to the conspicuity of the data collector • Disturbance from another vehicle from another lane • Radar may read one of several vehicles/distinguish one target from another

Source [27]

Technology advancements have taken a vast in recent years in the field of non-intrusive speed measurement devices to intrusive speed measurement devices, making them further consistent, precise, safe, and easy to use. Due to these reasons and several other reasons such devices are increasingly becoming more accepted with private firms and sectors of transportation [27].

2.4.1.2. Traffic Volume

Traffic Volume is the number of vehicles passing a specified point during a specified period. It is usual to express traffic volume in the vehicle per hour.

$$q = \frac{nt}{t} \qquad \text{…….……. Eq. 4}$$

Where:

q = vehicle/hour,

n_t = counting the number of the vehicle,

t = Specified period.

The traffic volume data used in planning, designing a road system. In a macroscopic traffic narrative, one does not describe individual vehicles. Rather, one describes for each road segment the aggregated variables. Then volume *q* specified as the vehicle's number passing a reference point per unit of time. Other expressions for volume are though put; flow or intensity is similarly can represent the concept of the term volume [28].

2.4.1.3. Density

Density (*K*) is also known as concentration is the number of vehicles that exist in a specified section of the road at an immediate. It is frequently articulated in the vehicle per kilometer

length of road per lane. Density also calculated using the fundamental relation between the volume, density, and speed as given in the equation.

$$k = \frac{q}{v} \qquad \text{…….…….. } Eq.\ 5$$

Where:

k = density (Veh/km),

q = volume (Veh/km),

v = avg. mean stream speed (km/h).

Density k can be specified how close up in space vehicles are collected. Commonly speed-flow-density relationships are functional for highway design and planning process as the relationships present quantitative approximations of the change in speed as a function of projected changes in traffic demand. They are equally useful in real-time traffic control or incident detection based on changes in traffic flow parameters [22].

2.4.1.4. Capacity

Capacity is the greatest hourly rate at which persons or vehicles can reasonably expect to pass through a reference point or a uniform segment of a lane or street throughout a given period, under the existing road, the traffic, and organizes conditions. Capacity reduction and traffic congestion in urban roads due to side friction are very familiar in developing countries. Capacity is essential to planning, design, and operation of the roads. Capacity is helpful to resolve several lanes required by considering a volume of the vehicles, their composition, and other traffic interrelated parameters. Following a capacity reduction in the urban road, numerous reasons influence the capacity factor such as on-street parking, pedestrian progress, the presence of street hawkers, roadside bus stop [29].

2.4.2. Influences of roadside friction on traffic flow characteristics

Sherin George considered that an investigation of roadside friction on an arterial in thickly populated urban cities viz. Mumbai, Bengaluru, and Thiruvananthapuram. Side frictional feature was limited to pedestrian progress along the roadside, the bus stopped at bus stops and on-street parking. Their relationship was analyzed using multiple linear regression

analyses. Speed reduction was studied for all individual factors and a combined effect. They have concluded that side friction has a significant effect on speed and need to include side friction in all traffic-related study for proper result [29].

The impact of the side friction activities on the speed examined in India by conducting a progression of traffic field studies. Accordingly, pedestrian activities, entry-exit of vehicles from the environment, and parked vehicles, and incorrect way movements were considered and examined to analyze the collective effects of all the activities. It found that the vehicular speed reduces as side friction raises at all the levels of traffic volume. However, no change in speed proven at lower level side friction. The capacity assessment attained for collective data based on Green shield's theory that showed a 9% reduction in the value considering with and without side friction[30].

Another research informs that the decrease in average Stream speed is observed because of side friction. Stream speed decreased to 49-57% because of bus stops and bus bays while on-street parking decreases the stream speed by 45-67% [31].

Ahmad Manuwar in his study takes the speed was a major factor that affects capacity in standard case geometric and environmental characteristics specified. Also, they found there was a large difference between the expected speed in IHCM (Indonesian Highway Capacity Manual) and the real speed, and recommended that multi-regression formula is effective to verify high side friction activity since IHCM does not contain this type of sensitivity [32].

An investigation was carried out to define the intensity of side friction. Based on the analysis it concluded that the side friction for the developing countries might become a strict problem as it is directly influencing the speed of the vehicles. However, the street is designed for particular speed and capacity but it may not achieve the expected speed and capacity due to activities running along roadsides. This is a major problem for current cities in developing countries. Therefore this issue requires a solution for its adverse impact on time, speed, flow, density, and capacity [33].

As the research, review indicates in India, the overall performance of traffic parameters affected due to the presence of side friction. In heterogeneous traffic, slow-moving vehicles and non-motorized vehicles reduced the effectual road width due to roadside parking vehicles, and other parking and not parking exercise are some of the obstacles that degrade

road performance. Normally, these actions are practiced at nearby commercial areas/markets and it is necessary to study in detail about these parameters for calculating its result on traffic stream and further parameters. As well as to find out unit weighting factors for each event to have a single friction index value which is the roadside friction index (RSFI) [29].

Roadside friction caused capacity reduction because of temporary blockages created by on-street parking, entering exiting the bus from the bus bay, and bus stop nearby at the road edge. In various study sections, a significant difference in capacity reduction was observed using static and dynamic PCUs since to the high percentage of heavy vehicles. Percentage reduction in capacity because of bus bay is more than curbside bus stops as the number of buses operating in the latter case is a less and more overbuilding entry at the exit of bus bay overstated the capacity reduction. Using both types of PCUs bus bays and bus stops 10-53% capacity reduction was observed. On-street parking caused 28-63% capacity reduction upsetting the functionality of urban roads. Also, they reside time of buses that showed a substantial effect on capacity. With the rise in the period of dwelling time of the bus, it is found that capacity is reduced as more the time bus stops on road more the disturbance it causes to traffic on the section [31].

On-street parking problems are more serious in developing countries although limited research is conducted so far in their context. Urban transportation planners in India and other developing nations are facing trouble in designing the roads due to the lack of appropriate capacity guidelines that would also judge the control of parking. There have been little efforts to evaluate the influence of on-street parking on capacity, but its proper quantification is absent, which is more significant for the transportation planners [34].

Activities generating an impact on traffic performance on the road section normally described as side friction are not included in HCM-models as a rule, which begins from developed countries with a high level of motorization and a low quantity of roadside activities. The influence of the side friction points reduced by commanding a few limitations or appropriate design of the side friction point. It has been practical that the existence of side friction ultimately reduces the roadway capacity its and an effort has been tried to compute the overall speed reduction due to side friction points [31].

The capacity of a network depends on its roads. The capacity of a road is the maximum number of vehicles that can pass a certain road section per hour. Road width, lanes, and speed limit determine the capacity of a road. If the traffic demand is larger than the road capacity, congestion will occur. When congestion is present, the road network can no longer fulfill its task. Therefore, one tries to prevent or decrease congestion with traffic management measures[10].

Capacity related to three definite conditions: Traffic condition, it points to the traffic volume composition in the road such as the mix of cars, buses, trucks, etc. in the flow. It moreover includes proportions of turning movements at intersections, peaking characteristics, and the like. Next, capacity depends on roadway characteristics; this refers to the geometric characteristics of the facilities. These include shoulder width, lane width, lane configuration, vertical alignment, and horizontal alignment. Finally, capacity related to control conditions, this primary concern to surface facilities and often refer to the intersections signals, etc. [29].

CHAPTER THREE

MATERIAL AND RESEARCH METHODOLOGY

3.1. Introduction

This chapter defines and presents the research methods and logic steps followed to reach the overall objective of the study under the following subtopics: study area, study period, research design, and population, study variables, software and instruments, data collection process, data processing, and analysis.

3.2. Study Area

This research was conducted at Nekemte city, East Wollega zone, west Ethiopia that is located at 335Km West of Finfinne (the capital city). Nekemte has geographical coordinates of (9°02'00" - 9°07'00")N latitude and (36°28'30" - 36°37'00")E longitude, having an altitude of 1960m to 2170m above sea level. The average annual temperature of the city is 14° to 26° c, with a yearly rainfall of 1,500 to 2,200mm.

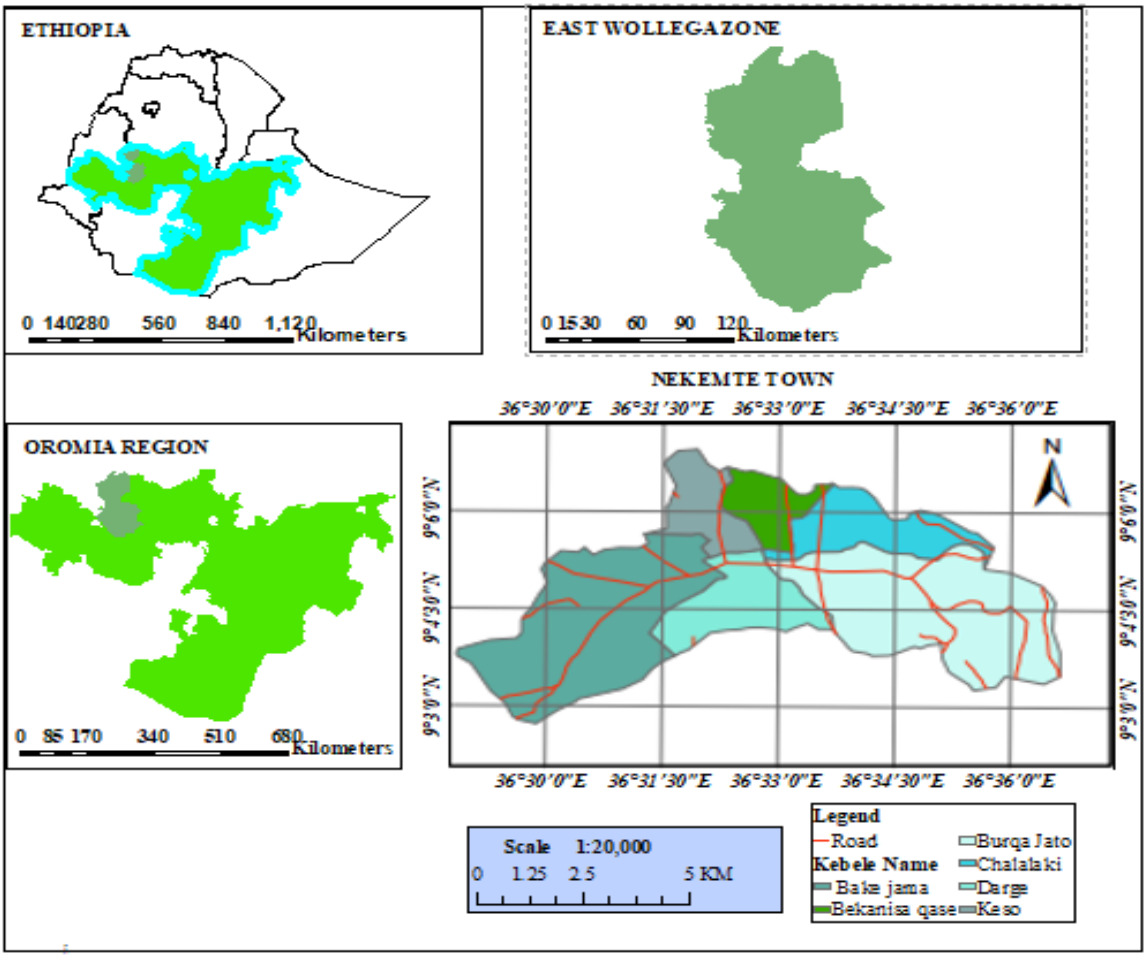

Figure 3. 1. Study Area (from Ethiopian Map agency)

3.3. Research Design

The study was started by identifying the factors relating to major problems incurred the motorists from the roadside activities. In this step, all RAs causing a problem on motorists are recognized with their location, arrangement, density, and approach to motorists. Next for identified roadside activity rank given according to drivers' responses and the effect of the activities on the traffic flow characteristics. In this case, the study is more focused on observational and motorist's responses to weigh the effects of each roadside activity. At the end mathematical model using regression analysis relating the different variables of RAs that affecting the traffic flow characteristics developed.

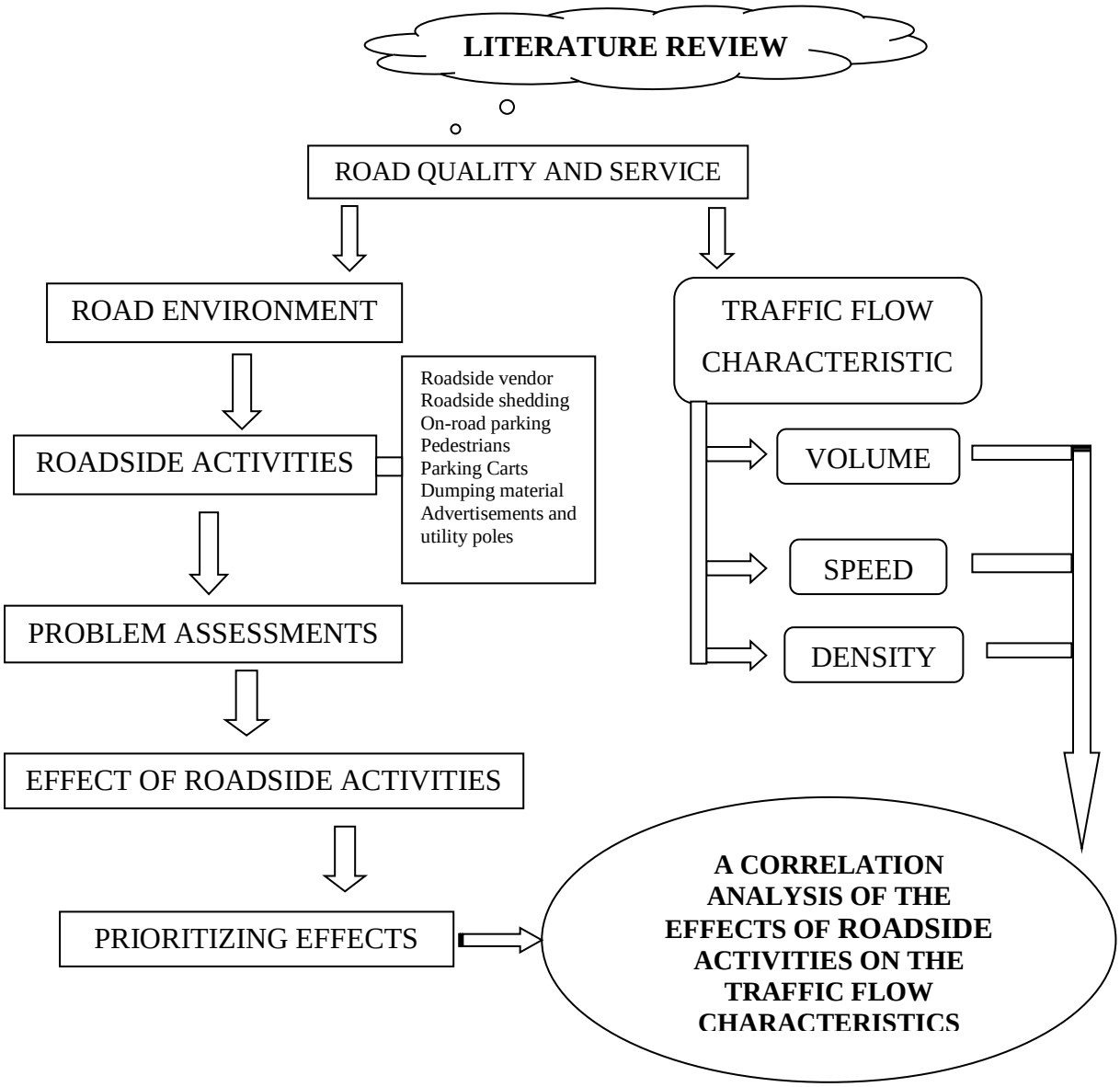

Figure 3. 2. Study Design

3.4. Population

The data was collected from site (Road) inspection and related urban roadside manuals and standards, pedestrian, driver, Nekemte city traffic flow (Vehicles), traffic police, Nekemte city transportation authority, and some kinds of literature. Therefore, the populations for the proposed study were the Nekemte city road network, roadside activities, and road users.

3.4.1. Sample Size and Selection

In this study, a purposive sampling technique was utilized, while the sample selection was based on their validation. The required sample sizes were determined from each population by using evidence corresponding observation and the two offices, namely the Nekemte city transportation authority and Traffic police office were communicated to gather information. Accordingly, for questionnaires' information, purposively taxi and Bajaj (three-wheel) drivers were selected. This was done because taxi and Bajaj drivers are the most common users and they were experiencing the roadside activities problem as well as familiar with the required information very well. From the transportation authority record, there were 27 taxi and Bajaj lines on the arterial road through Nekemte city that were formally recognized by the office. For these lines, 3 buses, 137 taxies, and 1014 Bajaj (total 1154 vehicles) are functional on the line by providing transportation service for Nekemte city communities. However, to fix the sample size with a number, some calculation is done by using single population proportion formula and the result indicated 318 (38 taxis driver and 280 Bajaj driver) were taken as a representative sample for the questionnaire and assumed they can represent the whole population.

The required sample size was determined by considering a 50% estimated proportion of roadside activity problems because there is no such study conducted in the area before.

The sample size formula:

a. Sample size – infinite population (where the population is greater than 50,000)

$$SS = \frac{Z^2 * p * (1-p)}{C^2} \qquad \text{……. Eq. 6}$$

Where:

SS Sample Size

P Proportion or percentage of population picking a choice expressed as a decimal (e.g., 50%=0.5)

Z Degree of confidence (e.g., 1.96 for a 95 percent confidence level)

C Degree of precision/confidence interval expressed as a decimal (e.g., 0.05=±5 percent)

$$SS= (1.96)^2*0.5*(1-0.5)/ (0.05)^2 = 384$$

b. Sample size – finite population (where the population is less than 50,000)

$$\textbf{New SS} = \frac{\textbf{SS}}{(\mathbf{1}+\frac{(\mathbf{SS}-\mathbf{1})}{\mathbf{Pop}})} \qquad \textit{……. Eq. 7}$$

$$New\ SS = \frac{384}{(1+\frac{(384-1)}{1154})} = 288.312 \approx 289$$

Taking 10% additional allowance in case of non-response or non-returnable rate which is 10% of 289 becomes 28.9 ≈ 29 adding to the previous one it becomes 318 (applicable sample size).

3.4.2. Sampling Techniques and Procedure

The study was adopted Purposive sampling techniques for the representative area and population selection. The method of sampling is based on the information gained from Nekemte city transportation authority and researcher observations that describe the type, location, and approximate density of the RAs existing in Nekemte city along the arterial road. The recognized area was the site of a mini-market, educational institutions, and illegal on-road parking: both vehicle and non-motorized carts. Besides, problematic roadway segments with various roadside activities and pedestrian dominated intersections in Nekemte city selected as sample populations.

3.5. Study Variables

3.5.1. Dependent Variable

In this study, the researcher needs to correlate the effect of different RAs with traffic flow characteristics. This indicates traffic flow characteristics are influenced by the effect of roadside activities. Therefore, a traffic flow characteristic was a dependent variable for the proposed study.

3.5.2. Independent Variables

The effect of roadside activities is variables influence traffic flow characteristics (speed, flow, and density). It means independent variables are the RAs that affect traffic flow characteristics and these activities were identified throughout the study.

3.6. Instruments

While performing this research, the researcher was used instruments such as Cameras to capture a photograph and a Video recorder to record some videos for data collection and assessment. Moreover, computer aid to record and analyze the data had been employed.

3.7. Data Collection Process

The data collection process started in Nekemte city transportation authority. Office interview conducted with Nekemte city transportation authority and some of the detail of the problem of RAs identified. Next taking the interview information as input the data collection process continued with field observation. In this observation, the arterial road through Nekemte city was analyzed. After that depending on the two information questionnaires developed and distributed for Nekemte city drivers. In line with this process, the segment of the arterial road through Nekemte city considered and the correlation of the effect of roadside activities on traffic flow characteristics analyzed. Hence, relevant data collected from the site and all stakeholders through the following methods.

3.7.1. Field Survey

The study conducted a field survey to collect some data that are critical for research design and analysis. Accordingly, from field observation RAs location, density, arrangement, and approach of the events to the traffic (vehicle) observed, speed and RAs participants are recorded with road data such as effective road geometry and the condition of the road checked out. Traffic flow characteristic data recorded appears in appendix A. Appendix F Shows some of the RAs captured during a field observation on Monday, October 14, 2019, and it includes dumping construction materials, illegal roadside shedding, carts, roadside vendors, and pedestrians on the travel way.

3.7.2. Questionnaire survey

In the form of questioners, the information was also collected from the driver regarding their ideas on RAs problems and effects by using nine-question. Questionnaire surveys were designed to get information on three major issues. The first five questions were designed for problem assessment. These questions request driver perceptions on the existence of the problem, level of the problem, roadside activities causing the problem, and the major activities causing the problem. The technique used with those questions were "YES" or "NO" question, Rating scale "1=very high, 2= high, 3= moderate, 4= Small, and 5= Very small", choosing from the list with an open response, ranking and problem identification respectively. The second part is for the collection of information on the level of effects of RAs on traffic flow characteristics with possible consequences. The last part that contains the eighth and ninth question prepared to gather additional information about the cause and possible measurements on the issues. Further, for the pedestrian, because the current situation was not appropriate and unfair to deal with the pedestrian case, relatively recent research was conducted at a normal condition reviewed as evidence.

3.7.3. Interview

The interview was performed to get some of the information about roadside activities regarding their type, location, problem, stakeholders, etc. from concerning government sectors. Namely, the Nekemte transportation authority and Nekemte traffic police are the offices where the interview was interviewed. The information from these sectors used as input information for the questionnaire survey to fix the sample segment from the arterial road for the conducted study. Also individually, Traffic police, street vendors, and the local community interviewed to gather applicable information for the research carried out. The interviewing format is attached to the research in appendix D.

3.8. Data Processing and Analysis

Using the above data collection method and process all relevant data gathered. From the Nekemte transportation authority, and Nekemte traffic police office, road segment samples considered were identified, and the existing roadside activities were recorded. Through this process, the researcher identified the different factors related to major problems incurred by motorists from RAs.

After that by using a questionnaire response from the driver, confirmation of the problem, level of the problem, stakeholders of the problem, the effects of the problem gathered, and according to the effects of RAs major factors mostly affecting the traffic flow characteristics ranked. Speed determination is done by the manual method that is suitable for only low volume traffic. Since traffic volume in Nekemte city was suitable and manageable, using manual speed determination was effective. Therefore, the 85m length of the road segment is considered in evaluating the speed. Speed distribution of vehicles recorded in a specified place that accommodates different RAs. Traffic volume counted three days each for 10hrs to decide peak volume and other traffic characteristics driven from macroscopic traffic flow characteristics relationship that is flow-speed-density equation.

The study developed a statistical correlation expression of the effect of roadside activities with traffic flow characteristics. In this case, the four RAs existing at the Board area namely Roadside vendors, Pedestrians, parked vehicles, and carts recognized and individually correlated to traffic flow characteristics that are speed. Moreover, to predict and model the combined effect of these four activities multiple regression formulae provided below were used.

$$Y = a + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 \quad \text{……. } \textit{Eq. 8}$$

Where: **Y** is a dependent variable (speed),

a is constant

B_1, B_2, B_3, and **B_4** is coefficient of independent variable and

X_1, X_2, X_3, and **X_4** is an independent variable which is RAs

To quantify the effect of RAs on traffic flow characteristics, the researcher reviewed kinds of literature, used the general traffic flow characteristic (speed-flow-density) equation according to their function, and related existing limits by considering the on-hand condition. Also, the road users' perception of how to reduce the effects and solve the problem is collected. Finally, the study suggested relative counter measurements and forwarded the important recommendation to decrease the adverse impact of RAs on the motorists and traffic flow characteristics that enhance the efficiency of the arterial road through Nekemte city.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Roadside activities relating to major problems incurred the motorists.

The efficiency of the road does not only depend on the roadway condition. Roadside activities considerably can influence driver condition and traffic flow characteristics. Therefore, dealing with RAs factors that obstruct drivers and influence transportation facilities plays a great role in assuring a further quality transportation system that is an essential basis for the development of a nation's economy. This suggests that even at a local level facilitating and increasing the efficiency of the road that is free of obstructing factors contribute to the upgrading of community income, safety, travel time, travel cost, etc. That is why the transportation system is the engine of economic activities all over the world.

Although road structure is significant, delivering access with better quality is not an easy task. Many arterial roads in several developing nations point up deteriorated capacity and poor performance. Previously studies done on this problem to make out the cause and found that because of urbanization; there is often a great deal of activity on and/or along arterial roads, which affects how it operates [31] this circumstance also obtainable in Nekemte city. This research conducted more of focusing on the problem that incurs the driver from roadside activities and factors influencing existing traffic flow characteristics on the arterial road through Nekemte city. While conducting this research a segment of a major road from western Ethiopia to the capital city Finfinne that passes through Nekemte city considered as a sample.

4.1.1. Investigation of problem incurring driver from roadside activities

Problem incurring the driver that obstructing their work could generate from different factors. This indicates that to produce a problem-free environment for the driver the broad transportation system should be considered. Also, dealing with all of the participants in the transportation system will reduce the efforts required to overcome the challenge with the transportation system that is made to facilitate a better transportation system. Nevertheless, considering all of them within single research under a unique subject is not an easy task that is done in a short time of period with limited resources. Therefore, only drivers, arterial

roads (facilities), and roadside activities factors with their effects on traffic flow characteristics are critical in this study.

Normally the arterial road is designed to provide motorists with reasonable levels of protection against serious ran-off-road crashes. The clear zone concept has been the cornerstone of this protection philosophy for many years. Under this philosophy, roadside hazards within the clear zone either eliminated or moved. When hazards are cannot be removed or relocated a determination needs to make if a safety device (e.g., guardrail or crash cushion) warranted protecting motorists from the roadside obstacle. According to this study, nowadays numerous activities that obstruct the driver's condition and traffic flow characteristics were running along and/or on travel way that is embedded in a clear zone. Even though the study did not replicate the previously reported dilemma that came with roadside activities that take place along and/or on travel way, the result of this research suggests that RAs cause a problem on more than 90% of drivers in Nekemte city. That means the result confirms the previous study conducted on the problem of RAs in developing countries. Since the first preparation of this study is to identify the RAs that affect traffic flow and relating to major problems incurred by the motorists from the RAs, the questionnaire survey used for the execution of this specific objective and their result discussed below. Moreover, roadside activities need further investigation for their nature and detail characteristics that are left from this study.

Field observation and Nekemte city transport authority interview responses were included to verify that the status of the existing problem of RAs and traffic flow characteristics. This helps the study to design a questionnaire survey that can address the required information to answer the research question. Accordingly, the information gained from the Nekemte transport authority verified that an undoubting RAs problem exists on the arterial road through Nekemte city. Moreover, for the question they asked to identify the segment that mostly containing RAs; the response indicates the total segment from Bake Jama to Wollega University compass experiencing different RAs that may obstruct the driver and traffic flow characteristics. Also, some of the activities performing on these road segments like illegal roadside vendors, on-road parking, illegal roadside shedding, etc. are identified by using the communication. In line with those findings pedestrians, parking carts, and dumping construction materials existing along and/or on the arterial road in Nekemte city observed while field investigation was executed. This specifies and settles that RAs be

among the considerable factors in the transportation system that influences traffic flow characteristics as well as obstructs drivers' condition on their work. Moreover, this study gathered the perceptions of the driver on the issue of RAs and the result and analyses of the collected information presented in the next topics.

4.1.1.1. Driver perceptions' on the problem incurring motorists from RAs

Driver perceptions gathered on the issues of RAs that obstructing them from the work. For this purpose, 309 drivers have participated in the questionnaire survey, but the limitation of this study was a taxi, and Bajaj drivers only purposively selected. Because taxi and Bajaj drivers are experiencing their work on the arterial road all day, expected they know the problem and able to express an average or balanced impact of RAs on their work with current conditions. As the RAs are time and place dependent may be their effects are insignificant for those only facing this problem once or few in a day. Another reason to limit the participants of questioner survey was most of the vehicles using the arterial road go through the city and it is difficult to recollect the questionnaire papers distributed. Therefore, these reasons were why taxis and Bajaj drivers are considered.

The questionnaire surveys prepared for the driver designed to get information on three major issues by using nine questions. The first five questions were designed for problem assessment. These questions request driver perceptions on the existence of the problem, level of the problem, roadside activities causing the problem, and the major activities causing the problem. "YES" or "NO" question, Rating scale "1=very high, 2= high, 3= moderate, 4= Small, and 5= Very small", Choosing from the list with an open response, ranking choose and problem identification are techniques used with these questions respectively. The second part is for the collection of information on the level of effects of RAs on traffic flow characteristics with possible consequences. The last part that contains the eighth and ninth question prepared to gather additional information about the cause and possible measurements on the issues. The results of the questionnaires survey correspondingly presented below:

4.1.1.2. Problem assessment of roadside activities by using "YES" or "NO" questions in the questioner survey

The arterial road through Nekemte city is experiencing numerous RAs running along and/or on travel-way, this is perceived from the interview and field observation. So that the presence of these RAs causes a problem for the drivers. In this study, the question prepared for the driver to answer whether these activities exist or not was "Is a problem facing the driver from roadside activities along and/or on the arterial road through Nekemte city?" and the result shows most of the driver are facing a problem from these activities. In percentages, 91.3% of the driver responded to the required information as there is a problem incurring them from RAs progressing beside the major road through the city. Where 8.7% of respondents responses for NO answers that indicate there is completely no or maybe no serious problem incurring the driver from RAs. Therefore, as the study outcome shows the existence of RAs through and/or on a travel way generates an undoubted problem for the motorists. Similarly, RAs running along and/or on the road affect the driver's condition and lead to result in poor performance on their work. Further, the figure that is with YES or No questioner survey outcome confirms the previous study result that indicates the impact of RAs is among the considerable factors reducing the performance of transportation facilities in developing countries. Hence, it is clear that RAs are factors troubling the drivers besides obstructing traffic flow characteristics. Therefore, these basic findings are consistent to deal with the very significant influences of RAs.

Table 4. 1. Drivers' perceptions of roadside activities are factors troubling motorists

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	27	8.7	8.7	8.7
	YES	282	91.3	91.3	100.0
	Total	309	100.0	100.0	

4.1.1.3. Level of the roadside activities problem by the Rating scale

Assessing the level of the problem in dealing with RAs helps to put required remedial measures on time. So that in this study the level of the problem incurring the motorist that was generated from RAs was studied by using the question requesting the status of the

problem by a rating scale. “How do you evaluate the level of problem that incurring driver from roadside activities along and/or on the main road through Nekemte city?” This question was fundamental to know the level of the problem and it was set with a rating scale that represented with “1= Very high, 2=high, 3=moderate, 4= small, and 5= very small”. From the YES or No question, notably, there is a problem. The second question was requested to identify the level of the problem. For this question among all participants (91.9%) are valid respondents and the average result shows that the level of the problem is nearest to a high level which has a mean value equal to 2.43 but accurately between high and moderate levels.

Table 4. 2. View of motorists’ about Level of the RAs problem by the Rating scale

Level of Problem		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very High	72	23.3	25.4	25.4
	High	93	30.1	32.7	58.1
	Moderate	61	19.7	21.5	79.6
	Small	42	13.6	14.8	94.4
	Very Small	16	5.2	5.6	100.0
	Total	284	91.9	100.0	
Missing System		25	8.1		
Total		309	100.0		

From the replies to the above two questions, it is concluded that there is a problem incurring the driver from RAs and the level of this problem is almost high. Therefore, it is necessary to identify what factors of RAs are troubling the driver in Nekemte city. To answer the question the third questionnaire survey question was designed depending on the evidence collected from different resources. As Hayu (2018) suggested in his research in Nekemte city the current roadside is encroached either by vendors, utility poles, parking carts, or dumping construction materials in different places [6]. Moreover, the interview made with the Transportation authority officer shows in addition to the activities listed in Hayu's research there is also illegal shedding and on-road parking vehicle. Further, the finding of field observation adds pedestrians' movement as RAs. Therefore the third question was included these eight activities found in the city. The question is prepared as choosing with one more alternative space for further answers.

4.1.1.4. The consideration of existing roadside activity in Nekemte city

Side friction is defined as a composite variable describing the degree of interaction between the traffic flow and activities along the side(s) and sometimes across or within the traveled way. Further, variables on behalf of activities going on or along the carriageway can define the side friction. Various activities representing side friction are grouped as follows: [15].

A. Reduction in a traveled way which includes:

   i. Vehicles stopping for pick up and set down of passengers
   ii. Pedestrians crossing or moving along the roadside
   iii. Non-motorized and slow-moving vehicles (SMV)
   iv. On-road parking
   v. Improper coordination and lack of multimodal terminals

B. Shoulder activities include:

   i. Parking and unparking activities
   ii. Pedestrian and non-motorized vehicles moving along shoulders

C. Roadside activities include:

   i. Vehicles entering and leaving the road
   ii. Food stalls vendors etc.

According to the above grouping, the limitation of this study was all activities considered in this research named as RAs. Vehicles stopping for pick up, and set-down passengers exist in Nekemte city but not studied in this research. This made from the reason that the participants in the questionnaire survey were the driver of passengers car and it is difficult to get balanced information from them as well these activities are not severing issues that should be included. Then the question and finding of this subject described below:

The drivers requested to answer from the following roadside activities in Nekemte city which activities regularly obstruct them by using the multiple response questions.

a) Illegal roadside vendor
b) Illegal roadside shedding

c) On-road parking vehicle

d) Pedestrians

e) Parking Carts and non-motorized vehicles

f) Dumping construction material on the road

g) Roadside advertisements and utility poles

h) Others

The same outcome with the previous study that suggests the street vendors overcrowd the majority of main roads in main cities in Ethiopia has resulted in this study. Roadside vendors and pedestrian activities got high consideration as regularly obstructing RAs from drivers. This also endorses previous research conducted in Nekemte city that states RAs are blamed for problems created in sidewalks in streets and the current sidewalk is influenced either by vendors, parking carts, utility poles, or prohibited construction materials at diverse places in Nekemte city [6].

Table 4. 3. Case summary of multiple response questions of Roadside activities

Case Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Roadside Activities	283	91.6%	26	8.4%	309	100.0%

Table 4. 4. Responses frequencies of drivers' consideration for Roadside Activities

Roadside Activities Responses Frequencies result				
		Responses		Percent of Cases
		N	Percent	
Roadside Activities	Roadside Vendor	215	20.1%	76.0%
	Illegal Shedding	88	8.2%	31.1%
	On-road Parking	202	18.8%	71.4%
	Pedestrians	254	23.7%	89.8%
	Parking Carts and non-motorized Vehicle	190	17.7%	67.1%
	Dumping Construction Materials	87	8.1%	30.7%
	Advertisements and Utilities Pole	36	3.4%	12.7%
Total		1072	100.0%	

To describe the results of RAs frequencies responses, which show among the total drivers 76.0% got a problem because of roadside vendors. 31.1% got challenging with illegal roadside shedding, 71.4% incur dilemma from on-road parking, and about 89.8% trebled with the pedestrians' presence on road. Where parking carts and the non-motorized vehicle also contribute problems for 67.1% of drivers, and around 43.4% are facing problems from dumping construction materials on the road, advertisement, and utility poles. These results demonstrated that all of the roadside activities listed in the survey question are causing the problem for drivers. This confirms that the unlawful RAs running along and/or on the major road in the Nekemte city are a serious problem for drivers and transportation systems. Generally, this means the existence of RAs along and/or on the major road highly related to driver condition. When the road is occupied with illegal activities, it creates an uninteresting condition for the driver and influences traffic characteristics that acceptably result in reducing the efficiency of the facilities.

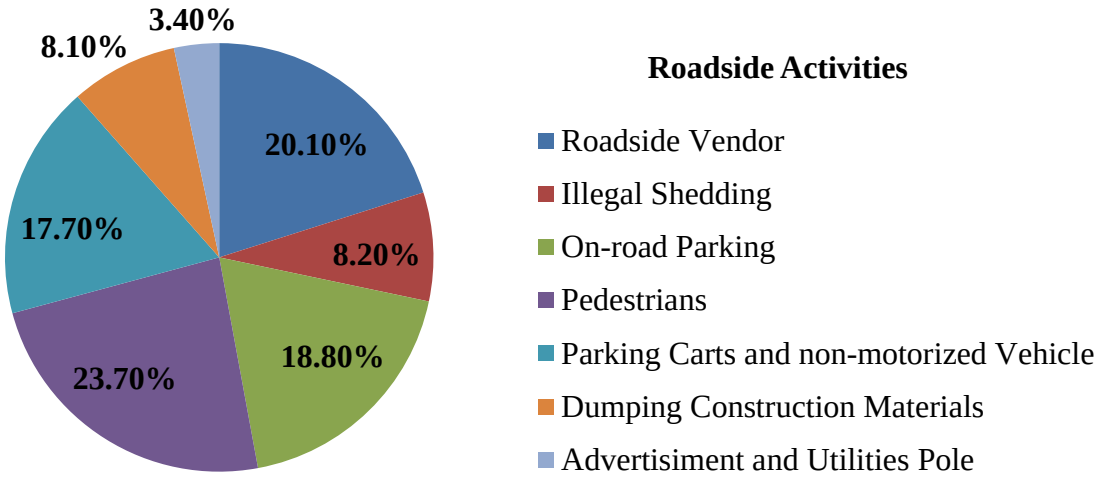

Figure 4. 1. Roadside Activities Responses Frequencies Percent

Roadside activities are the main problem for the arterial road that serving heterogeneous traffic flow in developing countries. The limited research was conducted on these issues, especially to quantify their impacts on traffic flow characteristics. Assessing the RAs problem on the driver in addition to correlating the effects with traffic flow characteristics will make this research unique. Hence preceding the problem incurring the driver from RAs was the procedure of this research. From the short review above, key findings emerge there is a high problem incurring drivers that rise from RAs: roadside vendor, illegal roadside

shedding, on-road parking, pedestrians, parking carts, and non-motorized vehicle, on-road dumping of construction materials, and advertisement and utility pole. Therefore, roadside activities relating to major problems incurring the driver from roadside in Nekemte city are roadside vendors, illegal roadside shedding, on-road parking vehicles, pedestrians, parking carts, and non-motorized vehicle, on-road dumping construction materials, and advertisement and utility pole. This result ties well with previous studies wherein they discussed as contributing factors for also pedestrian safety problems [6]. Even though, in this study pedestrian activity along and/or on the roadway is also considered as RAs that problematizing the drivers' conditions and traffic flow characteristics.

4.1.1.5. Problem incurring driver from roadside activities

The interest of drivers influenced by the conditions of the roadside in addition to the quality of the roadway structure. Activities take place at the roadside generates different problems and affects driver situations and traffic flow characteristics. Pathway block, overcrowd the road, slowing speed, delays, etc. are among the effects of the problem. These effects generally result in a productivity reduction in the facilities. Further than reducing effectiveness RAs like street vending, at this time often produce more hazardous traffic conditions than comparable traditional commercial developments. If access and parking facilities are poor, or if traffic conditions vary, then street selling can lead to unexpected traffic maneuvers and increased crash risk. In the conducted study to analyze the problem of RAs multiple response questions developed, and drivers' perceptions have been collected and the result of this response discussed next.

Most of the RAs overcrowd the majority of arterial roads in Nekemte city. In the city, the current roadside is encroached by either vendor, pedestrians, parking carts or illegal construction materials, etc. in different places. Due to the walkway is occupied by different RAs also pedestrians forced to walk in travel way. So that these conditions generate different problems for the driver. Normally mistreated and obstructing RAs are a cause to arise many problems for drivers. To study the problems that come with RAs multiple response questions organized and 283 drivers reflected their ideas on the cases. The result indicates among the respondents 62.9% disturbed, 32.5% irritate, 42.8% worried, 88.7% blame RAs for the blocked sight distance, and 77% changed the way due to the existence of RAs. Accordingly, disturbing, irritating, worrying, blocking sight distance, and forcing

the driver to change the way was the problem incurred the driver from RAs in Nekemte city. This result shows the presence of different RAs along and/or on the arterial road highly related to drivers' discomforts. Table 4.6. summarizes the outcome of motorists' perceptions of problem incurring them from RAs.

Table 4. 5. Case Summary of the problem of roadside activities

Case Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Problem of roadside activities	283	91.6%	26	8.4%	309	100.0%

Table 4. 6. Result of Roadside activities problem by drivers' view

The problem of roadside activities Frequencies				
		Responses		Percent of Cases
		N	Percent	
The problem of roadside activities	Disturbing	178	20.7%	62.9%
	Irritating	92	10.7%	32.5%
	Worrying	121	14.1%	42.8%
	Block Motorists Sightline	251	29.2%	88.7%
	Make motorists change the route	218	25.3%	77.0%
Total		860	100.0%	

Another case that makes the problem of RAs serious in Nekemte city is a different activity that exists in the same location where traffic flow is congested and horizontal alignment is curvature. Accompanying this condition is seen as a high opportunity for the cause of the accident that may result in fatalities, serious injuries, or property damage. A similar conclusion reached by the coverage that Fana broadcasting cooperation broadcasted by Afaan Oromo on 30/08/2018 happens the problem of the roadside vendor. To sum up, disturbing, irritating, worrying, blocking motorists' sightlines, and forcing the driver to change the way was the problem caused by RAs. Moreover, the report covers roadside trade

is very dangerous in most of the Ethiopian cities like Nekemte, and detail of the problem with roadside traders, initial causes, participants, and solutions still need further investigation. The potential cause and effects of roadside activities on traffic flow characteristics with fundamental findings and suggested solutions integrated into the next topic.

4.2. Prioritizing potential cause and effects of illegal roadside activities

4.2.1. Cause of illegal roadside activities

In line with dealing with the problem of RAs incurring the driver and their effects on traffic flow, this study tried to investigate the practicable cause of illegal RAs in Nekemte city. The most dominating RAs in Nekemte city are roadside vendors, pedestrians, parking vehicles, and carts. The major cause of these activities identified in this research. By comparing the results with the information got from the Nekemte transportation authority, observation, and mass Medias the cause related to lack of awareness, lack of good management, wrong location of activities, and poor arrangement of activities. Four major reasons that generalized by the researcher for possible causes of illegal RAs placed in questioner survey and 282 drivers respond to the case. Further, the cause may be beyond these identified and may include means of hiding from taxation, market attractiveness, and means of getting a daily income and so on that are left from this study. The restriction with this method was only fewer Transportation experts and drivers articulated their ideas regarding this case. However, the outcome indicates valuable findings that are addressed and summarized in the table below. In this study, evidence was found on some of the causes of illegal RAs. Besides, all the activities related to the traffic flow characteristics are analyzed depending on driver perceptions and communication with the transportation authority.

From the study results, it is clear that the lack of good management is one of the causes of illegal RAs. In Nekemte city unauthorized and authorized users are found on the considered arterial road. When upright facility management is absent, the existing resource goes to inefficient and produces poor services. 84.8% of the respondents blame RAs managing system. Normally controlling RAs rolling along and/or on the major road is not only belongs to the transportation authority. In formulating and implementing the transport facilities regulation and strategies all considering governmental sectors have to participate.

This indicates in producing an obstruction-free transportation system all transportation authority, traffic police, the Revenue Authority, and the city administration sector are held responsible. On the other hand, lack of cooperation to improve the transportation system by managing all activities around the road through Nekemte city was considered one of the causes of RAs. The following table 4.7. shows the drivers' views on the cause of RAs.

Table 4. 7. Case Summary of Cause of roadside activities

Case Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Cause of roadside activities	282	91.3%	27	8.7%	309	100.0%

Table 4. 8. Drivers' outlook of Cause of roadside activities

		Responses		Percent of Cases
		N	Percent	
Cause of roadside activities	Lack of Good Management	239	31.0%	84.8%
	Wrong Location of Activities	114	14.8%	40.4%
	Poor Arrangements of Activities	194	25.2%	68.8%
	Lack of Awareness	224	29.1%	79.4%
Total		771	100.0%	

Most of the studies conducted on roadside activities in developing countries agree as activities stakeholders purposively target the prohibited location to install their activities to attract their customers or to give the service. According to this study, 40.4% of respondents recognize the location of activities as the cause of illegal RAs. The same result most of the activities rolling along and/or on travel way in Nekemte city are very close to vehicle operation areas. Therefore, in this condition the activities have wrongly located that end in the block the travel way, cover sight distance, reduce roadway, and obstruct driver and traffic flow characteristics. Hence targeted location of activities found by this research as a significant cause for the illegal RAs.

The greatest problems troubling the driver came with road vendors, pedestrians on the travel way, illegal roadside shedding and carts, and parking vehicles on the road. Even if roadside activities are popular in developing nations along and/or on travel ways in the city that have heterogeneous traffic flow their unplanned, unfortunate, close to the arterial roads or misplaced arrangement complicates the problems. Most of the drivers blamed the arrangement of activities as the cause of RAs. So that the arrangement of the activities also blamed by the respondents as a critical cause of RAs.

The last one, lack of awareness of RAs is the fundamental findings in this research and this used to direct professionals to study how stakeholders in illegal RAs understood or reminded the adverse impact of their activities regarding their safety. In the study conducted among the respondents 79.4% link cause of RAs with lack of awareness. Normally there are fewer concerns for adverse effects of RAs on the transportation system. Generally, the study obtains good results with this simple method.

4.2.2. Effects of roadside activities on traffic flow characteristics

Although it is widely expressed that events at the roadside affect the operation of the traffic stream and may cause delay, there are few references which try to quantify their effects directly especially for developing country where their outcome is likely to be high. This specifies dealing with the effect of RAs is still an interesting research area especially for developing countries.

Bearing in mind that this study collected driver perception on RAs that more of based on the availability of RAs, level of RAs problem, cause of the problem, and effect of RAs on traffic flow characteristics and possible solution as stakeholders. Even though the objective of this study is, identifying the major problem incurred by the motorist from RAs; the driver assessed by questioner method to express their perception of the effects of RAs in traffic flow. Accordingly, 282 drivers expressed their perceptions on the cases. Within this case, four topics namely speed, travel time, accident, and geometry organized as the subject of effects.

Commonly RAs studied with numerous professionals in different point-of-view in Ethiopia. As discussed in the above topics the finding of this research confirms that activities running along and/or on major roads cause undoubting problems for drivers.

Through vendors in the roadway and the lively activity of street sales, crowded sidewalks, and pedestrians displaced onto the road may block motorist's sightlines at intersections and may distract drivers from their driving. The field study of the effect of RAs on traffic flow characteristics included in the correlation analysis part. Further, the effects of RAs on traffic flow investigated and discussed next.

4.2.3. Driver perceptions on the effects of roadside activities on traffic flow characteristics

The role of the driver in the transportation system is very significant. Permission to drive on public main road granted based on a set of conditions met and drivers are required to follow the established road and traffic laws in the location they are driving. As demand for road considers traffic volume in the transportation system; the problems incurred by the driver from RAs should have to get consideration. This study confirmed that numerous RAs running along and/or on travel way significantly influence the condition of motorists and traffic flow characteristics. Therefore, to deal with the effects of RAs on traffic flow characteristics also drivers prepared to respond to the case that concerns the effects of RAs.

It was known that the presence of different roadside activities along and/or on travel way obstructs the condition of motorists. Further, this condition also imposes different influences on traffic flow characteristics. As the outcome of this study indicates among the effects of RAs slowing speed, causing delay, cause traffic accidents, and narrowing travel way geometry are obtainable.

Table 4. 9. Case Summary of Effects of roadside activities

Case Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Effects of roadside activities	282	91.3%	27	8.7%	309	100.0%

Table 4. 10. Drivers' response to the effects of roadside activities on the transportation

		Responses		Percent of Cases
		N	Percent	
Effects of roadside activities	Slowing Speed	258	32.9%	91.5%
	Increase Travel Time	73	9.3%	25.9%
	Cause Traffic Accident	187	23.9%	66.3%
	Narrowing Road Width	266	33.9%	94.3%
Total		784	100.0%	

From the above result summary, one can understand that slowing speed, increasing travel time, cause of traffic accident, and narrowing road width is the considerable effects of RAs. The percent with the parameters are not indicatives for the magnitude of the effects rather they show among the respondents 91.5 % of drivers agree with slow down speed because of the activities going around the road. It is popular that slowing speed increases travel time but because RAs are time and location-dependent the increase in travel time considered in this study with 25.9 % of the total drivers participated in the questionnaire survey. 66.3 % and 94.3% of respondents blame RAs for causing traffic accidents and narrowing road width respectively. Finally, speed reduction, delay, cause a traffic accident, and narrowing travel way geometry due to roadside activities were included in these research findings.

4.2.4. Prioritizing the effects of roadside activities

Normally there are numerous factors influencing traffic characteristics that are difficult to study all those factors in solo research; following RAs in Nekemte city are discussed. RAs are among considerable issues regarding the influencing factors of traffic flow characteristics. This factor namely stated in world classic manuals like AASHTO and HCM where ERA manuals lightly consider these factors under density and character of adjoining land use that not well explained for RAs. However, Ethiopia is a developing country in which roadside activity mainly exists in main cities along main roads. Also, Nekemte experienced the same condition. Undoubtedly, their appearance is highly related to reducing road service quality and make road users uninterested in the facilities.

The present study confirmed the findings in an urban area, roadside serves a different purpose. Urban roadsides are places for people to shop, socialize, interact, and normally engage in the different array of social, recreational, and most non-motorized activities in addition to acting as main roads for motorists. This makes urban living enjoyable. Nevertheless, besides making urban living enjoyable, RAs are considered as factors obstruct the motorists, and this is confirmed by the finding discussed in the above parts. Normally the effect of RAs specifically running along and/or on travel way is predictable since the RAs share road environments with vehicles. Currently, this condition is among the factors challenging the performance of the facilities and needs contemplations in the city. Moreover, on the subject of this, the valuable concern desired by identifying the major problems incurred the motorists from the RAs in Nekemte city by collecting the driver perceptions.

In dealing with the second specific objective of the study, from the questionnaire survey, the fourth question let the driver order the activities. RAs ranked depends on driver perception using RII and activity effects. The result showed that pedestrians and roadside vendors are the two more challenging activities where the effect of others is not as bigger. Two hundred eighty-three participants respond to this question, 45.6% of drivers gave the first rank for pedestrians, and 43.8% prioritize roadside vendors as the major problem contributory factor. Also, some of them considered other activities. Further specifically RAs have observed along main roads in Nekemte city and list of them presented and drivers ordered these activities according to the information required, the requested information asks the driver to prioritize the roadside activities depending on their effects and the result presented below:

- Roadside vendors
- On-street parking
- Pedestrians
- Parking carts and non-motorized
- Illegal roadside shedding
- Dumping construction material on the road
- A utility pole and advertisement

Table 4. 11. Ranking Roadside activities

Ranking Roadside activities						
		Frequency as 1st rank	Percent	Valid Percent	Cumulative Percent	RII
Valid	Roadside Vendor	124	40.1	43.8	43.8	0.78
	Illegal roadside shedding	6	1.9	2.1	45.9	0.48
	On-road parking	10	3.2	3.5	49.5	0.49
	Pedestrians	129	41.7	45.6	95.1	0.81
	Cart and non-motorized parking	14	4.5	4.9	100.0	0.51
	Total	283	91.6	100.0		
Missing System		26	8.4			
Total		309	100.0			

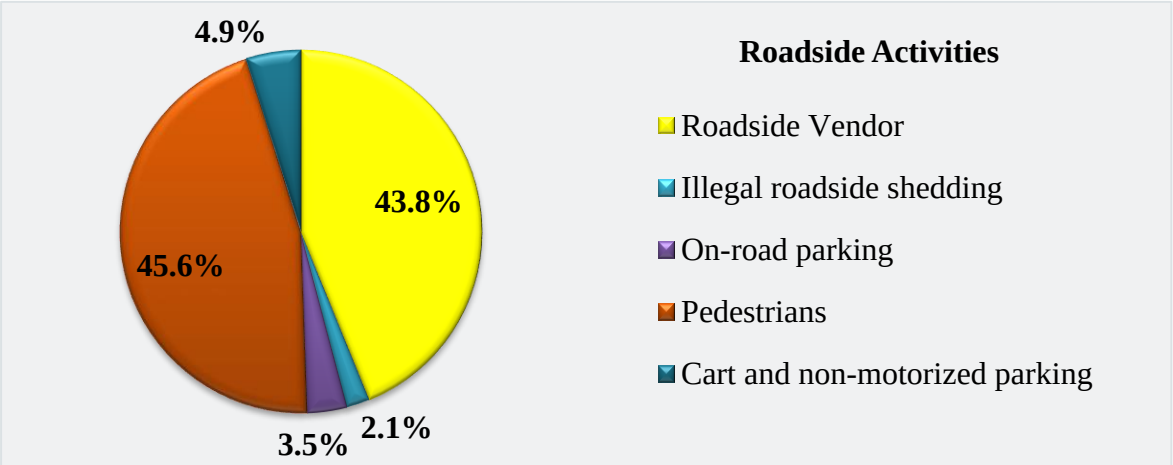

Figure 4. 2. Prioritizing effects of roadside Activities

On the other hand, the relativity importance index of the activities confirms pedestrians' activities that have an RII value 0.81 and roadside vendors that have an RII value 0.78 are the two major roadside activities that influence the driver's condition and traffic flow characteristics. Therefore, the study demonstrates pedestrians and roadside vendors come first and second respectively. In addition to the result of the drivers' response, the researcher attempted to prioritize the effects of RAs on traffic flow characteristics depending on the location (along and/or on travel way), length (length of the road covered with RAs), width (reduced road width due to existence of RAs). All of the criteria considered in this case only related to road geometry. It is clear that RAs are time and location-dependent this

means the density of these activities alter through the day on different segments so the value present in this table was the magnitude that measured arbitrarily while field investigation was conducted in line to check the balance of drivers' response regarding this case. The following table summarizes this investigation and prioritization remarks.

Table 4. 12. Effect of Roadside Activity on the reduction of road geometer

Effect of Roadside Activity on the reduction of road geometer						
No.	Roadside Activity	Location	Length (m)	Width (m)	RII	Remark
1	Roadside Vendor	Along & on	50	1.5	0.78	2nd
2	On-Street Parking	On	100	3	0.49	4th
3	Pedestrian	Along & on	Unidentified	1.5	0.81	1st
4	Cart Parking	On	20	2	0.51	3rd
5	Illegal shedding	Along	10	unknown	0.48	5th

Finally, as the result demonstrates pedestrian and roadside vendors precede the activities according to their effects. However, dealing with the activities as the factor that reducing road geometer and traffic accident contributory factor is a crucial point that left from this study.

4.3. Correlation analysis of traffic flow characteristics and roadside activities and remedial measure for roadside activities

Traffic streams are made up of individual drivers, vehicles, and roadways and environments. Driver behavior and vehicle characteristics typically vary and this makes no two traffic streams will behave exactly in the same way. Traffic stream parameters are divided into macroscopic and microscopic characteristics. The elements of macroscopic traffic stream parameters are volume, speed, and density. Speed of individual vehicles, headway, and spacing embedded in microscopic characteristics of the traffic stream.

Studying fundamental traffic flow characteristics and vehicle dynamic behavior is essential for the operation of the transportation system. The fundamental characteristics of traffic studied in this research. A suitable methodology adopted to collect and extract volume and speed data. The result of the study has shown that in Nekemte city the traffic is heterogeneous traffic dominated by three-wheeler and small cars. Also, the influence of

RAs on these characteristics observed in the analysis. In the next sub-section, the detail of traffic volume and speed data are discussed.

I. Traffic flow survey

Traffic volume is the number of vehicles passing a given point on a roadway during a specified period and usually expressed as vehicles per hour. Traffic volume count is used for designing, improving traffic systems, planning, management, etc. Traffic in Nekemte city is a heterogeneous condition in which three-wheel and small car vehicles dominate the road. The result of traffic volume counting shows that 44% of the volume is three-wheel vehicles, 45% is a small car, 3% is a motorcycle, 1% is a bus, 4% is a medium truck, 1% is a heavy truck, and 1% articulated truck.

In another way, the data from the Nekemte transportation authority indicated that there were 3 buses, 107 taxis, and 1017 Bajaj that registered to give transportation services in the city. In addition to these vehicles, many vehicles passed through Nekemte city since the arterial road from western to the capital city go through Nekemte city. Additionally, as the evidence from Nekemte bus station implies Nekemte bus station served an averagely 580 different vehicles per day. To determine this information and know traffic flow this study conducted vehicle count for 10hr (7:00 AM - 5:00 PM within 15 minutes intervals) times three days. Monday (August 12, 2019), Wednesday (August 14, 2019), and Saturday (August 17, 2019) were the day of the week. The traffic counting has taken at a locally known Board area. The result indicated Monday (August 12, 2019) comprised the peak volume. There were 7926 different vehicles passed this point for 10 hours of observation time in two directions. From here, it showed 275 the greatest vehicle volume that was recorded between 8:15 AM-8:30 AM. It means the counting time from 8:00 AM-8:00 AM hr. was the peak hr. for the counted traffic volume at this point. The calculated peak hour factor (PHF) for the counting resulted in 0.898. The traffic counting is presented below in the form of a graph and the tabulated numerical data enclosed in Appendix A.

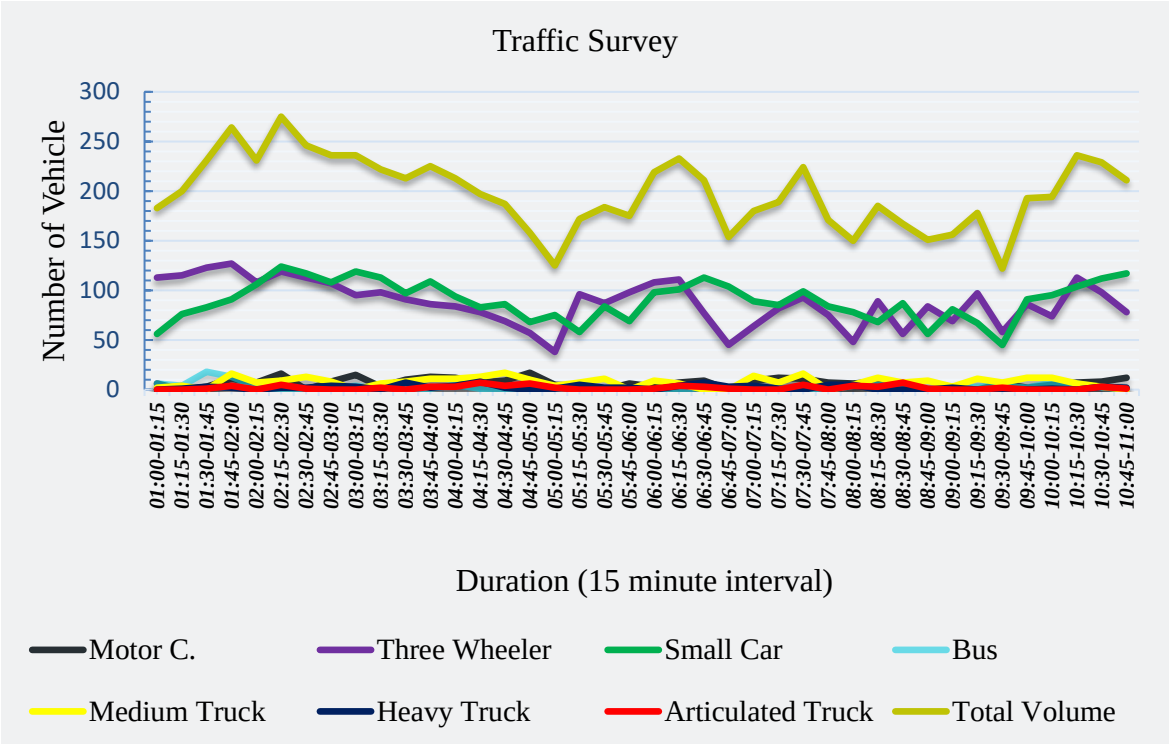

Figure 4. 3. Traffic survey

At the location where this counting was taken, the observed traffic volume confirms vehicle classification using the facilities was heterogeneous that encompass different types of design vehicles. The following graph shows the percentage of a vehicle type that counted at the board area.

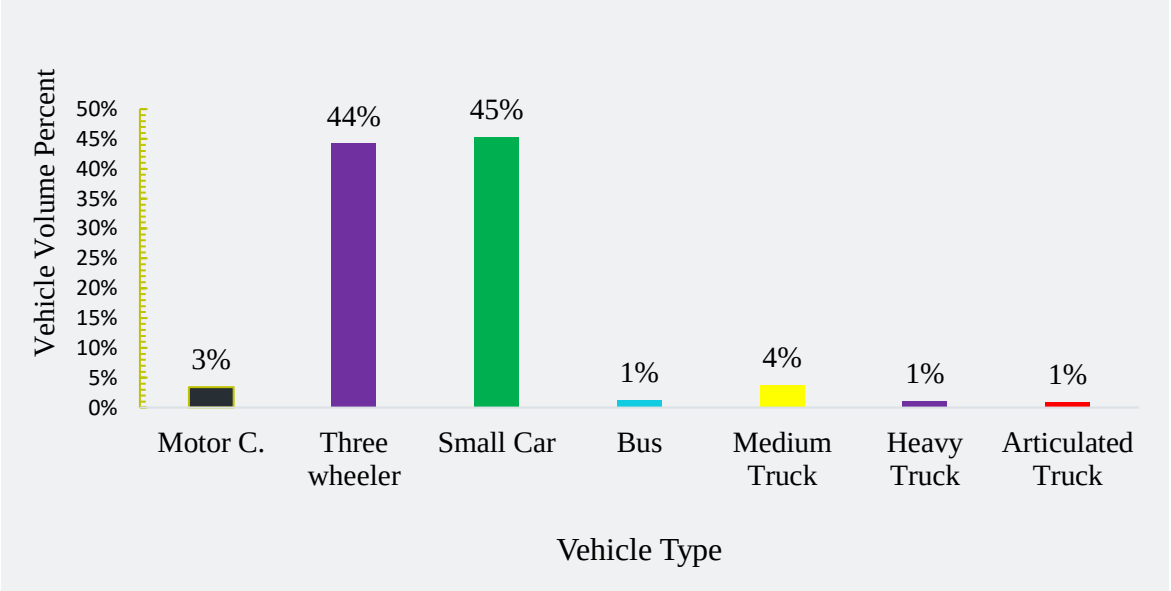

Figure 4. 4. Percentage of Vehicle Volume

II. Speed

Speed is an essential transportation consideration for it relates to time, safety, comfort, convenience, and economics. In this research, time mean speed studies are used to determine the speed distribution of traffic flow. The data gathered in speed determinations used to determine vehicle speed, which is useful in analyzing the effect of RAs on traffic flow characteristics. The appropriate study length considered to collect vehicle speed in this research was 85m and the location for this length is on the segment at RAs exist. The same length is considered along the segment without RAs to study the speed distribution. The result of observations on time-mean speed study data present in the table in appendix E. The records demonstrate that speed distributions are different for both conditions that were with and without RAs.

The influence of the RAs on the speed was analyzed in this study by conducting a series of traffic field surveys. Pedestrian movements, parked vehicles, parking carts, and roadside vendors are the major observed RAs from inspection. RAs on the segment analyzed to estimate their effects on traffic flow characteristics. To examine the effects of all the activities, correlation analysis was performed by SPSS. It found out that the vehicular speed decreases as RAs increases at all the levels of traffic volume. Factors decreasing vehicle speed discussed in the correlation analysis part of this chapter with their contribution value.

4.3.1. Correlation analysis of the effects of RAs on traffic flow characteristics

Urban transportation influenced by various factors like speed of vehicles on the facilities, width of roadway, structure of the road, construction work on roads, various land uses that attracts motorized / pedestrian traffic bound to institutional, commercial area, shoulder and roadway width, access points, terrain, etc. However, for urban roads, the impact of RAs i.e. roadside vendors, carts, and non-motorized vehicles, on-street parking, pedestrian crossing, etc. are also much significant. According to the conducted study, vehicle speed decrease as the number of roadside activities participants increase. In the shown study, four RAs were separately analyzed and all the factors negatively correlated with the speed. The correlation of these activities was obtained after collecting the speed data with RAs at the same station

for several days. Accordingly, more than 20-speed records for each three class of vehicle extracted and an investigation carried out to analyze the correlation of RAs and speed.

However, the street is designed for particular speed and capacity but it does not achieve the expected speed and capacity due to activities running along and/or on the travel way. This is a major problem for current cities in developing countries. Based on the analysis it concluded that the RAs in the Nekemte city become a strict problem as it is directly influencing the speed of the vehicles. Especially pedestrians and roadside vendors highly correlated with speed reduction. In the shown correlation study, the r^2 values of the analysis show the reduction of the speed 83.6%, 81.3%, 55.26%, and 62.9% correlated with the presence of pedestrians, roadside vendors, parked vehicles, and carts respectively. Therefore, all of the examined activities that rolling around the travel way which is along and/or on arterial road negatively correlated with the speed of vehicles. As the activities densified on the road the speed of vehicles goes to a very minimum. Hence, this issue requires a solution and further studies on its adverse impact on the transportation system and risk assessment of pedestrians and roadside vendors on arterial roads. In the conducted study about 20-speed records for every three classes of vehicles extracted and attempted to deal with their relationship with RAs. The following graph shows the result of the correlation analysis of separated roadside activity with Speed.

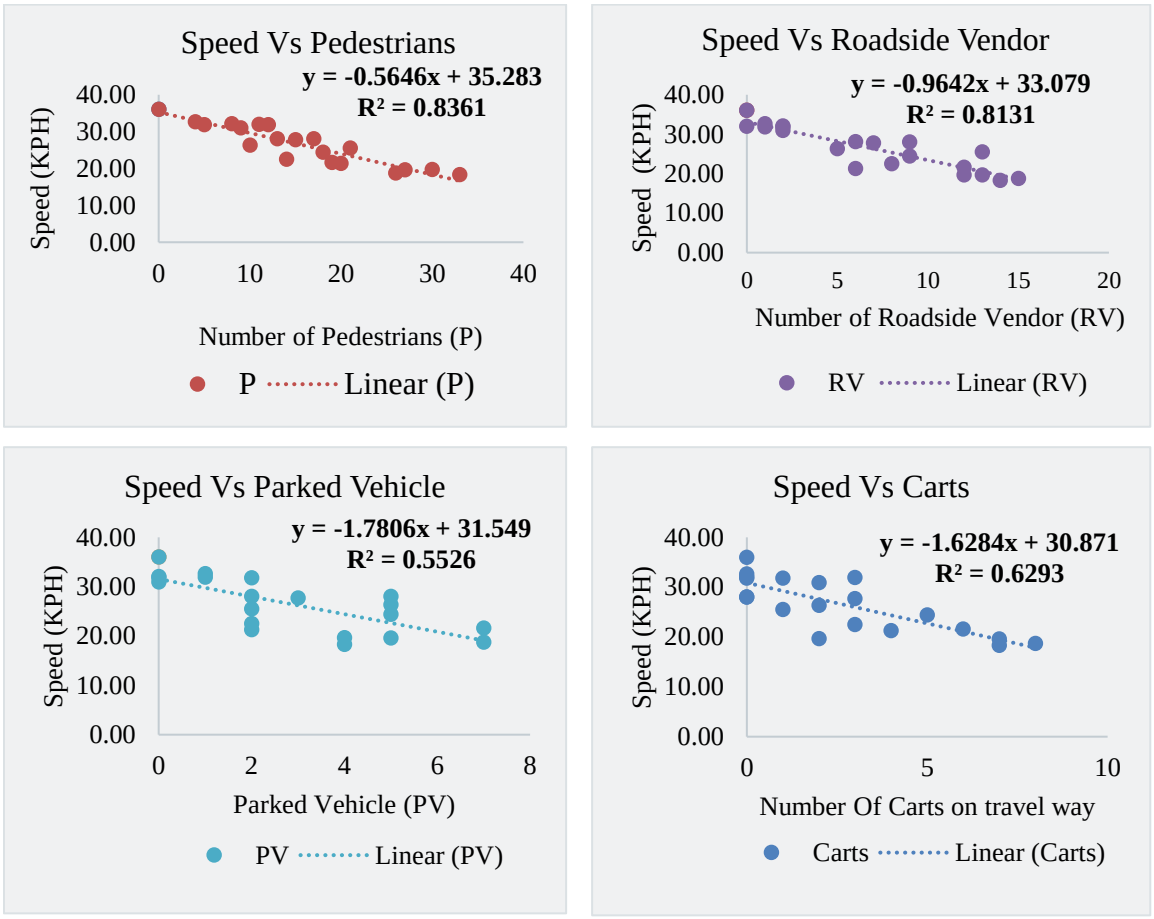

Figure 4. 5. Correlation of Speed and Roadside activities

4.3.2. Speed prediction model

In this research, an attempt was made to investigate the effects of RAs on traffic flow characteristics. As described earlier speed is one of the macroscopic characteristics of traffic flow. In the urban area, most of the time speed is raised with the subject of safety, operation, and performance of the facilities. Accordingly in this research speed is chosen characteristics to correlate with the effects of RAs like roadside vendor, on-road parking, pedestrian activities, and the presence of parked cars on the travel way. The speed data extracted by considering 85m travel distance. In the same section, the number of RAs participants counted with corresponding speed. The speed and RAs recorded data documented in the last Appendix E. Therefore, in this analysis speed considered as a dependent variable and roadside vendor, on-road parking, pedestrians, and parked carts were an independent variable. From the correlation analysis, it is known that the four independent variables are negatively correlated to speed. In line with the correlation analysis, this study attempted to develop the model to predict speed distribution for the road

that experiencing these RAs. This is carried out to know the combined effect of each activity that reduces the speed. In the model, the four roadside activities have a negative coefficient. Therefore, it shows even the presence of one of these activities significantly minimizes the speed of the vehicle. Further, to quantify the effect of RAs in traffic flow characteristics the provided equation is logically correct. Reduction of speed on the arterial road due to RAs that obstructs traffic flow characteristics were normal but the quantified effects observed in this study show as the RAs are among critical factors.

Table 4. 13. Speed Prediction Model

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	34.600	.950		36.405	.000
	Pedestrian (P)	-.273	.117	-.442	-2.323	.035
	Roadside Vendor (RV)	-.326	.229	-.305	-1.422	.175
	Cart (C)	-.500	.252	-.244	-1.986	.066
	Parked Vehicle (PV)	-.099	.330	-.041	-.301	.768
a. Dependent Variable: Speed						

Table 4.13 shows the result of linear regression models developed for a combined roadside activity to predict the speed on the arterial road. The model developed depending on the speed data extracted from the arterial road that experiencing pedestrians, roadside vendors, carts, and parked vehicles around the Board area. Therefore, depending on the linear regression coefficients provided the speed on the major road predicted as:

Predicted speed = 34.6 - 0.273P - 0.326RV - 0.5C - 0.099PV

The model developed for speed prediction using the data from the arterial road at Board, which is having all the four RAs. According to the result of the study, the speed on the arterial road that has these four activities can predict using the provided equation. The speed on the arterial decreases because of the existence of these activities, but there are reasons to doubt this explanation that direct the result provided to further investigation. Normally as described above RAs running along and/or on the travel way obstruct the traffic flow. Besides this condition, also currently drivers sometimes forced to stop their vehicles in the

city for the security cheek up most of the time at the pedestrian dominated section of the road. Moreover, another condition that challenge this study to analyze speed with the activities was the arterial road section with the RAs were surface deteriorated that leads the vehicles to decreases the speed to pass this section. These conditions make the researcher doubt the correlation analysis and regression model result. Therefore, the specific objective that aimed to model the effect of RAs on traffic flow characteristics again needs extra investigation within the normal condition.

4.3.3. Impact of roadside activities on density and capacity

III. Density

The street designed for particular speed and capacity may not achieve the expected speed and capacity due to activities running along roadsides. This is a major problem for current cities in developing countries. An investigation was carried out to assess the influence of RAs on traffic flow characteristics. Based on the analysis it concluded that for Nekemte city the RAs become a strict problem as it is directly influencing the speed of the vehicles.

Traffic density is the number of vehicles occupying a given length of the highway in a traffic lane. It is inversely proportional to the volume of traffic this means if the density is less, then speed will be more and traffic volume will be more, and if the density is greater, then the speed will be low and traffic volume will be less. From the above finding, the existence of RAs along and/or on the major road considerably affects the speed of the vehicle that means when RAs occupy a travel way, the speed reduction is observed. The reduction of speed on the arterial road was correlated 83.6%, 81.3%, 55.26%, and 62.9% with the presence of pedestrians, roadside vendors, parked vehicles, and carts respectively. On the other hand, when speed is low traffic volume also less and this situation leads to create high density. So that in general speed reduction due to the existence of RAs causes low traffic volume, a high number of vehicles on the road segment that leads to creating congestion.

IV. Capacity

Highway capacity related to three definite conditions: Traffic condition, it points to the traffic volume composition in the road such as the mix of cars, buses, trucks, etc. in the

flow. It moreover includes proportions of turning movements at intersections, peaking characteristics, and the like. Next, capacity depends on roadway characteristics; this refers to the geometric characteristics of the facilities. These include shoulder width, lane width, lane configuration, vertical alignment, and horizontal alignment. Finally, capacity related to control conditions, this primary concern to surface facilities and often refer to the intersections signals, etc. [29].

As research suggests the influence of RAs is critical in the reduction of road geometry and its performance. In this study, it was observed that different RAs occupied the travel way. For example, roadside vendor covers up to 1.5m width of the road with 50 m length, parking carts also reduce the width of the road up to 2m on continues 20m segments not only this but also the reduction of road geometry due to on-street parking and pedestrian activities are not minimum. Roadside activities caused capacity reduction because of temporary blockages created by pedestrian activities, roadside vendors, on-street parking vehicles, and carts nearby at the road edge and on the travel way. In addition to traffic demand that is larger than the road capacity, the existence of numerous RAs along and/or on the road creates an occasion for congestion. When congestion is present, the road network can no longer perform its task well. Therefore, in preventing or reducing congestion with traffic management measures the consideration of RAs is very important. In the present study, the effects of RAs on vehicle speed investigated and from relation to the theoretical influence of RAs raised. But the effects of RAs that generate high traffic density and result in the reduction of road capacity because of geometric reduction due to RAs occupied the facilities need further investigation.

4.3.4. Important findings of roadside activities in Nekemte city

The outcome of this study cast a new light on RAs place, management, density, and approach to the traffic flow that adapted along and/or on the arterial road through Nekemte city. It is important to highlight the fact that most of the RAs create a problem on the majority of the main roads in the main cities in Ethiopia. As well as among RAs boldly the street vendors and pedestrians are blamed for problems created in streets [5]. This research also confirmed the existence of this problem. Still, in Nekemte city the current roadside is encroached either by vendors, illegal roadside shedding, utility poles, on-road parking vehicle, parking carts, and illegal construction materials in different places [6]. Therefore,

an important question associated with the detail of RAs discussed in this topic. This is important for knowing the detail of the problem reduces the exertions made in the way of finding the solution.

A. Location of challenging roadside activities in Nekemte city

Transportation systems and land development are interrelated. As Nekemte city is the well-known oldest market city the road segment that experiencing RAs is the road within the area where the market and commercial activities take place. This analysis found evidence for, the road around Bake Jama was busy by pedestrian and on-road parking vehicle located beside and on the travel way. Where Bake Jama to Nekemte Auditorium was occupied by roadside vendors and pedestrians those progressing their trade and movement on the carriageway. On the segment around education institutions that exist around Jitu and Wollega University area, pedestrians' activities are observed in the wrong direction (right hand) and walking in the travel way. The road around the Board is exhibiting different RAs like a pedestrian, illegal roadside shedding, and on-road parking vehicles and carts at the junction. Further, many on-road parking vehicles were recorded along with the road known as Eng. Mesele Hayile road. In addition to the segment, roadside vendors, parking vehicles, pedestrians, parking carts, and illegal shedding, occupy most of the intersections and roundabouts in Nekemte city. Finally, the observation result demonstrated that RAs along and/or on the arterial road through Nekemte city were challenging factors for the drivers and the transportation system in the city.

It is interesting to note that the location of most of the RAs: roadside vendors, pedestrians, and parking vehicles and carts are at a junction, intersections, and roundabouts where traffic flow is overcrowded. The findings on the location of RAs at least hint that the primary place to be focused and studied in Nekemte city to take counter measurements on the way to improve the transportation system that clarified from problem incurring driver and obstructing RAs.

B. Managing Roadside Activities along and/or on the travel way

Transportation demand management also called travel demand management aims to maximize the efficiency of the urban transport system by discouraging unnecessary RAs that influence the traffic flow characteristics in addition to private vehicle use and

promoting more effective, healthy, and environment-friendly modes of transport. It focuses on understanding how people make their transportation decisions and helping people use the infrastructure in place for transit, ridesharing, walking, and biking. However, nowadays within managing and performing transportation, the influence of RAs is momentous. Together, the present findings confirm in most developing countries, this problem is increasing day by day and it is one of the biggest factors of the road accident. This shows RAs directly affecting the safety measures in the road in addition to challenging traffic flow characteristics [33].

Another promising finding of this study was the accountable offices with the improvement of the factor: roadside trade, illegal roadside shedding, on-road parking, carts and non-motorized, on-road dumping construction materials, etc. that are directly affecting the driver condition and traffic flow characteristics in Nekemte city identified. They are the Nekemte city Transportation authority, Nekemte police station office, the city administration, and the Revenue authority. As the investigation indicates they are planning to get together to cut or reduce the impact of these activities on city transportation. Moreover, they are expecting this cooperation will impose important measures especially to overcome the most challenging RAs that direct how to manage transportation demand.

C. Roadside Activities Density and physical Approach to traffic flow

This result highlights that little is known about the density and physical approach of the RAs to the traffic flow characteristics. The previous study has demonstrated that comparative risk assessment outcomes show village sites to be not as hazardous as residential and shopping sites. Village sites, which are different from residential and shopping locations, live in single-purpose, land use zones consisting mostly of the single-family house and roadside shopping units with sufficient off-street parking. Residential and shopping areas are characterized by multi-purpose, land-use zones permitting a combination of activities found in residential, shopping, and commercial areas. Village sites are sound for pedestrians, which is, have sidewalks and crosswalks, permit on-street parking, have speed limits, and other facilities that support walking [19]. In line with this study Nekemte city as an urban experienced roadside activity along with and/or on an arterial road. From the short review above, key findings emerge in Nekemte, different

activities take place at the roadside and these activities contribute to the dilemma relative to their approach for traffic flow characteristics.

The density of the activities along the road varies through the segment. As the field observation outcome implies roadside vendors densified at the junction, intersection, and roundabout appear. Pedestrian movement in travel way and carts also found at minimarket adjacent to arterial segments and vehicles parked on-road which cover half of the travel way with a high length of road. One concern about the findings of Density and physical Approach to traffic was rather than stakeholders' perceptions only physical characteristics analyzed. Regarding the approach of RAs stakeholders', only physical performance with the arterial road was analyzed. Roadside vendors are too close to the vehicle movement and in addition to disturbing drivers; they expose themselves to a traffic accident. Same for the pedestrian in the wrong way or in the travel way they challenge road users and traffic flow characteristics. Finally, it is very important to deal with the risk assessment of activities stakeholders' that is beyond the scope of this study.

4.3.5. The Suggested remedial measure for the roadside activities problem

The urban transportation system has an enormous contribution to the economic development of the developing country. Following that, to improve their transportation system different countries formulate their manuals by considering different influencing factors of traffic flow characteristics relative to world classic manuals.

Urban roadway performance is influenced by various factors like speed of vehicles on the road, structure of the road, construction work on the roads, various land uses. These factors attract motorized/pedestrian traffic bound to hospitals, institutional, commercial area, shoulder and roadway width, access points, terrain, etc. however for urban roads, the impact of RAs i.e. roadside vendor, illegal roadside shedding, on-street parking, Pedestrian crossing, non-motorized and carts, etc. are also much significant. Roadside events causing an impact on traffic performance are commonly described, as side friction is normally also problematic for drivers.

To improve the functions of the road some investigators consider different factors influencing the performance of the facilities that may generate before and during operation time. Accordingly in enhancing the road function and improving the facilities, it is very

important to bear in mind that the effect of RAs in developing countries. In Ethiopia, most of the traffic characteristics on the major road are heterogeneous and exposed to the effect of RAs. Normally to overcome the challenges with RAs this study suggested solutions.

4.3.5.1. Improving mini-market area and sidewalk facilities

Whenever the traffic jam problem creates at a certain point, then by the consideration of the peak hour volume, the solution may go ahead towards the widening of the road, fly over or underpass. Nevertheless, improving the mini-market area and sidewalk facilities play a great role in controlling congestion and accidents generate from the transportation system. Improving the mini-market area will solve the problem with roadside vendor those stall their supplies on the travel way by authorizing and keeping them in a safe place. This condition creates undisturbed traffic characteristics that are free from obstruction of roadside vendors. In another way, by improving sidewalk facilities pedestrian kept in the harmless place this enhances pedestrian walking benefits and makes them not exposed to travel way instead of seeking the facilities for their movement. This also clarifies the pedestrian from the travel way and cut the problem with a pedestrian in travel way that was the major problem incurring driver from RAs.

4.3.5.2. Improving parking locations for vehicles and controlling carts and non-motorized vehicles

Accidents, the loss of street space, and traffic attendant congestion are some of the serious ill effects of parking. The capacity of the streets reduced, the journey speed drops down and delays increase. Parked vehicles degrade the environment of the city center. Stopping and starting of vehicles result in noise and fumes. The effect of on-street parking on roadway capacity is well known. The substitution of a road lane by a parking lane has an important impact on capacity and a potential effect on traffic operations. This is expected to be the case when on-street parking is introduced to the major arterial road through the city. On-street parking limits street capacity in two ways. First, it preempts lanes that otherwise would be used by moving traffic. Second, parking and un-parking maneuvers frequently reduce the capacity of the adjacent lanes. Even a single vehicle parked within a curb lane can effectively close the lane to moving traffic. Therefore, separating travel way for carts and non-motorized vehicles and identifying suitable parking place for vehicles can

improve the problem incurred by the driver and obstructing factors that affect traffic flow from the roadside.

4.3.5.3. Improving management system

In the way of solving the problem with different RAs, the cooperation of all stakeholders is mandatory. For example, roadside vendors causing the problem for driver and traffic need the collaboration strategies made by all about governmental sectors. The transportation sector, traffic police, revenue authority, and all road users should act together to improve the transportation system in the city. Therefore, to achieve this aim improving the management system is essential. In a city with a huge population, a single sector or limited governmental bodies cannot succeed with improved and safe transports. Finally, in this study improving management systems that manage and supervise all road users and RAs stakeholder with enclosing strategies has a very crucial role in enhancing safety and well-performed facilities.

4.3.5.4. Giving awareness for participants in roadside activities

Investing in human perception is very difficult but it is productive. However, informing the society about the effects of RAs is another way in which the adverse effects of the activities running along and/or on the road can minimize. A human being in nature needs improvement but without changing the perception expecting the change is worthless effort so the finding of this research demonstrates RAs running along and/or on the road generate problems for the driver and make the transportation inefficient. The problem is not only these but also the road user and activities stakeholders victimized because of this case. Therefore, be aware of the societies about the problem, effects, cause, and counter measurements of the effects of RAs; the impact of RAs minimized and a safe and interesting transportation environment developed.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

- Currently, in Nekemte city RAs like roadside vendors, illegal roadside shedding, on-road parking, pedestrians, parking carts, and non-motorized vehicle, and on-road dumping construction materials are rolling at the roadside and/or on the travel way. That existing RAs cause problems for most of the drivers in Nekemte city.
- The result of this study demonstrates pedestrian and roadside vendors precede the roadside activities according to their effects. However, the adverse effects of other RAs like parking cart, on-street parking vehicle, and illegal roadside shedding in Nekemte city are also considerable.
- The correlation examination of four RAs namely pedestrians, roadside vendors, on-road parking vehicles, and carts with speed shows a negative correlation. The investigation specifies the reduction of speed was 83.6%, 81.3%, 55.2%, and 62.9% correlated with the presence of pedestrians, roadside vendors, parking vehicles, and carts respectively. On the other hand, an attempt made to analyze the combined effect of these activities and the developed model indicated the speed on the arterial road with roadside activities: pedestrian, roadside vendor, parked vehicle, and carts predicted as **V = 34.6 - 0.273P - 0.326RV - 0.5C - 0.099PV**. Finally, major roadside activities that obstructing the driver's condition and traffic flow characteristics need attention and further studies to quantify the effects, validate the equation, and lower the adverse impact of the activities.

5.2. Recommendation

The following recommendation that improves the transportation system and reduces adverse effects of RAs on drivers and traffic flow characteristics in Nekemte city forwarded.

1. Nekemte city should manage RAs and Improve travel way facilities by removing activities that obstructing driver condition and traffic flow characteristics along and/or on the major road.
2. Alerting, enforcing, and warning the pedestrians to use the right directions for their movement helps to clear the travel way for vehicles that enhances interesting safe passage coordination for both pedestrians and vehicles. Therefore, the pedestrian should use the sidewalk facilities out of the travel way that provided for them in the right direction.
3. The roadside vendor should be enforced to set up their stalls at places in the way vehicles can safely operate. Illegally placed stalls that create hazardous traffic conditions should remove as soon as possible. Also, the site should be supervised so they.
4. Drivers always should remember about RAs and take care of their driving.
5. Strictly implement traffic rules and regulations. Appropriate administration of transportation organizations should be required. Besides this administration as discussed in the result of the findings the cooperation of the three governmental sectors namely: Transportation office, Traffic police, and revenue office is very vital in minimizing the impact of obstructing factors of driver condition and traffic flow.
6. Further research is very important on the issue of road geometric reduction due to RAs, Pedestrians' risk assessment around roadside vendor dominating areas, and Assessment of RAs as traffic accident contributory factors in Nekemte city.

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Appendix

Appendix A: Traffic Survey Data

Title: **A Correlation Analysis of the Effect of Roadside Activities on the Traffic Flow Characteristics in Nekemte City**

Objectives of the research:

- ✓ To identify the factors relating to major problems incurred by the motorists from the roadside activities
- ✓ To rank the effects of roadside activities on traffic flow characteristics
- ✓ To develop a mathematical model using regression analysis relating the different variables affecting the traffic flow characteristics due to roadside activities

1. ADT Traffic counting format

Date: Monday

Name of surveyor: Dabala Misgana ID: _____

Direction from: Two Directional Along the arterial road at Board station

Time	Types of Vehicle						
	Motor C.	Three wheels	Small Car	Bus	Medium Truck	Heavy Truck	Articulated Truck
01:00-01:15	6	113	56	6	2	0	0
01:15-01:30	0	115	76	4	4	1	0
01:30-01:45	3	123	83	18	0	3	1
01:45-02:00	11	127	91	13	16	2	4
02:00-02:15	7	108	106	3	7	0	0
02:15-02:30	16	119	124	0	9	2	5
02:30-02:45	0	113	117	0	13	2	1
02:45-03:00	8	107	108	1	8	4	0
03:00-03:15	15	95	119	4	0	3	0
03:15-03:30	3	98	113	0	6	0	2
03:30-03:45	10	91	97	0	8	7	0
03:45-04:00	13	86	109	1	11	2	3
04:00-04:15	12	84	94	5	11	4	3
04:15-04:30	7	78	83	1	13	8	7
04:30-04:45	9	69	86	0	17	2	4
04:45-05:00	17	57	68	0	10	0	6
05:00-05:15	5	38	75	0	4	1	2
05:15-05:30	4	96	58	2	7	5	0
05:30-05:45	0	87	84	0	11	2	0
05:45-06:00	6	98	69	0	0	2	0
06:00-06:15	3	108	98	0	9	0	1
06:15-06:30	7	111	101	0	6	4	4
06:30-06:45	9	77	113	2	0	7	3
06:45-07:00	0	45	104	1	0	3	1
07:00-07:15	9	64	89	0	14	4	0
07:15-07:30	12	82	85	2	7	1	0
07:30-07:45	11	93	99	0	16	0	5
07:45-08:00	7	75	84	0	0	5	0
08:00-08:15	6	48	78	4	5	5	4
08:15-08:30	8	89	68	5	12	0	3
08:30-08:45	7	56	87	3	7	0	7
08:45-09:00	0	84	56	1	9	0	1
09:00-09:15	0	69	81	1	3	2	0
09:15-09:30	0	97	67	3	11	0	0
09:30-09:45	6	58	45	4	7	0	2
09:45-10:00	2	86	91	2	12	0	0
10:00-10:15	5	74	95	7	12	1	0
10:15-10:30	7	113	104	6	6	0	0
10:30-10:45	8	98	112	2	3	3	3
10:45-11:00	12	78	117	1	0	2	1

Appendix B: Questionnaire for Motorist Afaan Oromo Version

Gaaffii Qorannoo konkolaachisaaf

Mata duree: Xiinxala hariiroo dhiibbaa taateewwan daandii bukkee magalaa naqamtee keessaa sochii konkolaataa irratti qaban

Xiyyefannoo Qorannoo:

- **Taateewwan ijoo konkolaachisaaf rakkoo ta'an adda baasuu.**
- **Dhiibbaa taateewwan daandii bukkee irratti hundaa'uun taateewwan tartiibessuu.**
- **Bu'ura shallaggii dhiibbaa jijjiiramoota ykn taateewwan daandii bukkef malu uumuu.**

I. Odeefannoo Waliigalaa

Saala: ***Dhiira*** ☐ ***Dhalaa*** ☐ ***SadarkaaBarnotaa:*** _____

Umurii: ***(15 gadi)*** ☐ ***(15-20)*** ☐ ***(21-30)*** ☐ ***(31-40)*** ☐ ***(41-50)*** ☐ ***(50-ol)*** ☐

Eeyyama konkolaachisummaa: ☐ ***Gosa konkolaataa:*** ☐

II. Ilaalcha konkolaachistootni magaalaa Naqamtee taateewwan daandii bukkee irratti qaban

1. Rakkoon taateewwan (gochaawwan) daandii bukkee irraa konkolaachistoota mudatan ni jiruu?

   EEYYEE ☐ LAKKI ☐

2. Yoo deebiin gaaffii 1ffaa EEYYEE ta'e, sadarkaa rakkoo taateewwan daandii bukkee irraa dhufan akkamiin madaaltu?

   Bay'ee Guddaa ☐ Guddaa ☐ Giddu galeessa ☐ Xiqqoo ☐ Bay'ee Xiqqoo ☐

3. Taateewwan daandii bukkee armaan gadii keessaa kamtu guyya guyyaan isin mudata?

☐ a. Daldaltoota seeraan alaa daandii bukkee

☐ b. Sheediwwan daandii bukkee

☐ c. Konkolaataa daandii irra dhaabuu

☐ d. Lafoo deemtota

☐ e. Gaarii ykn konkolaataa mootora dhabeeyyii daandii irra dhaabuu

☐ f. Meeshaalee ijaarsaa daandii irra kuusuu

☐ g. Maxxansa, beeksisootafii utubawwan garagaraa daandii irra jiran

☐ h. Kan biraa_____

4. Taateewwan armaan olii filattan keessaa kamtu rakkoo ol'aanaa geessisa? Taatee rakkoo guddaa qaqabsiisu irraa gara taatee rakkoo xiqqaa qaqabsiisuutti tartiibessaa.

   I. _____

   II. _____

   III. _____

   IV. _____

   V. _____

   VI. _____

5. Rakkoon taateewwan daandii bukkee irraa konkolaachistoota mudatan maalfaadha?

☐ Jeeqamuu
☐ Aaruu
☐ Sodaachuu
☐ Fuldura konkolaachistootaa haguuguu ykn arguu dhorkuu
☐ Konkolaachisaan sababa gochawwan daandii bukkeef daandii akka jijjiirratu gochuu
☐ (Kan hafe barressaa)_____

6. Sadarkaa dhiibbaan taateewwan daandii bukkee sochii konkolaataa irratti qabu akkamiin madaaltu?

Bay'ee Guddaa ☐ Guddaa ☐ Giddu galeessa ☐ Xiqqoo ☐ Bay'ee Xiqqoo ☐

7. Taateewwan daandii bukkee akkamiin sochii konkolaataa miidhu

☐ Saffisa konkolaataa hir'isuu
☐ Yeroo adeemsaa dabaluu
☐ Balaa konkolaataa fiduu
☐ Daandii dhippisuu ykn bal'ina daandii hir'isuu
☐ Kan biraa_____

8. Ka'umsa(madda) rakkoo taateewwan daandii bukkeef maaltu sababa ta'a jettanii yaaddu

☐ Hir'ina to'annoo
☐ Bakka argama taateewwanii
☐ Haala qubannaa qooda fudhattootaa
☐ Hubannoo dhabuu
☐ Kan biraa_____

9. Dhiibbaa taateewwan daandii bukkee sochii konkolaataa irratti fidan hir'isuuf maaltu fala ta'a?

☐ Bakka gabaa xixiqqaa foyyesuu
☐ Bakka dhaabbii konkolaataa foyyesuu
☐ Sirna to'annoo foyyesuu
☐ Hubannoo taateewwan daandii bukkee fii sochii konkolaataa qooda fudhattootaaf kennuu
☐ Kan biraa_____

GALATOOMAA!!!

Appendix C: Questionnaire for Motorist English Version

Title: **A Correlation Analysis of the Effect of Roadside Activities on the Traffic Flow Characteristics in Nekemte City**

Objectives of the research:

- ✓ To identify the factors relating to major problems incurred by the motorists from the roadside activities
- ✓ To rank the effects of roadside activities on traffic flow characteristics
- ✓ To develop a mathematical model using regression analysis relating the different variables affecting the traffic flow characteristics due to roadside activities

Part I: **General Information**

1. Motorist

Sex: ***Male*** ☐ ***Female*** ☐ ***Education level:*** _____

Age: ***15-20*** ☐ ***21- 30*** ☐ ***31-40*** ☐ ***40-50*** ☐ ***above 50*** ☐

Driving license: ☐ ***Vehicle type:*** ☐

Part II: Motorist's Perceptions toward Roadside Activities in Nekemte City

1. Do you think there is a roadside activity problem incurred by motorists?
   YES ☐ NO ☐
2. If your answer to question number 1 is YES, what do you think the level of roadside activities problems?
   Very High ☐ High ☐ Moderate ☐ Low ☐ Very Low ☐
3. What do you think about the factors of roadside activities problem in the city?

☐ a. Illegal roadside vendor

☐ b. Illegal roadside shedding

☐ c. On-road parking vehicle

☐ d. Pedestrians

☐ e. Parking Carts and non-motorized vehicles

☐ f. Dumping construction material on the road

☐ g. Roadside advertisements and utility poles

☐ h. Others _____

_____

_____

4. Prioritize the above roadside activities depending on their effect

I. _____
II. _____
III. _____
IV. _____
V. _____
VI. _____

5. What do you think about the problem incurred by motorists from roadside activities?

☐ Disturbing
☐ Irritating
☐ Worrying
☐ Block Motorists Sightline
☐ Make motorist to change the roadway from disturbing roadside activities
☐ Other _____

6. What do you think about the level of effect of roadside activities on traffic flow characteristics in the city?

Very High ☐ High ☐ Moderate ☐ Low ☐ Very Low ☐

7. How roadside activities influence traffic flow in the city?

☐ Delay Traffic flows
☐ Increase travel time
☐ Cause traffic Accident
☐ Create Congestions

8. What do you think the cause of roadside activities problem in the city?

☐ Lack of good management
☐ Wrong location of activities
☐ Poor arrangements
☐ Lack of awareness on the influence of roadside activity on traffic flow characteristics
☐ Other_____

_____

_____

9. What do you suggest to minimize the adverse impact of roadside activities on traffic flow in the city?

☐ Improve location of mini-market area (“Gulit”)
☐ Develop appropriate location for utilities
☐ Improve Parking arrangements
☐ Improving Management
☐ Giving awareness on the effect of roadside activities on traffic flow characteristics
Other_____

_____

_____

Thank You for Your Time!

Appendix D: Interviewing Issues

Title: **A Correlation Analysis of the Effect of Roadside Activities on the Traffic Flow Characteristics in Nekemte City**

Objectives of the research:

- ✓ To identify the factors relating to major problems incurred by the motorists from the roadside activities
- ✓ To rank the effects of roadside activities on traffic flow characteristics
- ✓ To develop a mathematical model using regression analysis relating the different variables affecting the traffic flow characteristics due to roadside activities

Date: _____

Interviewer: _____

Interviewee: _____

Interviewed Office: _____

Issues covered in interviewing progress:

a) Is there any roadside activities problem incurred by motorists?

b) Which roadside activities more influencing the motorists?

c) What is the adverse impact of this major problem on traffic flow?

d) What plans does the municipality have to control the encroachment of roadside activities on road reserves in the future?

e) What policy measures has the municipality put in place to control roadside activities on main roads?

f) Which body has been responsible for the implementation of these policies and what powers do they have?

g) What have been the significant challenges in the implementation of these policies?

h) What are the planning regulations that govern development along the road? (plot setbacks, building lines, zoning plans, and plot ratios)

Appendix: E Recorded Speed

Date: August 2019
Name Dabala M. Travel Distance 85m
Location: Board Area Weather: Clear
Speed Limit: 30kph Surface Condition: Deteriorated

Condition	Roadside activities				Time (s)			Speed (KPH)			TMS (KPH)
	1*	2*	3*	4*	Small Car	Bus	Truck	Small Car	Bus	Truck	
1	0	0	0	0	7.80	8.00	10.00	39.23	38.25	30.60	36.03
2	4	1	0	1	8.2	8.92	11.6	37.32	34.30	26.38	32.67
3	14	8	3	2	10.24	15.4	17.2	29.88	19.87	17.79	22.51
4	33	14	7	4	14.53	17.2	19	21.06	17.79	16.11	18.32
5	18	9	5	5	12.6	12	13	24.29	25.50	23.54	24.44
6	13	6	0	2	8.7	11.4	13.8	35.17	26.84	22.17	28.06
7	11	0	3	1	8.08	9.4	12	37.87	32.55	25.50	31.97
8	10	5	2	5	10.16	11.3	14	30.12	27.08	21.86	26.35
9	19	12	6	7	12.63	14.28	15.9	24.23	21.43	19.25	21.63
10	17	9	0	5	8.9	11.32	13.46	34.38	27.03	22.73	28.05
11	21	13	1	2	9.6	12	15.9	31.88	25.50	19.25	25.54
12	15	7	3	3	8.6	11.4	14.7	35.58	26.84	20.82	27.75
13	9	2	2	0	8.42	10	11.8	36.34	30.60	25.93	30.96
14	30	12	2	4	14.34	15.44	17.04	21.34	19.82	17.96	19.71
15	26	15	8	7	14.8	16.5	18	20.68	18.55	17.00	18.74
16	27	13	7	5	14	16.04	17	21.86	19.08	18.00	19.64
17	20	6	4	2	12.4	13.1	19.2	24.68	23.36	15.94	21.32
18	8	2	0	0	8.4	8.9	12	36.43	34.38	25.50	32.10
19	12	1	0	2	9.23	9.08	10.68	33.15	33.70	28.65	31.83
20	5	2	1	0	8.7	9.02	11.56	35.17	33.92	26.47	31.86

NB: 1 Pedestrian, 2* Roadside Vendors, 3* Carts, and 4* Parked Vehicle*

Appendix F: Roadside activities figure












Appendix: G Descriptive Statistics

Descriptive statistics of questioner survey participants

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Sex	305	1	2	1.02	.127
Age	302	2	6	3.47	.826
Driving License	292	3	7	3.77	1.343
Vehicle Type	308	2	3	2.15	.360
Yes No question	309	0	1	.91	.283
Level of Problem	284	1	5	2.43	1.179
Roadside Vendor	283	0	1	.76	.428
Illegal Shedding	283	0	1	.31	.464
On-road Parking	283	0	1	.71	.453
Pedestrians	283	0	1	.90	.304
Parking Carts and non-motorized Vehicle	284	0	1	.67	.471
Dumping Construction Materials	283	0	1	.31	.462
Advertisements and Utilities Pole	283	0	1	.13	.334
Ranking Roadside activities	283	1	5	2.66	1.523
Disturbing	282	0	1	.63	.483
Irritating	283	0	1	.33	.469
Worrying	283	0	1	.43	.496
Block Motorists Sightline	283	0	1	.89	.317
Make motorists to change route	283	0	1	.77	.421
Other	283	0	4	.03	.319
Level of Effects of roadside activities on TFCh.	283	1	5	2.89	1.082
Slowing Speed	283	0	1	.91	.284
Increase Travel Time	283	0	1	.26	.438
Cause Traffic Accident	283	0	1	.66	.474
Narrowing Road Width	283	0	1	.94	.238
Other	283	0	0	.00	.000
Lack of Good Management	283	0	1	.84	.363
Wrong Location of Activities	283	0	1	.40	.491
Poor Arrangements of Activities	283	0	1	.69	.465
Lack of Awareness	283	0	1	.79	.407
Others	282	0	1	.00	.060
Improve Location of mini Market	283	0	1	.92	.268
Improve Parking Locations	283	0	1	.75	.432
Improving Management	283	0	1	.86	.345
Giving Awareness	283	0	1	.95	.224
Other Suggestion	283	0	0	.00	.000