Title	Network Analysis of Transportation in Loilem District, Southern Shan State
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May Thu Naing

Abstract

This research focuses on nine areas in Loilem District and it's environ. The data required for this research were collected from Administrative Department, Construction Department, Land Records Department and Transport Project Department and field observation. The objective of this study is to clarify the transportation network in Loilem District by analyzing the measurement of connectivity and accessibility of transport routes. Transportation routes of Loilem District were classified as airways, railroads and motor roads to apply the methods used by Haggett (1965). This study emphasized on road transport because there are only one airway routes and only one railway line in Loilem District. It is found out that, depending upon the increasing number of motor vehicles and the increase of the use of roads, most of the roads were necessary to upgrade their quality. Transportation network grows rapidly and it will lead to economic development of Loilem District. Consequently, the living standard of the native people will improve better than ever in the future of Loilem District.

Key words: Transportation networks, living standard

Objectives

Main objectives of this research are:-

(1) To analyze the connectivity and accessibility of transportation route in Loilem District

(2) To evaluate the development of transportation network in Loilem District through network analysis

Study Area

Loilem District is situated in the Southern Shan State. It lies between the latitudes of 20° 25' and 22° 50' north and between the longitudes of 97° 8' and 99° 00' east. Loilem District is the biggest District in Shan State. The total area of the Loilem District is about 7,624.87 square miles which include townships of Loilem, Mong Kaing, Nam San, Laikha, Kyay Thee, Mong Shu, Kun Hein and sub-townships of Panglong and Mong Naung. In the north, there are the districts of Lashio and Kyaukme. In the east,there is the Mong Hsat District, Linkyay District is in the Southern Shan State in Myanmar.

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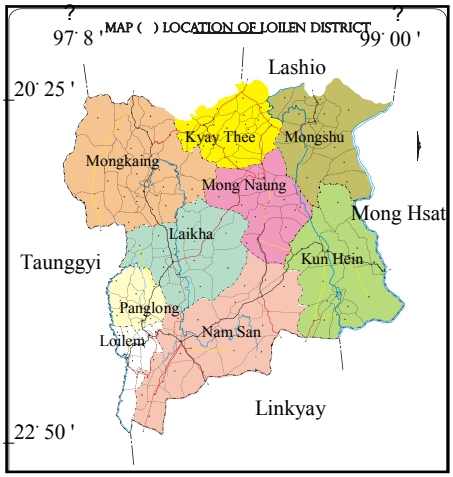

Figure (1) Location of Loilem District in Myanmar
Source: Geography Department of Panglong University, 2009

Materials and Methods

To depict a general picture of road network, secondary data are obtained from Administrative Departments, Construction Departments, Land Records Department and Transport Planning Department. Primary data and information are gathered by field observation. Several field observations were done for the study areas. Data and observations for measurements of connectivity and accessibility in transportation network were carefully made. Transportation routes of Loilem District were analyzed as motor roads to apply the Beta Index, Alpha Index, Gamma Index used by Haggett (1969).

Results and Findings

1. Relationship of Transportation routes and Geographical Bases of Loilem District

Transportation routes are related to the physical factors of the region. Generally, Loilem district is a mountainous region. The mountains are running from north to south. The average elevation is 3,000 feet to 4,000 feet. It is part of the Shan Plateau. Loilem district is the highest point with an elevation of 3,000 feet above sea level. The topographic conditions are undulating features.

The physical features of the Loilem district can be divided into two parts as follows; (a) Mountain region (b) Low lying valleys region(below 3,000 feet).Mountain region can be divided into two parts. In the middle of Loilem district the average elevation is between 3,000 feet to 6,000 feet above sea level. The highest point can be found in the west of Panglong and along the east longitude 97˚ 28′.Another highest part can also be seen in the north latitude 21˚ 4′. In the east, a few mountains have an average height of 3,000 feet. Here, Loilem Mountain is the highest point with an elevation of 6,334 feet above sea level. It is running from north to south.

Loi-Naung Pin Mountain (4,887 feet) lies between east longitude 97˚ 35′ and 97˚ 40′ east. In the north east part of Mong Pwan, Loi-Sai mountain (6,518 feet) and Loi-Souk Kha mountain are found in the north latitude 20˚ 37′ and east longitude 97˚ 28′.The eastern part of the Loilem and Nam San Township is dominated by mountain ranges, especially Loilem mountain (5,605 feet) and Loisan mountain (5,192 feet) are located in between North latitude 21˚ 3′ and east longitude 97˚ 56′.

Low lying valley region occupies 10 percent of the total area of the Loilem district. It can be found in the eastern part of the district. The elevation is moderately high and slopes are gentler than those of the other regions. Along the flow of Nam-tein stream, it is built up narrow from features. The features of rolling topography are mostly found in the township of Nam San, Linkhay and Panglong. It is built up of limestones (plateau limestone) and the top soil is very thin.

The major river of drainage area in Loilem district is the Than Lwin River which flows from north to south in the eastern part of the district with many tributaries such as Nam Pawn and Nam Tein streams. Nam Pawn stream is a major source of water for Kyaithei township, which flows in the western part of Loilem and Nam San township. It acts as a boundary between these townships. The length of Nam Pawn stream is 112 miles long and have always water throughout the year. Nam Tein stream is the longest and largest tributary of Than Lwin river. Tt takes its source at Mong Kaing township and it flows from west to east and its tributary flows into Than Lwin from the west. It is the swift stream with eddies and whirl-pools rendering navigation difficult but it is used for floating timber and irrigation for agriculture. Nam Sein Souti and Nam Yaw streamlets are tributaries of Nam Pawn stream. Nam-lat and Nam Sit are streamlets of Nam Tein stream.

Conditions of topography and climate can change the connectively and accessibility of transportation routes. Although Loilem district is located within the tropical area, it has subtropical climate because of the elevation. According to the Koppen's classification, it has Cwb type (sub-tropical mountain climate). It is widely distributed all over the area. Loilem

district is situated at 3,000 feet above sea level. The annual average temperature is 40°C and the monthly average temperature is 32° C. The coldest months are December and January. The lowest temperature of 10°C was recorded in 2009.Thus, in Loilem district, the outburst and duration of monsoon rainy season as the whole of Myanmar. The rainfall varies according to the natural features. The higher elevation gets more rain thethe lower. The number of average rainy days and the amount of average rainfall are 87 days and 53″ inches respectively. Generally, most of the rain occurs in May and August. Because with the sudden and violent burst of southwest monsoon, the whole of Loilem district receives rainfall in the month of June. According to the records from 1998 to 2009 year, it has an average rainfall of 33 inches.

Vegetation in Loilem district can be found in the three types of hill forest. These are Evergreen forest, Dry hill forest and Pine forest. The soil in Loilem district are mountainous red earth soil, Red brown forest soil, Yellow earth soil, Dark red brown soil and Meadow soil.

The construction of motor car roads is related to geological structure of this region.Geologically, metamorphic rocks of mainly schist's and gneisses are exposed in the north of the Loilem area. These rocks may be equivalent of Mogok series. The plateau limestone group predominantly built up in the east and west of the Loilem area. Structurally, the rock units are trending nearly like Nam San. The Loilem district mainly made up of the lower Paleozoic elastic and carbonate sediments. Among them, this area is dominantly underlain by the limestone and gneisses. This formation is well exposed along motor car roads.

In determining the living standard of population, as factors regarding the usage of routes have been calculated, the distribution of population and the transportation facilities are being analyzed. The population in Loilem district is 393,339 persons and the majority is the "Shan". The number of the "Shan" people living here is 241,084 persons and is 61 per cent of the district. The second most ethnic group is the Bamar and the number of its people is 17,691 persons and is of 4 per cent. 96 per cent of the people living in Loilem district are Buddhist, about 3 per cent are Chistian, 0.5 per cent per cent are Islanm, 0.5 per cent are Hindu.

The main occupation of the people living in Loilem district is agriculture and trading the regional products. For this season, people have concentrated an lowlands where agriculture can be practiced in places where transportation is easy. The streams Nam Pawn,Nam Tein and Nam let past flow the townships such as Loilem, Nam San,Kyay Theeand Mong Kaing. Such places are quite densely populated as these lowlwnds are cultivable and transport is more easier. Loilem district is located on the highway roads that run from Southern Shan State to Northern Shan State and from Eastern Shan State to the central Myanmar. The towns such as Loilem, Panglong, Nam San and some villages that are situated on these main highway roads, are quite densely populated.

In Loilem district, which has a population of 393,339 covers about 7,624.87 square miles. It is found that the density of the population is 52 per square mile and that 77 per cent of the people live in rural acres and 23 per cent live in urban areas.

It is found that various automobile vehicles of the district is 35,784 in Loilem District. 18 per cent of the over 18 year population of the district

have handled 45,447 personal driving licenses in Loilem District. Over 18 year population are 250,504 people which 205,057 persons or 82 per cent need driving licenses. As 32 per cent of driving license is motor cycle license.

2. Structural Analysis of Transportation Networks in Loilem District

Generally, the mode of transportation development in Loilem District can be divided as follows;(1) Land transportation (2) waterway transportation (3)Airway transportation. The main transport in Loilem District can be sub-divided into motor car roads and railroads. The motor car roads were constructed since the British regime. Motor roads radiate from Loilem district to various regions. The most significant truck roads which radiate from Loilem district are (1) Loilem- Kaingtung-Tachilleik road (2) Loilem - Taunggyi –Meiktila (3) Loilem –Panglong-Mong Kaing-Kyay-Thee (4) Loilem –Nam San-Kun Hein(5) Loilem- Pankaytu- Thi Paw (6) Loilem- Nam San- Moe Nei- Mong Pan roads. From these highways which radiate to other regions are formed like a network system.

At present railways lines were extensively built all over Myanmar. Nam San - ShweNaung and Nam San –Moe Nei- Kaingtone railway lines connect Nam-San in Loilem district. There are one up and down trains which run daily. The railway lines help the transportation and communication of the regions . Transportation by waterways along Than Lwin river which rises from the Northern Shan State of Myanmar and after flowing through Southern Shan State. The route of the waterway along the river can be used for the native people by boats in Kun Hein.In Loilem District, within Nam San Township, airport is situated. The air lines from

Nam San have their transits or terminals at Nam San-Yangon- Myitkyina. At present airways is for military use.

2. Nodes and Links of Transportation Routes in Loilem District

According to Graph Theory, these figure (2) represent the terminals and junctions of a network (as nodes or vertices) and the routes or links between them (called edges).The graph as a whole may be either directed (i.e.the existence of a direct link from A to B does not imply a link in the opposite direction) or undirected.

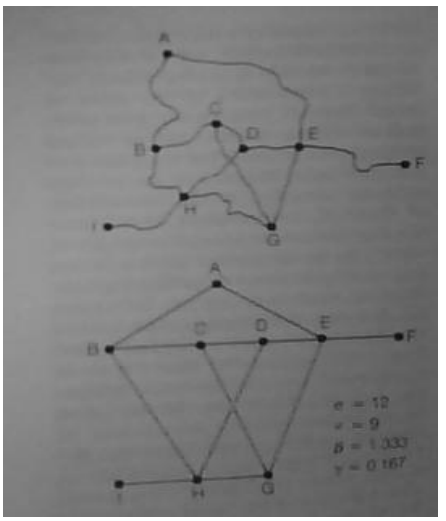

Figure (2)The interpretation of a railway network as a graph

Most road networks yield undirected graphs, but an urban area with one-way streets would be represented by a direct graph (digraph). Most Geographical applications use binary graphs in which only the presence or absence of a link is recorded, but valued graphs are also used.Graph Theory was first emphasized in TRANSPORT GEOGRAPHY by W.L Garrison, D.F. Marble and their associates. In transportation analysis, there are two main criteria: nodes and link. In transportation Geography, nodes may be the origins or destination of flows and they are points at which flows in the network can change their volume, direction of movement and mode of transport. Links are the connection lines of any two modes or more by any mode of transport. In this study, nodes are based on the line motorcar terminals, destination,

major junction and some prominent township. There are many nodes in the regional passenger transportation system of Loilem District.

A graph consists of vertices and edges. Vertices(node) are, in this case, villages and towns. An edge (link) is a direct route connecting two vertices. The number of vertices (v) and number of edges(e) may be used in descriptive measure of the graph. This is a number of sub-graph(p), unconnected graphs. In the diagram there is only one (Figure 2).The shortest path between vertices on a graph is measured by the smallest number of edges, not the length of the edges. They are the cycloramic number (u) which is u = e- v + s and the diameter (d) which is the maximum number of edges in the shortest path between each pair of vertices maximum value (10) in the table of shortest routes between pairs of vertices in Table (2,3).The diameter of graph for 1972 is 2.55 and 2009 is 2.6. It is found that these measures are used in comparison of the two networks, 1972 and 2009 , which shows the increase of the roads in this area figure(2).There are some measures which describe the accessibility of individual vertices within a given network.

The number demonstrates the centrality of a vertex, giving the maximum number of edges from any given vertex by the shortest path to any other vertex in the network(maximum in each column, table 4).Lower values indicate greater centrality. The centrality of vertice is Nam San(V_{22}).The Shimbel index expresses the total number of edges needed to connect any vertex with all other vertices in the network by the shortest path (table 6). Wan Sine(V_{14}), Hsai Mon (V_{15}),Nam San(V_{21}), Mong Shu(V_9), Kho Lan (V_{21}) were the most accessible vertices in 2009 whereas Kho Lan

(V_{21}) was the most accessible in 1972.Lower values again indicate greater accessibility.

Transportation Routes in Loilem district

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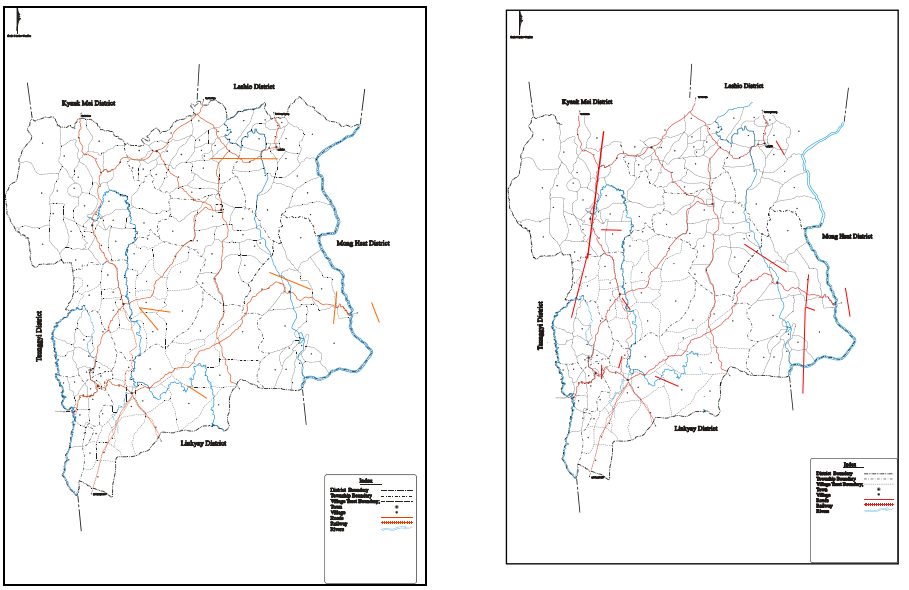

In 197 In 2009

Figure (3) Transportation routes pattern of Loilem District

Source: Land records Department of Loilem District,2009

Table (1) Nodes and Links of Loilem District in 1972 (Before 1988)

Nodes V	Place	Connectivity		Nodes V	Place	Connectivity
1	Loilem	3		14	Kyaing Tung	2
2	Panglong	2		15	Hsai Mon	4
3	Naung Lit	2		16	Nam San	4
4	Laikha	3		17	Lin Kyay	3
5	Mong Kaing	2		18	Wan Hark	3
6	Pan Kay Tu	3		19	Mauk Mae	2
7	Tan Log	2		20	Wan Salaung	3
8	Kyay Thee	3		21	Ho-Mein	1
9	Mong Shu	3		22	Mong Six	1
10	Mong Naung	4		23	Mong Pawn	2
11	Wak Sine	2		24	Nar Log	2
12	Kun Hein	2		25	Mong Pan	2
13	Kho Lan	4		26	Tar San	2

Source: Calculation based on data in 1972

A graph consists of vertices and edges. Vertices(node) are, in this case, villages and towns. An edge (link) is a direct route connecting two vertices. The number of vertices (v) and number of edges(e) may be used in descriptive measure of the graph. This is a number of sub-graph(s) , unconnected graphs. In the diagram there is only one (Figure 2).The shortest path between vertices on a graph is measured by the smallest number of edges, not the length of the edges. They are the cycloramic number (u) which is u = e- v + s and the diameter (d) which is the maximum number of edges in the shortest path between each pair of vertices maximum value (10) in the table of shortest routes between pairs of vertices in Table (4).The diameter of graph for 1972 is 2.55 and 2009 is

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Table (3) Nodes and Links of Loilem District in 2009 (after 1988)

Nodes V	Place	Connectivity		Nodes V	Place	Connectivity
1	Panglong	2		18	Hsai Mon	3
2	Naung Laing	3		19	Kun Hein	3
3	Wan Uaein	1		20	Kar Li	3
4	Laikha	3		21	Tar Kaw	2
5	Mong Kaing	3		22	Kaing Lun	1
6	Kah Pe	1		23	Hsai Khaung	3
7	Pankaytu	3		24	Kaing Khan	1
8	Tun Log	3		25	Kho Lan	3
9	Mong Lan	2		26	Nam San	5
10	Kyay Thee	3		27	Wan Naung	1
11	Naung Car	2		28	Haik Phik	1
12	Mong Naung	4		29	Mong Saik	1
13	Pha Kei	3		30	Loilem	4
14	Mong Shu	2		31	Skin Hospital	1
15	Mong Ouk	2		32	Mong Pawn	3
16	Hi Phak	1		33	Hway Kauk	1
17	Wan Sine	3		Total Connectivity		80

Source: Calculation based on field observation in 2009

Table (5) Calculation for Transportation Networks of Loilem District

Sr	Particulars	1972	2009
1	No. of edges (e)	31	35
2	No. of Vertices (v)	27	34
3	No. of Sub- graphs(s)	1	1
4	Cycloramic number (u)	5	2
5	Diameter	2.55"	2.6"
6	Beta Index(β)	1.15	1.06
7	Alpha Index(α)	0.1	0.03
8	Grammar Index(γ)	0.413	0.364

Source: Calculation based on Figure(1) ,(2) and Field Data

Network Indices (Based on E.T. Taaffee's Transportation Geography)

Any transport network may be considered as a topologic graph with three parameters from which quantitative measurements may be computed as a basic for the objective description. These parameters are (i) the number of separate(non-connecting) sub-graph in the network(G) (ii) the number of links or edges in the network (E) and (iii) the number of nodes or vertices in the network(V). In transportation network of Loilem district, there were 27 nodes and 31 links in 1972 and there were 35 nodes and 34 links in 2009. The evolution of links and nodes are shown step by step in figures No (3) and (4). These maps illustrate the development of transportation lines in orderly steps. Such evolutionary can be referred to by transportation Indies by the respective three indices: (a) the Beta Index (b) the Alpha Index (c) the Gamma Index.

(a)The **Beta Index** is introduced by Haggett 1965. The Beta index is a simple **measure of connectivity** terms of the average number of links per node within the network.

The formula is

$$\text{Beta Index}(\beta) = \frac{g = \Sigma\, {}^{n}{}_{1}\, E}{g = \Sigma\, {}^{n}{}_{1}\, V}$$

where g= number of sub-graphs, E= edges or links, v= Vertices or nodes Therefore, (1.15) in 1972,and (1.06) in 2009.According to Haggett values, this index ranges from zero to three. Higher value of the Beta Index result from increasingly complex and connected networks. The range of these values are as follows: from 0 to 1…low, from 1 to 2 …Moderate, from 2 to 3 high. The different situation of transportation of Loilem district can be analyzed by divided period such as in 1972 and 2009. According to values set by Peter Haggett, the Beta Index value in 1972 was (1.15) and (1.03) in 2009. The values are from 1 to 2, it means the network of Loilem district's transportation is moderately complex and connected.

(b) The Alpha Index is a measure of circuitry. A minimally connected network is one in which there are no isolated nodes and the number of connecting linkages is one less than the number of nodes. If one link is removed, the network is divided into two completely separate parts. On the other hand, if one or more linkages is added to the network, the connectivity is increased beyond the minimal configuration. Additional linkages in a network create circuitry. A circuit is defined as a finite, closed path in which the initial node of the linkage sequence coincides with the terminal node. In practical terms, the existence of circuitry means the establishment of additional or alternative path between nodes in the network. The number of alternative paths is determined by the number of linkages added to a minimally connected network. The maximum number of independent circuits in a network is also a function of the number of

nodes in the network and the number of linkages necessary for minimal connection between nodes.

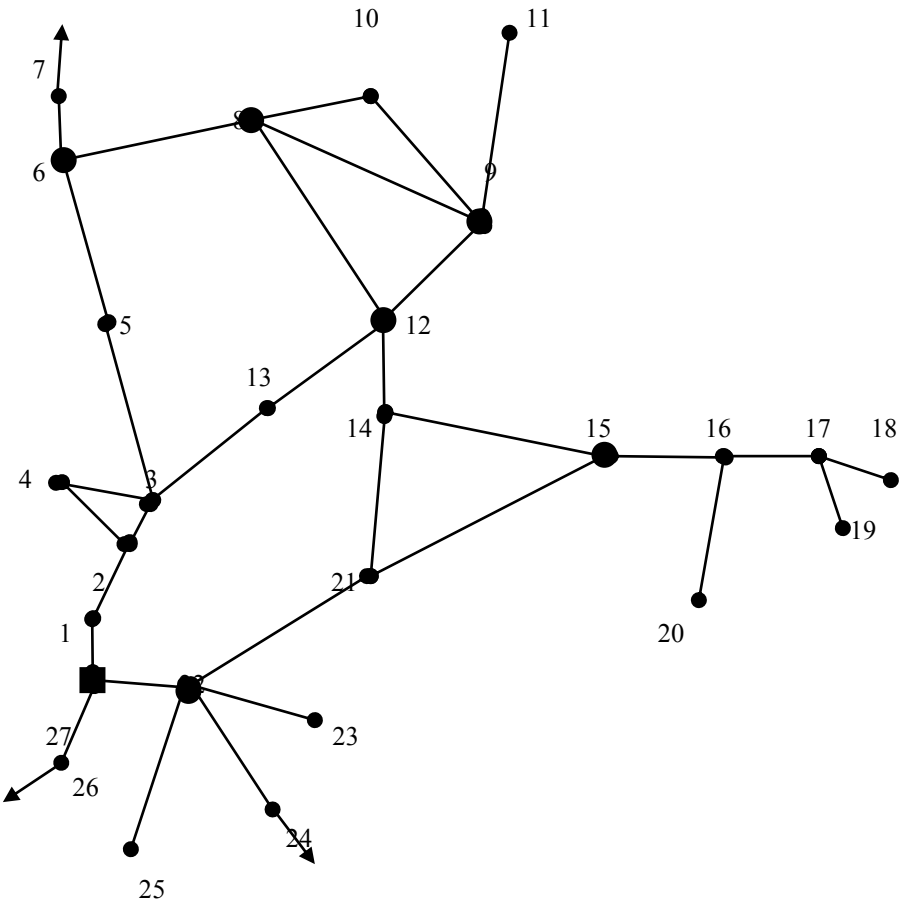

Figure (3) Transportation Networks of Loilem District in 1972

The connection can be computed by the following formula:

$$\text{Alpha Index}(\alpha) = \frac{\text{Actual circuits}}{\text{Maximum circuits}}$$

$$= \frac{e - v + 1}{2V - 5}$$

e = edges or links, v= Vertices or nodes

Therefore, (0.10) in 1972 and (0.03) in 2009.The range of index is from a value of 0 (zero) for a minimally connected network to a value of 1(one) for a maximally connected one. For convenience, the numerical value may be expressed as a percentage of circuitry in a network. Therefore, the value of 10 per cent and 3 per cent means the Loilem District's network circuitry is moderately connected.

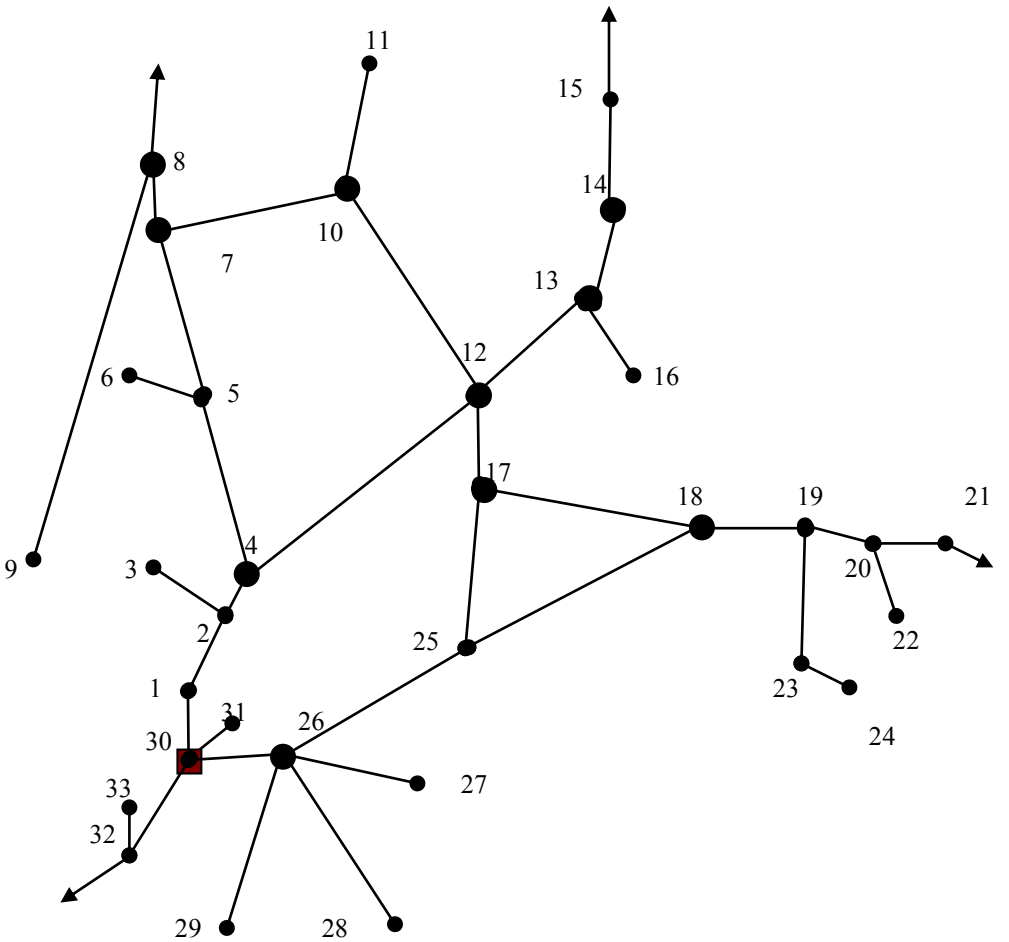

Figure (4) Development of Transportation Networks of Loilem District in 2009

(c) The **Gamma Index** is simply the ratio of the number of edges in a network to the maximum number possible in that network:

$$\text{Gamma Index}(\gamma) = \frac{\text{actual edges}}{\text{maximum edges}}$$

$$= \frac{e}{e\,(\text{mix})} \quad \text{or} \quad = \frac{e}{3(v-2)}$$

e = edges or links, v= Vertices or nodes

Therefore,(0.413) in 1972and (0.364) in 2009. Network connectivity as measurement by the gamma index is expressed in terms of a graph-theoretic range that varies from a set of nodes having no interconnections at one extreme to asset, of node in which every node has an edge connecting to a every other node in the graph. The numerical range for the gamma index is between 0 and 1 . For convenience in interpretation, the numerical value may be expressed as a percentage of connectivity. Therefore, the connectivity of Loilem District's transportation network is 41.33% and 36.45% or the connectivity of nodes within this network. But Beta Index shows that it is just between 0 and 1, indicating that the linkages had been developed at a moderate level.

At present, somewhere the types of roads are developing from tarred, gravelled, sub- gravelled and earth roads. The roads are getting better step by step. If the connectivity values are to be generally classified into good, fair and poor level, Nam San has the highest value of connectivity and accessibility for transportation roads. Thus, in marginal areas, especially Tar Kaw have poor level of connectivity with the least value. The most primitive measurement of accessibility is obtained directly from the connectivity matrix. The sum of each row equals the total number of direct linkages from a given centre in the network and is defined as the degree of a

node. The higher value of an individual node, the greater is its accessibility to all other centres. Therefore, V_{26}(Nam San) has the greatest degree of accessibility and V_{30},V_{12} (Loilem and Mong Naung) have the second greatest degree of accessibility in Loilem District's network.

Connectivity

In Loilem District's transportation Network structure, the greatest connectivity node is node (Nam San),which has the connectivity value of 5. The least connectivity node is Tar Kaw. It is shown in Table (5). Moreover, systematic classification of these connectivity value can be made by some statistical methods(frequency distribution first and cumulative frequency curve). Therefore, the class interval of connectivity values can be as follows.

$$\text{Class interval} = \frac{R \quad \text{or} \quad (H-L)}{1+ 3.322 + \log N}$$

R= H-L (H= Highest value, L= lowest value), N= Number of Nodes

= 0.6933 = 1(Nearest) (in1972)

= 0.6848 = 1(Nearest) (in 2009)

Table (6) Calculation for a Cumulative Frequency Curve of Loilem District's Connectivity in 1972 and 2009

Class-Limits	Number	Number	Cumulative Number(m)		m-0.5/nx100	
	1972	2009	1972	2009	1972	2009
1 - 1.99	9	14	9	14	33 %	42%
2 - 2.99	6	5	15	19	56 %	58%
3 - 3.99	8	11	23	30	85 %	90%
4 - 4.99	3	2	26	32	96 %	97%
5 - 5.99	1	1	27	33	100%	100%
Total	27	33				

Source: Calculation based on field Observation, 2009.

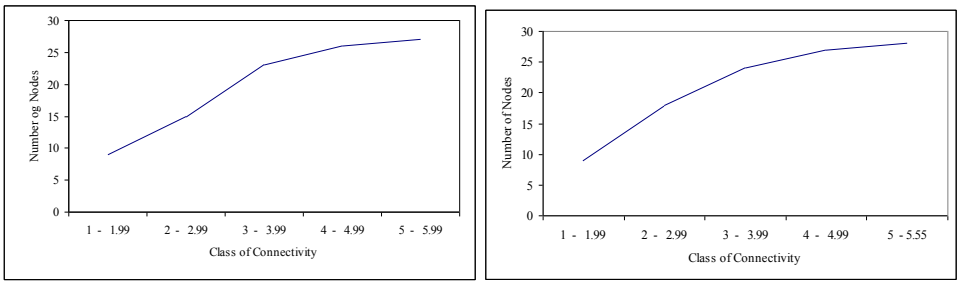

Figure (5) Frequency Curve For connectivity of Loilem District in 1972 and in 2009

Source: Calculation based on field observation in 2009

According to the frequency table in 1972, 27 nodes are included in the low connectivity classes. So it is found that 56 per cent of the nodes in the network structure of Loilem District is less connectivity. The frequency distribution curve is not symmetrical. It has a positively skewness which means that the lesser connectivity nodes have high frequency. Therefore, the connectivity of the nodes in Loilem District is moderate.

In 2009, 33 nodes are included in the low connectivity classes. So it is found that 58 per cent of the nodes in the network structure is less connectivity. The frequency distribution curve is not symmetrical. It has a positively skewness which means that the less connectivity nodes have high frequency. Therefore, the connectivity of the nodes in Loilem District is moderated

Accessibility Matrix

In Loilem District transportation network, the greatest accessibility node is Node (V_{26}) Nam San which has the accessibility value of 18,242,700 persons per year. The last accessibility node is Node (22)Kaing Lun (near Mong Hsat)which has accessibility value of 1. This table

shows a hierarchy of accessibility of Loilem District. Those nodes of (10001 -1000000000) accessibility value are V_1,V_2… According to the Cumulative frequency table, 27 nodes are included in the low accessibility classes. So it can be said that 51.85 % of the nodes in the network of Loilem District is less accessible. The frequency distribution curve is not symmetrical. It has a negatively skewness which means that the lesser accessible nodes have high frequencies.

Table (7) Cumulative Frequency Curve of Loilem District's Accessibility (Persons per year) in 2009

Class-Limits (persons)	Number		Cumulative		m-0.5/nx100	
	1972	2009	1972	2009	1972	2009
10001 - 100000	9	14	9	14	31.48%	42
100001 -1000000	6	5	15	19	51	58
1000001 -10000000	8	11	23	30	85 %	90
10000001 -100000000	3	2	27	32	83.33%	97
100000001 -1000000000	1	1	27	33	94.44%	100
Total	27	33		33	100%	100

Source: Calculation based on field Observation, 2009.

Therefore, the accessibility of the nodes in Loilem District's transportation network is moderated. According to Haggett values, this range from zero to three. The range of values are as follows: From 0 to 1 (Low), from (1 to 2 (Moderate), from 2 to 3 (High). Higher values of the Beta Index result from increasingly complex and connected networks, the railways transportation network value is (β) 0.67,the waterways transportation network is (β) o.5, and airways transportation network

(β)0.5, these value range from 0 and 1. Therefore, the network of Loilem District's railways, waterways and airways transportation are low complex and connected networks.

In observing the accessibility of transportation routes in Loilem District in 1972, there are 34 per cent tarred routes of this District's routes; 10 per cent graveled routes of this District's routes ; 56 per cent sub-graveled and earth routes of this District's routes .In 2009, there are 45 per cent tarred routes of this District's routes; 11 per cent graveled routes of this District's routes ; 44 per cent sub-graveled and earth routes of this District's routes in 2009. During the rainy season when the routes become destroyed, running water broke the bridges.

In Loilem District which has the roads of 644 miles in length which are 119 bridges. Thus the ratio of the routes miles to the amount of the bridges is (1: 5). That means on 5 miles of road, there is 1 bridge in 1972. In 2009, this District which has the roads length of 670 miles which are 294 bridges. Thus the ratio of the road miles to the amount of the bridges is (1: 2). That means on 2 miles of road , there is 1 bridge . 23 per cent bridges of this District are situated most important in Kun Heain Township.

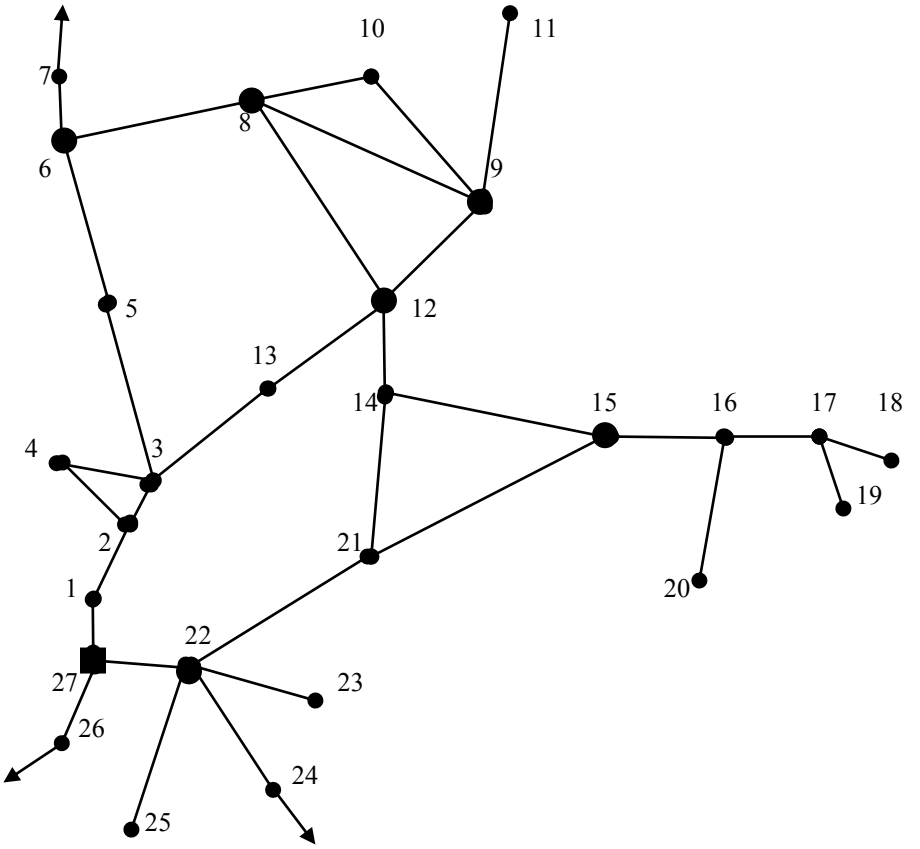

Figure (4) Transportation Network of Loilem District in 1972

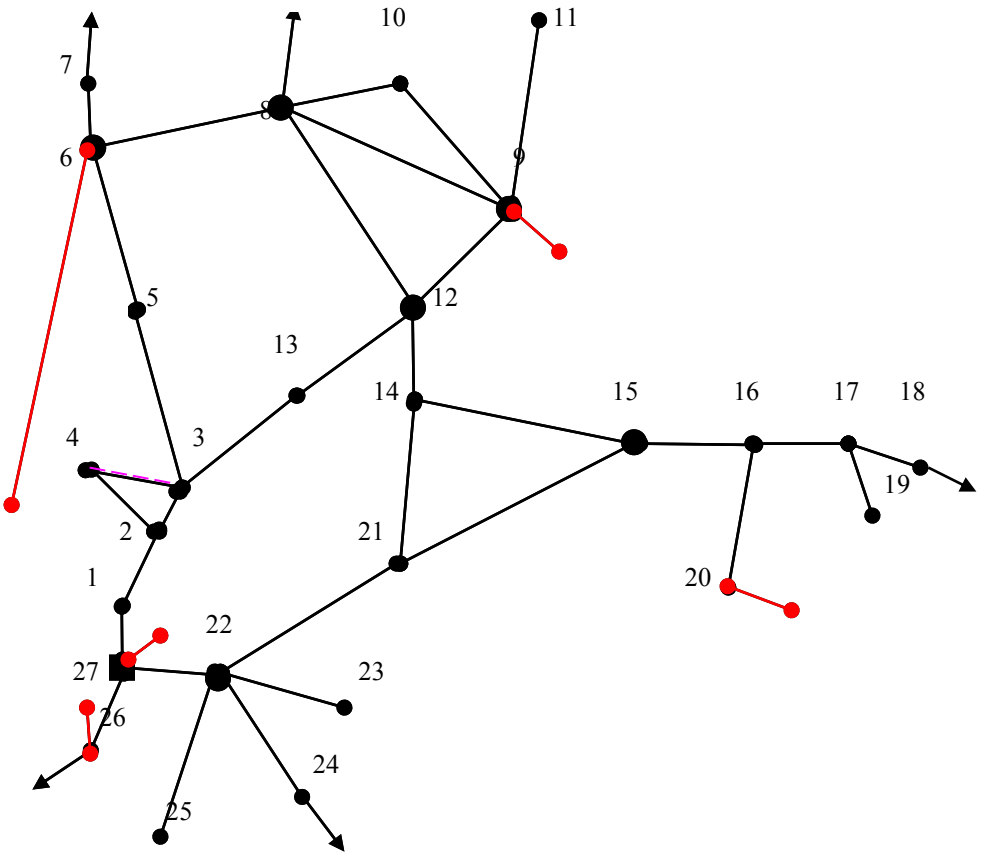

Figure (5) Development of Transportation Network of Loilem District in 2009

Table (2) Nodes and Links of Loilem District in 1972 (Before 1988)

Place	Nodes V	Connectivity		Place	Nodes V	Connectivity
Panglong	1	2		Hsai Mon	15	3
Naung Ling	2	3		Kun Hein	16	3
Laikha	3	4		Kar Li	17	3
Wan Yaein	4	2		Tar Kaw	18	2
Mong Kaing	5	2		Kaing Laine	19	1
Pankaytu	6	4		Hsai Khaung	20	1
Tan Log	7	2		Kho Lan	21	3
Kyay Thee	8	4		Nam San	22	5
Mong Shu	9	4		Wan Naung	23	1
Wak Hat	10	2		Haik Phak	24	2
Wak Sine	11	2		Mong Saik	25	1
Mong Naung	12	4		Mong Pun	26	2
Wak Hai	13	2		Loilem	27	3
Wak Sain	14	3				

Source:Calculation based on data,Geography Department of Panglong University in 1972

Table (3) Nodes and Links of Loilem District in 2009 (after 1988)

Place	Nodes V	Connectivity		Place	Nodes V	Connectivity
Panglong	1	2		Tar Kaw	18	2
Naung Ling	2	3		Kaing Laine	19	1
Laikha	3	3		Hsai Khaung	20	2
Wan Yaein	4	1		Kho Lan	21	3
Mong Kaing	5	3		Nam San	22	5
Pankaytu	6	4		Wan Naung	23	1
Tan Log	7	2		Haik Phak	24	1
Kyay Thee	8	5		Mong Saik	25	1
Mong Shu	9	3		Mong Pun	26	3
Wak Hat	10	1		Loilem	27	4
Wak Sine	11	2		Hway Kauk	28	1
Mong Naung	12	4		Skin Hospital	29	1
Wak Hai	13	2		Kaing Khan	30	1
Wak Sain	14	3		Hi Phak	31	1
Hsai Mon	15	3		Mong Ouk	32	2
Kun Hein	16	3		Hsan Da	33	2
Kar Li	17	3				

Source: Calculation based on field observation in 2009

Table(4)Calculation for Transportation Networks of Loilem District

Sr	Particulars	1972	2009
1	No. of edges (e)	31	34
2	No. of Vertices (v)	27	33
3	No. of Sub- graphs(p)	1	1
4	Cycloramic number (u)	5	2
5	Diameter	2.55"	2.6"
6	Beta Index(β)	1.15	1.03
7	Alpha Index(α)	0.1	0.03
8	Grammar Index(γ)	0.413	0.365

Source: Calculation based on Figure(1) ,(2) and Field Data

Network Indices (Based on E.T. Taaffee's Transportation Geography)

Any transport network may be considered as a topologic graph with three parameters from which quantitative measurements may be computed as a basic for the objective description. These parameters are (i) the number of separate(non-connecting) sub-graph in the network(G) (ii) the number of links or edges in the network (E) and (iii) the number of nodes or vertices in the network(V). In transportation network of Loilem district, there were 27 nodes and 31 links in 1972 and there were 34 nodes and 33 links in 2009. The evolution of links and nodes are shown step by step in figures No (3) and (4). These maps illustrate the development of transportation lines in orderly steps. Such evolutionary can be referred to by transportation Indies by the respective three indices: (a) the Beta Index (b) the Alpha Index (c) the Gamma Index.

(a)The **Beta Index** is introduced by Haggett 1965. The Beta index is a simple **measure of connectivity** terms of the average number of links per node within the network. The formula is

$$\text{Beta Index}(\beta) = \frac{g = \Sigma\, {}^{n}{}_{1}\, E}{g = \Sigma\, {}^{n}{}_{1}\, V}$$

where g= number of sub-graphs, E= edges or links, v= Vertices or nodes

Therefore, (1.15) in 1972,and (1.03) in 2009.According to Haggett values, this index ranges from zero to three. Higher value of the Beta Index result from increasingly complex and connected networks. The range of these values are as follows: from 0 to 1…low, from 1 to 2 …Moderate, from 2 to 3 high. The different situation of transportation of Loilem district

can be analyzed by divided period such as in 1972 and 2009. According to values set by Peter Haggett, the Beta Index value in 1972 was (1.15) and (1.03) in 2009. The values are from 1 to 2, it means the network of Loilem district's transportation is moderately complex and connected.

(b) The Alpha Index is a measure of circuitry. A minimally connected network is one in which there are no isolated nodes and the number of connecting linkages is one less than the number of nodes. If one link is removed, the network is divided into two completely separate parts. On the other hand, if one or more linkages is added to the network, the connectivity is increased beyond the minimal configuration. Additional linkages in a network create circuitry. A circuit is defined as a finite, closed path in which the initial node of the linkage sequence coincides with the terminal node. In practical terms, the existence of circuitry means the establishment of additional or alternative path between nodes in the network. The number of alternative paths is determined by the number of linkages added to a minimally connected network. The maximum number of independent circuits in a network is also a function of the number of nodes in the network and the number of linkages necessary for minimal connection between nodes.

The connection can be computed by the following formula:

$$\text{Alpha Index}(\alpha) = \frac{\text{Actual circuits}}{\text{Maximum circuits}}$$

$$= \frac{e - v + 1}{2V - 5}$$

e = edges or links, v= Vertices or nodes

Therefore, (0.10) in 1972 and (0.03) in 2009.The range of index is from a value of 0 (zero) for a minimally connected network to a value of 1(one) for a maximally connected one. For convenience, the numerical value may be expressed as a percentage of circuitry in a network. Therefore, the value of 10 per cent and 3 per cent means the Loilem District's network circuitry is moderately connected.

(c) The **Gamma Index** is simply the ratio of the number of edges in a network to the maximum number possible in that network.:

$$\text{Gamma Index}(\gamma) = \frac{\text{actual edges}}{\text{maximum edges}} = \frac{e}{e\,(\text{mix})} \quad \text{or} \quad = \frac{e}{3(v-2)}$$

e = edges or links, v= Vertices or nodes

Therefore,(0.413) in 1972 and (0.365) in 2009.Network connectivity as measurement by the gamma index is expressed in terms of a graph-theoretic range that varies from a set of nodes having no interconnections at one extreme to asset, of node in which every node has an edge connecting to a every other node in the graph. The numerical range for the gamma index is between 0 and 1 . For convenience in interpretation, the numerical value may be expressed as a percentage of connectivity. Therefore, the connectivity of Loilem District's transportation network is 41.33% and 36.45% or the connectivity of nodes within this network. But Beta Index shows that it is just between 0 and 1, indicating that the linkages had been developed at a moderate level.

At present, somewhere the types of roads are developing from tarred, gravelled, sub- gravelled and earth roads. The roads are getting better step by step. If the connectivity values are to be generally classified into good, fair and poor level, Nam San has the highest value of connectivity and accessibility for transportation roads. Thus, in marginal areas, especially Tar Kaw have poor level of connectivity with the least value. The most primitive measurement of accessibility is obtained directly from the connectivity matrix. The sum of each row equals the total number of direct linkages from a given centre in the network and is defined as the degree of a node. The higher value of an individual node, the greater is its accessibility to all other centres. Therefore, V_{22}(Nam San) has the greatest degree of accessibility and V_{27},V_{12} (Loilem and Mong Naung) have the second greatest degree of accessibility in Loilem District's network.

Connectivity

In Loilem District's transportation Network structure, the greatest connectivity node is node (Nam San),which has the connectivity value of 5. The least connectivity node is Kaing Lun . It is shown in Table (5). Moreover, systematic classification of these connectivity value can be made by some statistical methods(frequency distribution first and cumulative frequency curve).

Therefore, the class interval of connectivity values can be as follows.

$$\text{Class interval} = \frac{R \text{ or } (H-L)}{1+ 3.322 + \log N}$$

R= H-L (H= Highest value, L= lowest value), N= Number of Nodes

= 0.6933 = 1(Nearest) (in1972)

= 0.6848 = 1(Nearest) (in 2009)

Table (5) Calculation for a Cumulative Frequency Curve of Loilem District's Connectivity in 1972 and 2009

Class-Limits	Number	Number	Cumulative Number(m)		m-0.5/nx100	
	1972	2009	1972	2009	1972 %	2009 %
1 - 1.99	9	14	9	14	33	42
2 - 2.99	6	5	15	19	56	58
3 - 3.99	8	11	23	30	85	90
4 - 4.99	3	2	26	32	96	97
5 - 5.99	1	1	27	33	100	100
Total	27	33				

Source: Calculation based on field Observation, 2009.

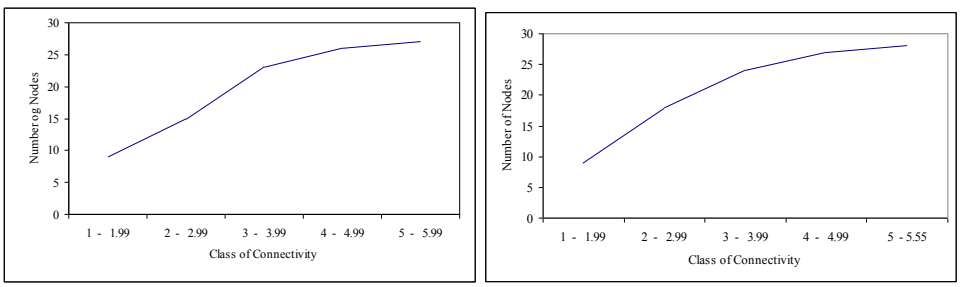

Figure (6) Frequency Curve For connectivity of Loilem District in 1972 and in 2009

Source: Calculation based on field observation in 2009

According to the frequency table in 1972, 27 nodes are included in the low connectivity classes. So it is found that 56 per cent of the nodes in the network structure of Loilem District is less connectivity. The frequency distribution curve is not symmetrical. It has a positively skewness which means that the lesser connectivity nodes have high frequency. Therefore, the connectivity of the nodes in Loilem District is moderate.

In 2009, 33 nodes are included in the low connectivity classes. So it is found that 58 per cent of the nodes in the network structure is less connectivity. The frequency distribution curve is not symmetrical. It has a positively skewness which means that the less connectivity nodes have high frequency. Therefore, the connectivity of the nodes in Loilem District is moderate.

Accessibility Matrix

In Loilem District transportation network, the greatest accessibility node is Node (V_{22}) Nam San which has the accessibility value of 18,242,700 persons per year. The last accessibility nodes are Node (18,19) Tar Kaw, Kaing Lun (near Mong Hsat)which has accessibility value of 1. This table shows a hierarchy of accessibility of Loilem District. Those nodes of (10001 -1000000000) accessibility value are V_1,V_2… According to the Cumulative frequency table, 27 nodes are included in the low accessibility classes. So it can be said that 51.85 % of the nodes in the network of Loilem District is less accessible. The frequency distribution curve is not symmetrical. It has a negatively skewness which means that the lesser accessible nodes have high frequencies.

Table (6.A) Shortest routes between pairs of vertices by number of edges

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Total
1	-	1	2	2	3	4	5	5	7	6	8	4	2	4	5	6	7	8	8	6	3	2	2	2	2	1	3	2	2	6	7	7	4	136
2	2	-	1	2	2	5	4	4	5	4	5	2	2	4	5	6	7	8	8	7	4	3	4	4	4	2	1	2	2	6	6	5	5	129
3	3	1	-	1	2	3	3	4	4	5	5	3	1	3	4	5	6	7	7	7	5	4	5	5	5	4	2	4	3	7	5	6	5	131
4	2	1	2	-	2	4	5	5	4	5	5	4	3	5	6	7	8	9	9	8	6	4	5	5	5	4	3	5	4	8	6	7	6	160
5	3	2	1	3	-	1	2	3	4	5	5	3	2	4	5	6	7	8	8	5	5	5	6	6	6	4	6	5	6	7	5	6	3	144
6	4	3	2	3	1	-	1	1	3	4	4	2	3	3	4	5	6	7	8	8	4	6	7	7	7	6	5	7	6	9	4	5	2	143
7	5	4	3	4	2	1	-	2	4	5	5	3	4	4	4	5	6	7	7	7	4	7	8	8	8	7	6	8	7	8	5	6	1	160
8	5	4	3	5	2	1	2	-	2	1	3	1	2	2	3	4	5	6	6	5	3	4	5	5	5	7	6	8	7	6	3	4	3	123
9	5	4	3	4	4	3	4	2	-	1	1	2	2	2	3	4	5	6	6	5	3	4	5	5	5	7	5	7	6	6	1	2	5	122
10	6	5	4	6	3	2	3	1	1	-	2	2	3	3	4	5	6	7	7	6	4	5	6	6	6	7	6	8	6	7	2	3	4	140
11	5	4	4	6	5	4	5	3	1	2	-	2	3	3	4	5	6	7	7	6	4	5	6	6	6	7	6	9	7	7	1	1	6	148
12	4	3	2	4	3	4	5	1	1	2	1	-	1	1	2	3	4	5	5	4	2	3	4	4	4	46	4	6	5	5	2	2	4	142
13	3	2	1	3	2	3	4	2	2	3	3	1	-	2	3	4	5	6	6	5	3	4	5	5	5	4	4	6	5	6	3	5	5	117
14	5	4	3	5	4	5	3	2	2	3	3	1	2	-	1	2	3	4	4	3	1	2	3	3	3	4	3	5	4	4	3	4	4	97
15	4	5	4	6	5	6	7	3	3	4	4	2	3	1	-	1	2	3	4	4	1	2	3	3	3	4	3	5	4	3	4	5	8	115
16	5	6	5	6	6	7	8	4	4	5	5	3	4	2	1	-	1	2	2	2	2	3	4	4	4	5	4	6	5	3	5	6	9	133
17	6	7	7	8	7	8	9	5	5	6	6	4	5	3	2	2	-	1	1	2	3	4	5	5	5	6	5	7	5	3	6	7	10	159
18	7	8	9	9	8	7	8	6	6	7	7	5	6	4	3	2	1	-	2	3	4	5	6	6	6	7	6	7	6	4	7	8	9	182
19	7	8	9	9	8	7	8	6	6	7	7	5	6	4	3	2	1	2	-	3	4	5	6	6	6	7	6	7	6	4	7	8	9	182
20	3	4	5	5	6	8	7	5	5	6	6	4	5	3	2	1	2	3	3	-	3	4	5	5	5	6	5	7	6	1	6	7	10	150

Source: Calculation based on Field Observation,2009

Table (6.B) Shortest routes between pairs of vertices by number of edges

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Total
21	3	4	5	5	5	4	5	3	3	4	4	2	3	1	1	2	3	4	4	3	-	1	2	2	2	3	2	4	2	4	4	5	6	102
22	2	3	4	4	5	6	7	7	5	6	6	3	4	2	2	3	4	5	5	4	1	-	1	1	1	2	1	2	2	5	5	6	8	120
23	3	4	5	5	6	6	7	5	4	6	6	4	5	3	3	4	5	6	6	5	2	1	-	1	1	2	1	3	2	5	5	7	8	133
24	3	4	5	5	6	6	7	5	4	6	6	4	5	3	3	4	5	6	6	5	2	1	2	-	2	3	2	4	3	6	5	7	8	140
25	3	4	5	5	6	6	7	5	4	6	6	4	5	3	3	4	5	6	6	5	2	1	2	2	-	3	2	4	2	6	5	7	8	139
26	2	3	4	4	5	6	7	7	7	8	8	6	5	4	4	5	6	7	7	6	3	2	3	3	3	-	1	2	2	7	8	9	8	160
27	1	2	3	3	4	5	6	6	6	7	7	5	4	3	3	4	5	6	6	5	2	1	2	2	2	1	-	2	1	6	7	8	7	131
28	3	4	5	5	6	7	8	7	7	8	8	6	5	4	4	5	6	7	7	6	4	3	4	4	4	1	2	-	3	7	8	9	9	173
29	2	3	4	4	5	6	7	7	7	8	8	6	5	5	4	5	6	7	8	6	3	2	3	3	3	2	1	3	-	7	8	9	8	163
30	4	5	6	6	7	7	8	6	5	7	7	5	6	4	3	2	3	4	4	1	4	5	6	6	6	7	6	7	7	-	7	8	9	174
31	6	5	4	5	5	6	7	3	1	2	2	2	3	3	4	5	6	7	8	6	4	5	6	6	6	7	7	8	7	7	-	3	6	156
32	7	6	5	5	6	5	6	5	2	3	1	2	3	3	5	6	7	8	8	7	5	6	7	7	7	8	7	9	8	8	3	-	7	175
33	6	5	4	5	3	2	3	5	6	6	4	5	5	5	6	7	8	8	9	8	6	8	9	9	9	8	7	9	9	7	7	5	-	197

Source: Calculation based on Field Observation,2009

Table (7) Cumulative Frequency Curve of Loilem District's Accessibility (Persons per year) in 2009

Class-Limits (persons)	Number		Cumulative		m-0.5/nx100	
	1972	2009	1972	2009	1972 %	2009 %
10001 - 100000	9	14	9	14	31	42
100001 -1000000	6	5	15	19	51	58
1000001 -10000000	8	11	23	30	85	90
10000001 -100000000	3	2	27	32	83	97
100000001 -1000000000	1	1	27	33	94	100
Total	27	33		33	100	100

Source: Calculation based on Field Observation, 2009.

Therefore, the accessibility of the nodes in Loilem District's transportation network is moderated. According to Haggett values, this range from zero to three. The range of values are as follows: From 0 to 1 (Low), from (1 to 2 (Moderate), from 2 to 3 (High). Higher values of the Beta Index result from increasingly complex and connected networks, the railways transportation network value is (β) 0.67,the waterways transportation network is (β) o.5, and airways transportation network (β)0.5, these value range from 0 and 1. Therefore, the network of Loilem District's railways, waterways and airways transportation are low complex and connected networks.

In observing the accessibility of transportation routes in Loilem District in 1972, there are 34 per cent tarred routes of this District's routes; 10 per cent graveled routes of this District's routes ; 56 per cent sub-graveled and earth routes of this District's routes .In 2009, there are 45 per cent tarred routes of this District's routes; 11 per cent graveled routes of this District's routes ; 44 per cent sub-graveled and earth routes of this District's routes in 2009. During the rainy season when the routes become destroyed, running water broke the bridges.

In Loilem District which has the roads of 644 miles in length which are 119 bridges. Thus the ratio of the routes miles to the amount of the bridges is (1: 5). That means on 5 miles of road, there is 1 bridge in 1972. In 2009, this District which has the roads length of 670 miles which are 294 bridges. Thus the ratio of the road miles to the amount of the bridges is (1: 2). That means on 2 miles of road , there is 1 bridge . 23 per cent bridges of this District are situated most important in Kun Heain Township.

Discussions and Conclusion

Transportation routes are related to the physical factors of the region. Generally, Loilem district is a mountainous region. The mountains are running from north to south. The average elevation is 3,000 feet to 4,000 feet. It is part of the Shan Plateau. Loilem district is the highest point with an elevation of 3,000 feet above sea level. The topographic conditions are undulating features.

The population density of Loilem District was high within one square mile because it is the trade and communication centre of Southern Shan State. There are spatial structures of transportation networks such as regional transportation of Loilem with its interconnected distant towns and villages. So, transportation networks analysis in Loilem District, there are two main criteria. Nodes may be origins or destinations of flows and they are points. Links are the connection lines of any two nodes or more by any mode of transport. There are many nodes in regional passengers transportation system of Loilem District from 1972 to the present time.

According to the Peter Haggett's Index range ,higher value of the Beta Index result from increasingly complex and connected networks. The different situation of transportation networks of Loilem District can be analyzed by dividing two periods, 1972 and the present day 2009.

The Beta Index values of 1.15 and 1.06 means the transportation networks of Loilem District is moderately complex and connected. The Alpha Index values of 10% and 3% means Loilem District's transportation network circuitry is moderately connected. The Gamma Index values may be expressed as a percentage of connectivity. Thus, the connectivity of Loilem District's transportation network is 41.3% and 36.4 % or the connectivity of nodes within these networks.

It is found that the transportation network is increasing with a steadily increasing rate from the period of before independence up to the present time. The Beta Index value of (1) means, land transportation network of Loilem District is moderately complex and connected. But waterways transportation is not applied because Than Lwin river is strongly flowing. Thus, railways and airways transportation networks of Loilem District are less complex and poorly connected.

The most primitive measurement of accessibility is obtained directly from the connectivity matrix. The higher the value of an individual node, the greater is its accessibility to all other centre. Therefore, Nam San have the greatest degree of accessibility (18,242,700) in Loilem District's transportation network structure. In outer area, especially Kaing

Lun(V_{19}) has poor level of connectivity and accessibility with the least value of Loilem District's transportation network structure.

The construction of motor car roads is related to geological structure of this region.Geologically, metamorphic rocks of mainly schist's and gneisses are exposed in the north of the Loilem area. These rocks may be equivalent of Mogok series. The plateau limestone group predominantly built up in the east and west of the Loilem area. Structurally, the rock units are trending nearly like Nam San. The Loilem district mainly made up of the lower Paleozoic elastic and carbonate sediments. Among them, this area is dominantly underlain by the limestone and gneisses. This formation is well exposed along motor car roads.

In determining the living standard of population, as factors regarding the usage of routes have been calculated, the distribution of population and the transportation facilities are being analyzed. The population in Loilem district is 393,339 persons and the majority is the "Shan". The number of the "Shan" people living here is 241,084 persons and is 61 per cent of the district. The second most ethnic group is the Bamar and the number of its people is 17,691 persons and is of 4 per cent. 96 per cent of the people living in Loilem district are Buddhist, about 3 per cent are Chistian, 0.5 per cent per cent are Islanm, 0.5 per cent are Hindu.

The main occupation of the people living in Loilem district is agriculture and trading the regional products. For this season, people have concentrated an lowlands where agriculture can be practiced in places where transportation is easy. The streams Nam Pawn,Nam Tein and Nam let past flow the townships such as Loilem, Nam San,Kyay Theeand Mong Kaing. Such places are quite densely populated as these lowlwnds are cultivable and transport is more easier. Loilem district is located on the highway roads that run from Southern Shan State to Northern Shan State and from Eastern Shan State to the central Myanmar. The towns such as Loilem, Panglong, Nam San and some villages that are situated on these main highway roads, are quite densely populated.

In Loilem district, which has a population of 393,339 covers about 7,624.87 square miles. It is found that the density of the population is 52 per square mile and that 77 per cent of the people live in rural acres and 23 per cent live in urban areas.

It is found that various automobile vehicles of the district is 35,784 in Loilem District. 18 per cent of the over 18 year population of the district have handled 45,447 personal driving licenses in Loilem District. Over 18 year population are 250,504 people which

205,057 persons or 82 per cent need driving licenses. As 32 per cent of driving license is motor cycle license.

The traffic problem is lorries for hauling goods which also carried passengers. Traffic accidents usually take a large amount at the road corners of turning points. Many trucks and line buses have highest frequency of passage. In the transportation network system of Loilem District, between Loilem -Mong Pawn-Taunggyi roads pass through the major highway line . The number of passenger cars are numerous only in the crowded area but roads are narrow. They should be widened , in figure (6).As a result, it is found that depending upon the increasing number of motor vehicles and the increase of the use of roads, most roads had to be up-graded. The development of transportation networks have progressed rapidly and will be lead to economic development. Consequently, the living standards of the native people of Loilem District will improve better than ever in the future.

re the connection lines of any two nodes or more by any mode of transport. There are many nodes in regional passengers transportation system of Loilem District from 1972 to the present time.

According to the Peter Haggett's Index range ,higher value of the Beta Index result from increasingly complex and connected networks. The different situation of transportation networks of Loilem District can be analyzed by dividing two periods, 1972 and the present day 2009.

The Beta Index values of 1.15 and 1.06 means the transportation networks of Loilem District is moderately complex and connected. The Alpha Index values of 10% and 3% means Loilem District's transportation network circuitry is moderately connected. The Gamma Index values may be expressed as a percentage of connectivity. Thus, the connectivity of Loilem District's transportation network is 41.3% and 36.4 % or the connectivity of nodes within these networks.

It is found that the transportation network is increasing with a steadily increasing rate from the period of before independence up to the present time. The Beta Index value of (1) means, land transportation network of Loilem District is moderately complex and connected. But waterways transportation is not applied because Than Lwin river is strongly flowing. Thus, railways and airways transportation networks of Loilem District are less complex and poorly connected.

According to the frequency table, 14 nodes are included in the low connectivity classes. So it is found that 42 % of the nodes is less connectivity. The frequency distribution

curve is not symmetrical. It has a positively skewness which means that the less connectivity nodes have high frequency.

The most primitive measurement of accessibility is obtained directly from the connectivity matrix. The higher the value of an individual node, the greater is its accessibility to all other centre. Therefore, Nam San have the greatest degree of accessibility (18,242,700) in Loilem District's transportation network structure. In outer area, especially Kaing Lun(V_{22}) has poor level of connectivity and accessibility with the least value of Loilem District's transportation network structure.

The traffic problem is lorries for hauling goods which also carried passengers. Traffic accidents usually take a large amount at the road corners of turning points. Many trucks and line buses have highest frequency of passage. In the transportation network system of Loilem District, between Loilem -Mong Pawn-Taunggyi roads pass through the major highway line . The number of passenger cars are numerous only in the crowded area but roads are narrow. They should be widened , in figure (6).

As a result, it is found that depending upon the increasing number of motor vehicles and the increase of the use of roads, most roads had to be up-graded. The development of transportation networks have progressed rapidly and will be lead to economic development. Consequently, the living standards of the native people of Loilem District will improve better than ever in the future.

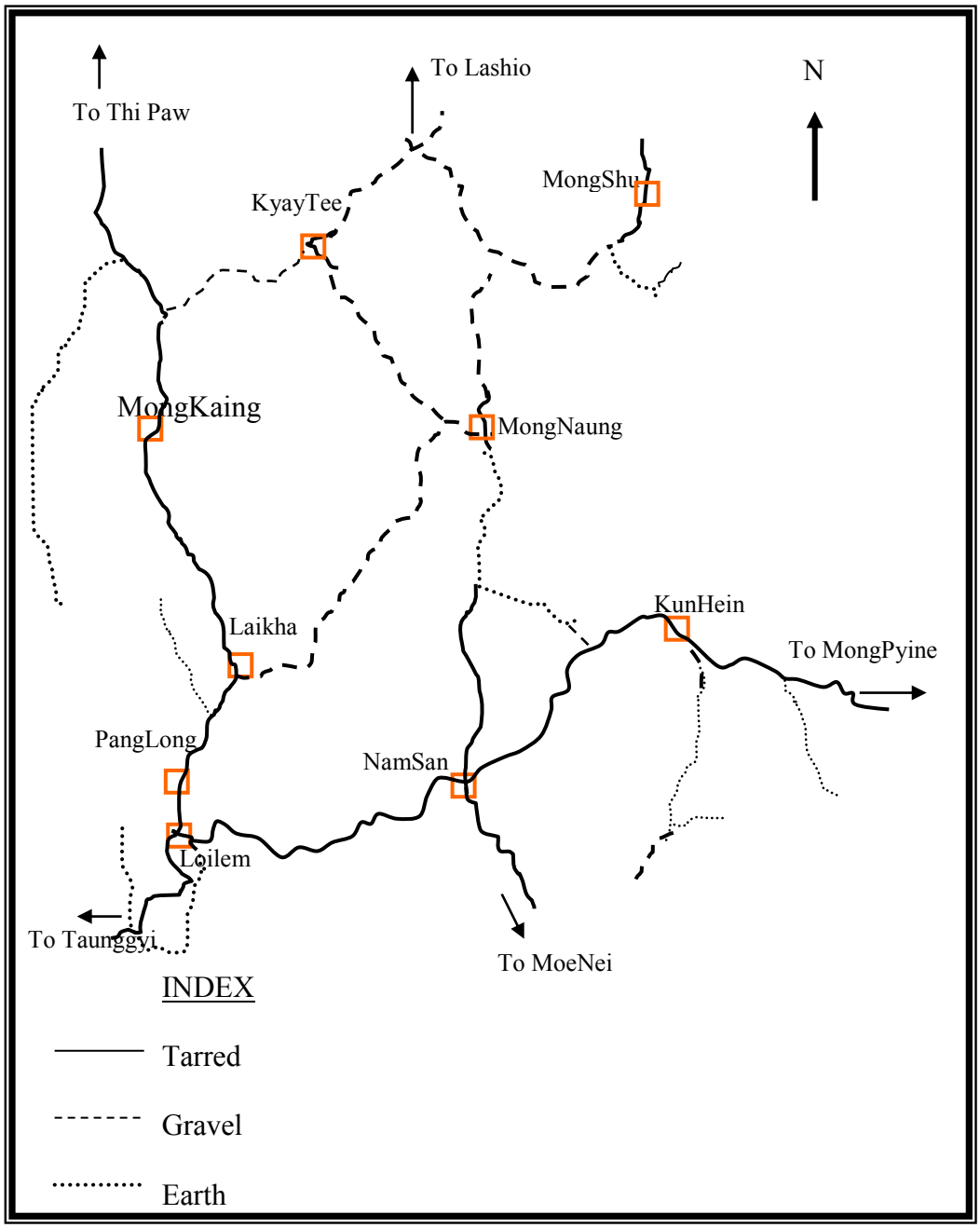

Figure (6) Suggestion for Transportation Networks in Loilem District
Source: Construction Department of Loilem District ,2010

Figure (7) Traffic Problems of Loilem District

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