## THE ROAD CONNECTIVITY OF HPA-AN TOWNSHIP, KAYIN STATE

Myat Yazar Soe<sup>1</sup>, Naw Paw Pale Wah<sup>2</sup>

## Abstract

This paper tries to present "The Road Connectivity of Hpa-An Township, Kayin State" from geographical point of view. The quality of life and economy of society rely on good transport system. In Hpa-an Township, there are four modes of transportation: road, waterway, railway and airway. After construction of river-cross bridges on Thanlwin River, motor road has become the most important mode of transportation in Hpa-an Township. All village tracts within Hpa-an Township have no direct motor routes between them. Road density of Hpa-an Township is only more than 0.12 km per square km. Apart from Myotma administrative units, most of the administrative units are characterized by minimum efficiency of road network in terms of connectivity. The node has more connectivity in Hpa-an Township is (V5) Hpa-an Town and the nodes have less connectivity are (V1 and V16) Duyinseik and Mizine. The main objectives of the paper are to explore the modes of transportation in Hpa-an Township, to examine road networks of the study area and to find out the degree of road connectivity of road network of Hpa-an Township. Degree of road connectivity is calculated by mean of Connectivity Matrix. To present the paper, secondary data were mainly applied and field observation was thoroughly done. Connectivity Matrix is mainly used in presenting Connectivity of Hpa-an Township.

Keywords: Connectivity, Connectivity Matrix, Road density, nodes

## Introduction

Transport is one of the fundamental pillars upgrading economics of the area and it gives positive effects on health of the given area (Dostál & Adamec). Nistor & Popa, 2014, stated that transport leads to the introduction of economic activities and local development and a well-developed internal transport system leads to linking economic activities within a region.

Garrison & Marble (1958) have studied transportation network of a region applying certain graph-theoretic measures. Graph-theory, as a branch of combinatorial topology, provides certain suitable measurements in the analysis of the structure of transportation network (Haggette, 1965).

The efficient transportation can increase firm productivity, the quality of life, markets and jobs, increase the supply of labor and entrepreneurship, and lead to changes in land use and spatial patterns that may improve growth and welfare. Improved transport infrastructure provides important benefits across all sectors and users. These benefits are typically realized in the form of reduced transport costs and times.

In the study area, the upgrading and maintenance of the rural roads resulted in better accessible and advantageous for local people, public institutions and regional markets. Moreover, the people who live in periphery areas deliver their products to the regional markets. And then, students go to schools and ill-health persons have faster and better access to health care centers. Road connectivity is important for economic and community development. Therefore, Hpa-an Township was selected to present road connectivity from geographical point of view.

<sup>&</sup>lt;sup>1</sup>Assistant Lecturer, Department of Geography, Hpa-An University

<sup>&</sup>lt;sup>2</sup> Assistant Lecturer, Department of Geography, Hpa-An University

#### **Objectives**

The main objectives are-

- to explore the modes of transportation in Hpa-an Township
- to examine road networks of the study area
- to find out the degree of road connectivity of road network of Hpa-an Township.

#### Methodology

Road network was examined by mean of graph-theory. The main tarred roads within Hpaan Township were considered as the links and junction points of road network as the nodes. All smaller lanes connecting with other villages were excluded. Nodal connectivity was used to find out the degree of road connectivity of the Township.

#### **Description of Study Area**

Hpa-an Township is situated in the middle part of the Kayin State of Lower Myanmar. It lies between  $16^{\circ}$  30' N and  $17^{\circ}$  44' N latitudes and also between  $97^{\circ}$  21' E and  $98^{\circ}$  1' E longitudes. It is bounded by Hlaing-bwe and Kawkareik Townships in the east, Paung, Tha-ton and Bilin townships in the west, and Kawkareik, Kyaikmaraw and Mawlamyine Townships in the south (Kyu Kyu Win, 2007).

Hpa-an Township has an area of 2901.02 square kilometers. The length from the north to the south of the township is 78 kilometre (125 miles) and the width from east to west 30 kilometre (48 miles). The township is composed of 9 administrative units with 9 wards and 91 village tracts.

Most of the high land areas are found in northern region and most of the low laying areas in southern parts. Most of the rivers run from north to south. The main river is Thanlwin River which passes through the middle part of the township. The most famous rivers and chaungs are Gyaing River, Donthami River, Mi-zaing, Hlaing-bwe, Hpa-on, the Hlaing, Kaya and the Zartha-pyin chaungs (Figure 1). Having mountain ranges, plains, limestone outcrops and forests in Hpa-an Township, mountain, forest, lateritic and meadow soils are found. Hpa-an Township has a moderate type of climate characterized by heavy rainfall during the monsoon in the month of June to September. The average annual rainfall is about 4500 mm. The summer is from February to May and April is the hottest month with mean daily maximum temperature of 40°C and mean daily minimum temperature of 21°C. The cool season lasts from late November to mid of February, and January is the coldest month with temperature ranging from 14°C to 36°C.

The distribution of Hpa-an Township population and transportation is influenced by physical feature. The land surface of Hpa-an Township is mountainous in the north, and low lying in the south. Therefore, the northern part is less transportation lines than the southern part. The total population of the township was about 421,575 persons (Regional Facts of Hpa-an, 2015) with the population density 145.26 persons per square kilometer. About seventy-five percent of Hpa-an Township population lived in the southern part and the remaining in the north.

### **Transportation of Hpa-an Township**

Transportation is one of the most important elements for regional development. In the transportation sector of Hpa-an Township, there are four modes of transportation: road, inland water way, railway and airway transportations (Khin Win Naing, 2003).

### Airway

In Hpa-an Township, there was one airport which is located on the north-east of Hpa-an town. Yangon-Mawlamyine-Hpa-an-Hpapun route ran three times a week until 1986.

## Railway

In Hpa-an Township, there is only one railway linking Thaton-Myaingkalay Village and Hpa-an Township. It was built in 1985-86 and was opened in December 1987 to transport the cements produced from the No.1 and No.2 Tatmadaw Cement Factories. The length of the railroad is 39 kilometre (24 miles). Today, railway does not run due to better accessibility of road transportation.

## Water Transportation

Before 2000, the waterway of Hpa-an Township was the most important transport mode. The main water routes were Hpa-an-Htone Aing-Zarthabyin-Mawlamyine route, Zarthabyin-Kyonedoe route and Hpa-an-Shwegun route. Htone-aing, Shwe-gun and Kama-maung villages had connection by the water transportation with Mawlamyine Township. After constructing bridges that cross the river such as Thanlwin Bridge, Gyaing-Zarthabyin Bridge and Gyaing-Kawkareik Bridge, the importance of water transportation gradually decreased the use of road transportation has increased.

### **Road Networks of the Study Area**

Motor road is the most important mode of transportation for Hpa-an Township. Hpa-an Township is connected with Upper Myanmar, Yangon, Thaton, Mawlamyine, Kawkareik, Myawaddy, Hlaingbwe and Hpa-pun Townships by the road networks. In Hpa-an Township, there are four types of road: tarred road, metalled road, lateritic road and earthen road. These roads connect Hpa-an and its neighbouring areas. Tarred roads and the other important roads in Hpa-an township are shown in table 1 and figure 1.

No	Road name	Length (km)
1	Duyinseik – Wabodaw – Hpakap – Hpa-an road	45.38
2	Wabodaw – Mizaing road	51.98
3	Hpakap – Yekyaw road	13.70
4	Hpa-an – Tawpone road	10.59
5	Hpa-an – Htoneaing road	23.14
6	Hpa-an – Zarthabyin road	38.43
7	Kawkyaik – Tawpone – Naunglone road	14.18
8	Hpa-an – Naunglone – Eindu – Gyaing road	61.57
9	Hpa-an – Naungkamying road	24.59
10	Hpa-an – Naungpalein road	18.78
11	Zarthabyin – Eindu road	23.50
12	Zarthabyin – Gyaing road	32.32
	Total	358.16

 Table 1 Main Road Transport within Hpa-an Township, 2018

Source: Department of Transportation in Hpa-an Township



Source: Department of Transportation in Hpa-an Township

Figure 1 Main Transportation Road Network of Hpa-an Township, 2018

In Hpa-an Township, there are nine administrative units including 91 village tracts (Figure 1). Nine administrative units are Watkyi, Hpakat, Mizan, Eindu, Myotma, Kawhtamalein, Htoneaing, Zarthaphin and Gyaing.

Four out of 17 village tracts are linked with tarred road in Watkyi administrative unit, seven out of 13 village tracts in Hpakat, two in 10 village tracts in Mizan, four in 11 village tracts in Eindu, five out of nine Wards in Myoma, two in eight village tracts in Kawhtamalein, three out of nine village tracts Htoneaing, four out of eight village tracts in Zarthaphin, and five in ten village tracts in Gyaing.

It is clear that the Myoma is located highly accessible area and it links 79 percent of the village tracts within its administrative unit (Table 2). It is located not only in the middle part of the township but also in the central place of economic activities of the township. And then, village tracts are close to one another. Moreover, it is densely populated area in the township. Hpakat, Zarthapyin and Gyaing have slightly high level of connectivity. In the area, about half of village tracts is located near the main tarred roads and lie on the small hill locks. Watkyi, Mizan, Eidu, Kakhtamalein and Htoneaing have low level of connectivity. Most of village tracts are situated in the poorly drainage low land areas and hilly areas. Village tracts also scatter throughout the area. Therefore, the degree of connectivity is directly or indirectly influenced by location, relief, population density and their economic activities.

Administrative Units	No. of village tract/ward	No. of village tract/ward linked with tarred road	Percentage %
Watkyi	17	4	24
Hpakat	13	7	54
Mizan	10	2	20
Eindu	11	4	36
Myoma	14	11	79
Kawhtamalein	8	2	25
Htoneaing	9	3	33
Zarthapyin	8	4	50
Gyaing	10	5	50

 Table 2 Connectivity of Tarred Road in Hpa-an Township, 2018

Source: Computed by the Author based on field observation

## **Connectivity of Road Networks in Hpa-an Township**

Geographers defined networks as "a set of geographic locations inter-connected in a system by a number of routes" (Kansky, 1963). The transportation network consists of a set of geographic locations interconnected in a system by a number of routes (Garrison, 1960). The degree of connection between all vertices is defined as the connectivity of the networks (Taaffe and Gauthier, 1973). Greater connectivity of an area somehow illustrates the more efficient in transportation that supports movements of goods and people of an area. The nodal connectivity is used to know the degree of connectivity of road network of Hpa-an Township. The nodal connectivity includes direct connectivity, indirect connectivity and total accessibility.

To analyse a road network of Hpa-an Township, it is needed to change the road network (Figure 1) into the form of a graph network (Figure 2). Here, points of origin/destination/junction of road network are considered as the nodes and the main tarred roads are considered as the links. Therefore, the converted topological network of Hpa-an Township consists of 16 nodes (v) and 19 edges (e) (Figure 2). Therefore, it's Alpha Index (e-v+1 / 2v-5, where, e = numbers of edges and v = number of vertices) is 0.15, Beta Index (a ratio the total number of edges to the total number of vertices) 1.19, Gamma Index (e / 3(v-2) is 0.45 and cyclomatic number (number of circuits) 4 respectively (Table 8).



Source: Based on Figure 1 Figure 2 Graph Network of Hpa-an Township, 2018

The prepared topological network of Hpa-an Township is represented as matrix. The matrix is usually a square matrix. Number of rows and columns of the matrix equal to the total number of nodes in the prepared graph network of Hpa-an Township. Since the prepared topological network has 16 nodes, the matrix that represents the road network is sixteen rows by sixteen columns grid. The horizontal rows of the matrix are defined as a set of origin and vertical columns are regarded as destination nodes. In this matrix, a value of '1' is filled in the cells that have a direct linkage between nodes and a value of '0' is filled in the cell that has no direct linkage. This matrix is commonly referred to as 'C' matrix /Original matrix/ direct connectivity (Table 3). In the 'C' matrix Table, the total value of each row (or) column equal to the number of direct linkages. Having only one direct linkage in  $V_1$ ,  $V_{12}$ ,  $V_{13}$ ,  $V_{14}$ ,  $V_{15}$ , and  $V_{16}$ , the total value of each its row (or) column is 1 and  $V_5$  has the maximum number of direct linkages with 6 links (Table 3). The direct connectivity cannot display the real situation of road connectivity. Thus, it is necessary to consider the indirect connectivity to examine the accessibility.

	<b>V1</b>	V2	<b>V3</b>	<b>V4</b>	<b>V5</b>	<b>V6</b>	<b>V7</b>	<b>V8</b>	<b>V9</b>	V10	V11	V12	V13	V14	V15	V16	Total
V1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
V2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
V3	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	3
V4	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	3
V5	0	0	1	1	0	1	0	0	1	0	0	0	1	1	0	0	6
V6	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	3
V7	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	3
V8	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2
V9	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	3
V10	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	3
V11	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	3
V12	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
V13	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
V14	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
V15	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
V16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

 Table 3 The 'C' Matrix (Original matrix)

**Source:** Based on Figure 2

The 'C' matrix is multiplied by itself to determine all linkages or indirect connections. The multiplying 'C' matrix is regarded as 'C<sup>2</sup>' matrix. To multiply a matrix, we need to match and produce the element by element of rows and columns in a matrix and then sum them. Table 4 represented a matrix manipulation of the first row (V<sub>1</sub>) to the first column (V<sub>1</sub>) to get a value for the cell of the first row and column of the 'C<sup>2</sup>' matrix. Each cell of the 'C<sup>2</sup>' matrix is filled up in this manner (Table 5). Then, the 'C' matrix (Original matrix) and the 'C<sup>2</sup>' matrix are added. A new matrix is product (Table 6). When the new matrix is multiplied again and add with the 'C' matrix (Original matrix), a next new matrix 'C<sup>3</sup>' is got. The multiplying and adding procedures going on until all zero (0) cells are filled (until the 'C<sup>6</sup>' matrix). The total of direct connection 'C' matrix or total accessibility (Table 7). Summing the rows indicates the total accessibility for each vertex in the road network of Hpa-an Township. The greater the value is, the higher the accessibility of the node is.

Table 4 Cor	nputing A	Value for	The Cell o	f The First	Row and	Column in	n A Matrix
						001011111	

The first <b>1</b>	OW	the first colu	ımn	Cell
(V1)	X	(V1)	=	V1 V1
0	Х	0	=	0
1	Х	1	=	1
0	Х	0	=	0
0	Х	0	=	0
0	Х	0	=	0
0	Х	0	=	0
0	Х	0	=	0
0	Х	0	=	0
0	Х	0	=	0
0	Х	0	=	0
0	Х	0	=	0

The first <b>1</b>	OW	the first colu	umn	Cell
(V1)	Х	(V1)	=	V1 V1
0	Х	0	=	0
0	Х	0	=	0
0	Х	0	=	0
0	Х	0	=	0
0	Х	0	=	0
	Sum		=	1

Source: Based on Table 3

# Table 5 The 'C<sup>2</sup>' matrix

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	Total
V1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
V2	0	3	0	0	1	0	0	0	0	0	0	0	0	0	1	0	5
V3	1	0	3	1	0	1	0	0	1	0	0	0	1	1	0	1	10
V4	0	0	1	3	1	2	0	0	1	0	1	1	1	1	0	0	12
V5	0	1	0	1	6	1	1	0	2	1	0	0	0	0	1	0	14
V6	0	0	1	2	1	3	0	1	1	0	1	0	1	1	0	0	12
V7	0	0	0	0	1	0	3	1	1	1	1	0	0	0	0	0	8
V8	0	0	0	0	0	1	1	2	0	1	1	0	0	0	0	0	6
V9	0	0	1	1	2	1	1	0	3	1	0	0	1	1	0	0	12
V10	0	0	0	0	1	0	1	1	1	3	0	0	0	0	0	0	7
V11	0	0	0	1	0	1	1	1	0	0	3	1	0	0	0	0	8
V12	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	3
V13	0	0	1	1	0	1	0	0	1	0	0	0	1	1	0	0	6
V14	0	0	1	1	0	1	0	0	1	0	0	0	1	1	0	0	6
V15	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	3
V16	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
Source	: Bas	ed on	Tah	le 3													
			I uo														
Table	6 '	The	Nev	v Ma	atrix	(Th	e 'C'	' Ma	atrix	(Ori	iginal	matr	rix) +	The '	C <sup>2</sup> , n	natrix	x)
Table	<b>6</b> ' V1	The V2	Nev	v Ma 3 V	atrix 4   V	(Th 5   V	e 'C'	<b>' M</b> a	atrix V8	x ( <b>Or</b> i V9	i <b>ginal</b> V10	matr V11	<b>rix)</b> + V12	<b>The '</b> V13	<b>C<sup>2</sup>, n</b> V14	natrix V15	x) V16
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V1           V2           V3           V4	6 V1 1 1 0 0	The           V2           1           3           1           0           1	Nev           V:           1           3           1           1		atrix           4         V           0         0           1         1           2         6	$(\mathbf{Th})$ $5  \mathbf{V}$ $0  0$ $0$ $1$ $2$ $2$ $3$	e 'C' 6 V 0 () () () ()	<b>' M:</b> '7 ) ) ) 1	atrix V8 0 0 0 0 0	x (Ori V9 0 0 1 2 3	<b>iginal</b> V10 0 0 1 1	<b>matr</b> V11 0 0 1 0	<b>ix</b> ) + V12 0 0 0 1 0	<b>The '</b> V13 0 1 1	C <sup>2</sup> , n V14 0 1 1 1	V15           0           1           0           1           0           1           0	x) V16 1 1 1 0 0
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V1           V2           V3           V4           V5           V6           V7           V8	6 V1 1 1 0 0 0 0 0 0 0	The           V2           1           3           1           0           1           0           0           0           0           0	Nev V: 1 1 1 3 1 1 1 1 0 0	v M:             v M:             3 V             0             0	Atrix       4     V       0     0       1     1       2     6       2     6       1     1       0     0	$ \begin{array}{c c} (\mathbf{Th}) \\ \hline 5 & \mathbf{V} \\ \hline 0 & 0 \\ \hline 0 & 1 \\ \hline 2 & 2 \\ \hline 0 & 1 \\ \hline 1 & 2 \\ \hline 0 & 1 \\ \hline 1 & 1 \\ \hline \end{array} $	e 'C' 6 V 0 (() () () () () () () () () () () () ()	<b>' Ma</b> 77 ) ) ) ) 1 1 3 2	atrix V8 0 0 0 0 0 1 2 2	x (Ori V9 0 0 1 2 3 2 1 0	iginal V10 0 0 1 1 0 1 1 1	<b>matr</b> V11 0 0 1 0 1 2 2	<b>ix</b> ) + V12 0 0 1 0 0 0 0 0 0	The ' V13 0 1 1 1 1 0 0	C <sup>2</sup> , n V14 0 1 1 1 1 0 0	<b>natrix</b> V15 0 1 1 0 1 0 0 0	x) V16 1 1 0 0 0 0 0 0 0
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V1         V2           V3         V4           V5         V6           V7         V8           V9         V10	6 V1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	The           V2           1           3           1           0           1           0           0           0           0           0           0           0           0           0           0           0           0           0	Nev           V3           1           1           1           1           1           1           1           1           1           1           1           1           0           0           0           0           0	v M:             v m: m:             v m:	$\begin{array}{c c}     atrix \\     4 & V \\     0 & 0 \\     1 \\     1 \\     2 \\     6 \\     2 \\     6 \\     2 \\     0 & 1 \\     0 \\     0 \\     3 \\     1 \\   \end{array}$	$(Th) = \begin{bmatrix} 5 & V \\ 5 & V \\ 0 & 0 \\ 0 \\ 0 \\ 1 \\ 2 \\ 2 \\ 2 \\ 3 \\ 1 \\ 0 \\ 1 \\ 1 \\ 2 \\ 0 \\ 0 \end{bmatrix}$	e 'C' 6 V 0 (() 1 () 1 () 1 () 1 () 1 () 1 () 1 ()	<b>' Ma</b> (7) () () () () () () () () () () () () ()	$ \begin{array}{c}     \text{atrix} \\     \overline{\text{V8}} \\     \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\       \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\      \overline{\text{0}} \\       \overline{\text{0}} \\       \overline{\text{0}} \\       \overline{\text{0}} \\       \overline{\text{0}} \\       \overline{\text{0}} \\       \overline{\text{0}} \\       \overline{\text{0}} \\       \text$	x (Ori V9 0 1 2 3 2 1 0 3 1	iginal V10 0 0 1 1 0 1 1 1 3	matr           V11           0           0           1           2           0           1           2           0           1	<b>ix</b> ) + V12 0 0 1 0 0 0 0 0 0 0 1	The ' V13 0 1 1 1 1 1 0 0 0 1 0	$     \begin{array}{c}       C^2, n \\       V14 \\       0 \\       1 \\       1 \\       1 \\       1 \\       0 \\       0 \\       1 \\       0 \\       0 \\       1 \\       0 \\       0 \\       1   \end{array} $	natrix           V15           0           1           0           1           0           0           0           0           0           0           0           0           0           0           0           0           0	x)       V16       1       1       0
V1           V2           V3           V4           V5           V6           V7           V8           V9           V10           V11	6 V1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	The           V2           1           3           1           0           1           0           0           0           0           0           0           0           0           0           0           0           0	New           New           1           1           1           1           1           1           1           0           0           0           0           0           0	$\begin{array}{c} \mathbf{v} \ \mathbf{Ma} \\ 3 \ \mathbf{V} \\ \hline 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 3 \\ 2 \\ 2 \\ 2 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \end{array}$	$\begin{array}{c c}     atrix \\     4 & V \\     0 & 0 \\     1 \\     1 \\     2 \\     6 \\     2 \\     6 \\     2 \\     0 & 1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	e 'C' 6 V 0 (() () () () () () () () () () () () ()	<b>' Ma</b> (77)))))))))))))))))))))))))))))))))))	$ \begin{array}{c} \text{atrix} \\  \hline V8 \\  \hline 0 \\  \hline 1 \\  \hline 2 \\  \hline 0 \\  \hline 1 \\  \hline 2 \\  \hline 0 \\  \hline 1 \\  \hline 2 \\  \hline 0 \\  \hline 1 \\  \hline 2 \\  \hline 0 \\  \hline 1 \\  \hline 2 \\  \hline 0 \\  \hline 1 \\  \hline 2 \\  \hline 0 \\  \hline 1 \\  \hline 2 \\  \hline 1 \\  \hline 1 \\  \hline 2 \\  \hline 1 \\  \hline $	x (Ori V9 0 0 1 2 3 2 1 0 3 1 0 3 1 0	iginal V10 0 0 1 1 1 1 1 3 1	matr           V11           0           0           1           0           1           2           0           1           3	$\dot{\mathbf{x}}$ ) + $\overline{V12}$ 0 0 1 0 0 0 0 0 1 1 1	The ' V13 0 1 1 1 1 1 0 0 0 1 0 0	$     \begin{array}{c}       C^{2}, n \\       V14 \\       0 \\       0 \\       1 \\       1 \\       1 \\       1 \\       0 \\       0 \\       1 \\       0 \\      $	V15           0           1           0           1           0           1           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0	x)       V16       1       1       0
V1         V2           V3         V4           V5         V6           V7         V8           V9         V10           V11         V12	6 V1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	The           V2           1           3           1           0           1           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0	Nev           Nev           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           0           0           0           0           0           0	$\begin{array}{c c} \mathbf{v} \ \mathbf{Ma} \\ \mathbf{v} \ \mathbf{Ma} \\ 3 \ \mathbf{V} \\ \hline 0 \\ 0 \\ 0 \\ 1 \\ 3 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \\ \end{array}$	$\begin{array}{c c}     atrix \\     4 & V \\     0 & 0 \\     1 \\     1 \\     2 \\     6 \\     2 \\     0 & 1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0$	(Th) = 5 V = 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	e 'C' 6 V 0 (() 1 () 1 () 1 () 1 () 1 () 1 () 1 ()	' Ma       (7       )       )       )       )       )       )       )       )       )       )       )       )       )       )       )       )       )       )       )	$\begin{array}{c} \text{atrix} \\ V8 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 2 \\ 2 \\ 0 \\ 1 \\ 2 \\ 0 \\ 0 \\ \end{array}$	x (Ori V9 0 1 2 3 2 1 0 3 1 0 0 0	iginal V10 0 1 1 0 1 1 1 3 1 1	matr V11 0 0 1 0 1 2 2 0 1 3 1	$\mathbf{i}\mathbf{x}$ ) + $\mathbf{V}12$ 0 0 1 0 0 0 0 0 1 1 1 1	The ' V13 0 1 1 1 1 1 0 0 0 1 0 0 0 0	C <sup>2</sup> , n V14 0 1 1 1 1 0 0 0 1 0 0 0	natrix           V15           0           1           0           1           0	<ul> <li>v16</li> <li>1</li> <li>1</li> <li>0</li> <li></li></ul>
V1         V2           V3         V4           V5         V6           V7         V8           V9         V10           V11         V12           V13         V14	6 V1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	The           V2           1           3           1           0           1           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0	Nev           Nev           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           0           0           0           0           0           0           0           1	$\begin{array}{c c} \mathbf{v} & \mathbf{Mi} \\ \mathbf{v} & \mathbf{Mi} \\ \hline 3 & \mathbf{V} \\ \hline 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 3 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1$	$\begin{array}{c c}     atrix \\     4 & V \\     0 & 0 \\     1 \\     1 \\     2 \\     6 \\     2 \\     6 \\     2 \\     0 & 1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\   \end{array}$	(Th) 5 V 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	e 'C' 6 V 0 () () () () () () () () () () () () () (	' Ma       (7       )       )       )       )       )       )       )       )       1       1       2       )       )       )       )	$\begin{array}{c} \text{atrix} \\ V8 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 2 \\ 0 \\ 1 \\ 2 \\ 0 \\ 1 \\ 2 \\ 0 \\ 0 \\ 0 \\ \end{array}$	x (Ori V9 0 1 2 3 2 1 0 3 1 0 0 1 0 0 1	iginal V10 0 1 1 1 1 1 1 1 1 1 1 0 1 1 0 0	matr           V11           0           0           1           2           0           1           2           0           1           3           1           0	$\dot{\mathbf{x}}$ ) + $\overline{\mathbf{V12}}$ 0 0 1 0 0 0 0 1 1 1 1 1 0 0	The ' V13 0 0 1 1 1 1 1 0 0 0 1 0 0 0 1 0 0 1	$     \begin{array}{c}       C^2, n \\       \overline{V14} \\       0 \\       0 \\       1 \\       1 \\       1 \\       1 \\       0 \\       0 \\       1 \\       0 \\       0 \\       1 \\       0 \\       0 \\       1 \\       1 \\       0 \\       0 \\       1 \\       1 \\       1 \\       0 \\       0 \\       1 \\       0 \\       1 \\       0 \\       0 \\       1 \\       1 \\       0 \\       0 \\       1 \\       1 \\       0 \\       0 \\       1 \\       0 \\       1 \\       0 \\       0 \\       1 \\       1 \\       0 \\       0 \\       1 \\       0 \\       1 \\       0 \\       1 \\       0 \\       1 \\       0 \\       1 \\       0 \\       0 \\       1 \\       0 \\       1 \\       0 \\       0 \\       1 \\       0 \\       0 \\       1 \\       0 \\       0 \\       1 \\       0 \\       0 \\       1 \\       0 \\       0 \\       1 \\       0 \\       0 \\       0 \\       1 \\       0 \\       0 \\       0 \\       1 \\       0 \\       0 \\       0 \\       1 \\       0 \\       0 \\       0 \\       1 \\       0 \\       0 \\       0 \\       1 \\       0 \\       0 \\       0 \\       1 \\       0 \\       0 \\       0 \\       1 \\       0 \\     $	natrix           V15           0           1           0           1           0	<ul> <li>x)</li> <li>V16</li> <li>1</li> <li>1</li> <li>0</li> <li< td=""></li<></ul>
V1           V1           V2           V3           V4           V5           V6           V7           V8           V9           V10           V11           V12           V13           V14	6 V1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	The           V2           1           3           1           0           1           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0	Nev           Nev           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           0           0           0           0           0           0           1	v Ma 3 V 0 0 0 0 0 0 0 0 0 0 0 0 0	$\begin{array}{c c}     atrix \\     4 & V \\     0 & 0 \\     1 \\     1 \\     2 \\     6 \\     2 \\     0 & 1 \\     0 \\     0 \\     1 \\     0 \\     0 \\     1 \\     1 \\     1 \\   \end{array}$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	e 'C' 6 V 0 (() () () () () () () () () () () () ()	' Ma       (7)       ()	$\begin{array}{c} \text{atrix} \\ \hline V8 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 2 \\ 0 \\ 1 \\ 2 \\ 0 \\ 1 \\ 2 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \end{array}$	x (Ori V9 0 0 1 2 3 2 1 0 3 1 0 0 1 1 1 1	iginal V10 0 1 1 1 1 1 1 1 0 0 0	matr           V11           0           0           1           2           0           1           3           1           0	$\mathbf{ix}$ ) + $\mathbf{V12}$ 0 0 1 0 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	The ' V13 0 0 1 1 1 1 1 0 0 0 1 0 0 1 0 0 1 1 1	C <sup>2</sup> , n V14 0 1 1 1 1 1 0 0 1 0 0 1 0 0 1 1 1	Natrix           V15           0           1           0           1           0	<ul> <li>x)</li> <li>V16</li> <li>1</li> <li>1</li> <li>0</li> <li< td=""></li<></ul>
V1         V2           V3         V4           V5         V6           V7         V8           V9         V10           V11         V12           V13         V14	6 V1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	The           V2           1           3           1           0           1           0           1	Nev           Nev           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           1           0           0           0           0           0           0           0           1           1           1	$\begin{array}{c c} \mathbf{v} \ \mathbf{Ma} \\ \mathbf{v} \ \mathbf{Ma} \\ 3 \ \mathbf{V} \\ \hline 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\$	$\begin{array}{c c}     atrix \\     4 & V \\     0 & 0 \\     1 \\     1 \\     2 \\     6 \\     2 \\     6 \\     2 \\     1 \\     0 \\     0 \\     1 \\     1 \\     1 \\     1 \\   \end{array}$	$(Th) = \begin{bmatrix} 5 & V \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 2 \\ 0 & 2 \\ 0 & 2 \\ 0 & 2 \\ 0 & 1 \\ 0 & 1 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \\ 1 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0$	e 'C' 6 V 0 () () () () () () () () () () () () () (	' Ma       (7       )       )       )       )       )       1       2       1       2       1       0       )       )       )       )       )       )       )       )       )       )       )       )       )       )       )       )       )       )	$\begin{array}{c} \text{atrix} \\ V8 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 2 \\ 2 \\ 0 \\ 1 \\ 2 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0$	x (Ori V9 0 1 2 3 2 1 0 3 1 0 0 1 1 1 0 0	iginal V10 0 0 1 1 1 1 1 1 1 0 0 0 0 0	matr           V11           0           0           1           2           0           1           2           0           1           3           1           0           0	$\dot{\mathbf{x}}$ ) + $\overline{V12}$ 0 0 1 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	The ' V13 0 1 1 1 1 1 1 0 0 0 1 0 0 1 1 1 0 0	$     \begin{array}{r}       C^{2}, n \\       \overline{V14} \\       0 \\       0 \\       1 \\       1 \\       1 \\       1 \\       0 \\       0 \\       1 \\       0 \\       0 \\       1 \\       1 \\       0 \\       1 \\       1 \\       0 \\       1 \\       0 \\       1 \\       1 \\       0 \\       1 \\       1 \\       0 \\       1 \\       1 \\       0 \\       1 \\       1 \\       0 \\       1 \\       0 \\       1 \\       1 \\       0 \\       1 \\       1 \\       0 \\       0 \\       1 \\       1 \\       0 \\       0 \\       1 \\       1 \\       0 \\       0 \\       1 \\       1 \\       0 \\       0 \\       1 \\       1 \\       0 \\       0 \\       1 \\       1 \\       0 \\       1 \\       1 \\       0 \\       1 \\   $	natrix           V15           0           1           0           1           0           1	<ul> <li>v16</li> <li>1</li> <li>1</li> <li>0</li> <li></li></ul>

**Source:** Based on Table 3 and Table 5

Vertex	C1	C2	С3	C4	C5	C6	Total Accessibility
<b>V1</b>	1	3	8	24	56	172	264
V2	3	5	21	53	169	442	693
<b>V3</b>	3	10	32	116	325	1091	1577
<b>V4</b>	3	12	45	164	505	1674	2403
<b>V</b> 5	6	14	72	227	793	2400	3512
<b>V6</b>	3	12	46	168	519	1715	2463
<b>V7</b>	3	8	34	105	339	1005	1494
<b>V8</b>	2	6	22	69	205	618	922
<b>V9</b>	3	12	50	175	571	1829	2640
V10	3	7	30	91	298	879	1308
V11	3	8	29	94	273	850	1257
V12	1	3	10	33	94	301	442
V13	1	6	20	78	233	799	1137
V14	1	6	20	78	233	799	1137
V15	1	3	13	35	119	328	499
V16	1	3	8	24	56	172	264

Table 7 The Total Connectivity Matrix of the road network of Hpa-an Township, 2018

Source: Computed by The Author

The total connectivity values help to determine not only the isolation but also centrality or accessibility levels. According to the total connectivity matrix, the least connectivity values are V1 and V16 (Duvinseik and Mizine) with 264 connections due to their marginal location. Although V1 (Duyinseik), V12 (Htoneaing), V13 (Naungkamying), V14 (Naungpalein), V15 (Yekyaw), and V16 (Mizaing) have only one direct linkage respectively, V13(Naungkamying), and V14 (Naungpalein) are directly connected with V5 (Hpa-an Town) that is the most connectivity values, V12 (Htoneaing) with V3 (Phakat) that has ranked 7<sup>th</sup> in terms of total accessibility, V15 (Yekyaw) with V10 (Kawtayokya) that has ranked 5<sup>th</sup> in terms of total accessibility, and V2 (Wabotaw) that has ranked 12<sup>th</sup> in terms of total accessibility is connected by V1 and V16 (Duvinseik and Mizine). Therefore, V1 and V16 (Duvinseik and Mizine) are more isolated location than V12 (Htoneaing), V13 (Naungkamying), V14 (Naungpalein), and V15 (Yekyaw). The most accessible node is V5 (Hpa-an Town) with 3512 connections because of it is not only a junction points of the major roads but also an urban area. Therefore, the more central place V5 (Hpa-an Town) has higher connectivity. It follows by V9 (Tawpon) with 2640 connections, V6 (Naunglon) with 2463 connections, V4 (Kawlaik) with 2403 connections and so on.



Source: Based on Figure 1 and Figure 2

Figure 4 Graph Network of Hpa-an Township

 Table 8 Connectivity Index of Current and Future Prospect

Connectivity Index	No. of Nodes (v)	No. of Edges (e)	Cyclomatic number (µ)	Alpha Index (α)	Beta Index (β)	Gamma Index (γ)	A.T.S
Current (2018)	16	19	4	0.15	1.19	0.45	5.79
Future Prospect	19	27	9	0.27	1.42	0.53	11.22

Source: Computed by The Author

In 2018, there were 16 nodes, 19 edges, 0.15 Alpha Index, 1.19 Beta Index, 0.45 Gamma Index and 4 cyclomatic number respectively (Table 8). If the red links shown in figure 3 and figure 4 gradually upgraded to tarred road, the road connectivity increased nearly two times. As the additional number of node and edges contained in graph network of Hpa-an Township are 3 and 8, there will be 19 nodes and 27 edges. Then, its alpha, beta and gamma indices increased from 0.15 to 0.27, from 1.19 to 1.42 and from 0.45 to 0.53 respectively. As well as, cyclomatic number became nine circuits (Table 8). As settlement area increased, the transport network also increased and vice versa.

#### Conclusion

In 2018, Hpa-an Township had total 358.16 km roads. It had road density more than 0.12 km per square km which was not satisfactory in position. Although there are 91 village tracts and 9 wards, more than half of village tracts have no direct motor routes between them. There are 16 nodes and 19 edges in the road network of Hpa-an Township. Therefore, it has 0.15 Alpha Index, 1.19 Beta Index, 0.45 Gamma Index and 4 cyclomatic number respectively. V5

(Hpa-an Town) has the highest connectivity and the highest level of centrality in the network. V1(Duyinseik) and V16 (Mizine) are the isolated locations due to its positions in the system and having only one directly linkage with V2 that is the almost last ranking in term of total accessibility score. The connectivity between nodes in the networks for Hpa-an Township is high but connectivity is low for each administrative units. Therefore, number of roads in all village tracts should be increased to achieve the better connectivity and accessibility. To achieve good efficiency, not only the quantity but also the quality of the road network should be developed. Due to limitations of airway, railway and water transport, the dependence on the road transportation system will continue in the future. Knowledge of the degree of connectivity will help to find out the requirements for transport development. The degree of connectivity is the index of the degree of socio-economic development of the area.

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## The 'C<sup>3</sup>' matrix

	<b>T</b> 71	110	110	374	<b>T</b> 7 <b>C</b>	IIC.	177	170	110	1710	<b>T</b> 711	1710	1110	3714	<b>T</b> 71 <i>F</i>	1110	<b>T</b> 1
	VI	<b>V</b> 2	V3	V4	V5	V6	V /	V8	<u>v9</u>	V10	VII	V12	V13	V14	V15	V16	Total
V1	1	3	1		1										1	1	8
V2	3	3	5	1	1	1			1				1	1	1	3	21
V3	1	5	3	2	8	2	1		3	1			1	1	3	1	32
V4		1	2	5	10	4	3	1	7	5	1	1	2	2	1		45
V5	1	1	8	10	10	10	2	1	10	2	2	1	6	6	1	1	72
V6		1	2	4	10	5	5	2	7	3	2		2	2	1		46
V7			1	3	2	5	5	5	2	2	6	1	1	1			34
V8				1	1	2	5	4	1	2	5	1					22
V9		1	3	7	10	7	2	1	7	2	2	1	3	3	1		50
V10			1	5	2	3	2	2	2	3	5	3	1	1			30
V11				1	2	2	6	5	2	5	5	1					29
V12				1	1		1	1	1	3	1	1					10
V13		1	1	2	6	2	1		3	1			1	1	1		20
V14		1	1	2	6	2	1		3	1			1	1	1		20
V15	1	1	3	1	1	1			1				1	1	1	1	13
V16	1	3	1		1										1	1	8
The '	C <sup>4</sup> , r	natri	x														
The '	$C^4$ , r	natri V2	x V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	Total
The '	$C^{4}$ , r V1 4	natri V2 3	x V3	V4	V5	V6 1	V7	V8	V9 1	V10	V11	V12	V13	V14	V15	V16	Total 24
The '0 V1 V2	$\frac{C^{4}}{V1}$	natri V2 3	x V3 6 5	V4 1 2	V5 1	V6 1 2	V7 1	V8	V9 1 3	V10	V11	V12	V13 1	V14 1	V15 1	V16 4	Total 24 53
The '0 V1 V2 V3	$ \begin{array}{c} C^{4}, \\ 1 \\ V1 \\ 4 \\ 3 \\ 6 \end{array} $	natri V2 3 14 5	x V3 6 5	V4 1 2 13	V5 1 11 12	V6 1 2	V7 1 2	V8	V9 1 3	V10 1 2	V11	V12	V13 1 1 9	V14 1 9	V15 1 6 3	V16 4 3	Total 24 53 116
The '0 V1 V2 V3 V4	$ \begin{array}{c} C^{4}, \mathbf{r} \\ \overline{V1} \\ \overline{4} \\ \overline{3} \\ \overline{6} \\ 1 \end{array} $	$ \begin{array}{r} \text{matri} \\ \text{V2} \\ 3 \\ 14 \\ 5 \\ 2 \end{array} $	x V3 6 5 19 13	V4 1 2 13 25	V5 1 11 12 23	V6 1 2 13 22	V7 1 2 6	V8 1 4	V9 1 3 13 20	V10 1 2 7	V11 2 10	V12	V13 1 1 9	V14 1 1 9	V15 1 6 3 2	V16 4 3 6	Total 24 53 116 164
The '0 V1 V2 V3 V4 V5	$ \begin{array}{c} C^{4}, r \\ V1 \\ 4 \\ 3 \\ 6 \\ 1 \\ 1 \end{array} $	matri V2 3 14 5 2 11	x V3 6 5 19 13 12	V4 1 2 13 25 23	V5 1 11 12 23 56	V6 1 2 13 22 23	V7 1 2 6 14	V8	V9 1 3 13 20 32	V10 1 2 7 14	V11 2 10 5	V12 1 6 2	V13 1 1 9 11 10	V14 1 9 11 10	V15 1 6 3 2 9	V16 4 3 6 1	Total 24 53 116 164 227
The '0 V1 V2 V3 V4 V5 V6	$   \begin{array}{c}     C^{4}, & r \\     \hline     V1 \\     \hline     4 \\     \hline     3 \\     \hline     6 \\     \hline     1 \\     1 \\     1   \end{array} $	$ \begin{array}{r} \text{matri} \\ \underline{\text{V2}} \\ 3 \\ 14 \\ 5 \\ 2 \\ 11 \\ 2 \end{array} $	x V3 6 5 19 13 12 13	V4 1 2 13 25 23 22	V5 1 11 12 23 56 23	V6 1 2 13 22 23 25	V7 1 2 6 14 9	V8 1 4 4 8	V9 1 3 13 20 32 20	V10 1 2 7 14 6	V11 2 10 5 11	V12 1 6 2 3	V13 1 9 11 10 11	V14 1 9 11 10 11	V15 1 6 3 2 9 9	V16 4 3 6 1 1 1	Total 24 53 116 164 227 168
The '0 V1 V2 V3 V4 V5 V6 V7	$ \begin{array}{c} C^{4}, \\ V1 \\ \hline 4 \\ \hline 3 \\ \hline 6 \\ \hline 1 \\ \hline 1 \\ \hline 1 \end{array} $	$ \begin{array}{r} \text{matri} \\ \hline V2 \\ \hline 3 \\ \hline 14 \\ \hline 5 \\ \hline 2 \\ \hline 11 \\ \hline 2 \\ \hline 1 \end{array} $	x V3 6 5 19 13 12 13 2	V4 1 2 13 25 23 22 6	V5 1 11 12 23 56 23 14	V6 1 2 13 22 23 25 9	V7 1 2 6 14 9 19	V8 1 4 4 8 12	V9 1 3 13 20 32 20 11	V10 1 2 7 14 6 11	V11 2 10 5 11 13	V12 1 6 2 3 2	V13 1 9 11 10 11 2	V14 1 9 11 10 11 2	V15 1 6 3 2 9 9 2 1	V16 4 3 6 1 1 1 1	Total 24 53 116 164 227 168 105
The '0 V1 V2 V3 V4 V5 V6 V7 V8	$ \begin{array}{c} C^{4}, & r \\ \hline V1 \\ 4 \\ 3 \\ 6 \\ 1 \\ 1 \\ 1 \end{array} $	$ \begin{array}{c} \text{matri} \\ \hline V2 \\ \hline 3 \\ \hline 14 \\ \hline 5 \\ \hline 2 \\ \hline 11 \\ \hline 2 \\ \hline 1 \\ \hline 1 \end{array} $	x V3 6 5 19 13 12 13 2 1	V4 1 2 13 25 23 22 6 4	V5 1 11 23 56 23 14 4	V6 1 2 13 22 23 25 9 8	V7 1 2 6 14 9 19 12	V8 1 4 4 8 12 12	V9 1 3 13 20 32 20 11 4	V10 1 2 7 14 6 11 8	V11 2 10 5 11 13 12	V12 1 6 2 3 2 2 2	V13 1 1 9 11 10 11 2 1	V14 1 9 11 10 11 2 1	V15 1 6 3 2 9 9 2 1	V16 4 3 6 1 1 1 1	Total 24 53 116 164 227 168 105 69
The '0 V1 V2 V3 V4 V5 V6 V7 V8 V9	$     \begin{array}{c}       C^{4, r} \\       V1 \\       4 \\       3 \\       6 \\       1 \\       1 \\       1 \\       1   \end{array} $	$ \begin{array}{c} \text{matri} \\ \text{V2} \\ 3 \\ 14 \\ 5 \\ 2 \\ 11 \\ 2 \\ 1 \\ 3 \\ \end{array} $	x V3 6 5 19 13 12 13 2 1 13 2 13	V4 1 2 13 25 23 22 6 4 20	V5 1 11 12 23 56 23 14 4 32	V6 1 22 23 25 9 8 20	V7 1 2 6 14 9 19 12 11	V8 1 4 4 8 12 12 4	V9 1 3 20 32 20 11 4 27	V10 1 2 7 14 6 11 8 11	V11 2 10 5 11 13 12 5	V12 1 6 2 3 2 2 2 2 2	V13 1 1 9 11 10 11 2 1 11	V14 1 9 11 10 11 2 1 11	V15 1 6 3 2 9 9 2 1 1 3	V16 4 3 6 1 1 1 1 1 1	Total 24 53 116 164 227 168 105 69 175
The '0 V1 V2 V3 V4 V5 V6 V7 V8 V9 V10	$   \begin{array}{c}     C^{4}, & r \\     \hline     1 \\     \hline     1 \\     \hline     1 \\     1   \end{array} $	$ \begin{array}{r} \text{matrix}\\ V2\\ \hline 3\\ \hline 14\\ \hline 5\\ \hline 2\\ \hline 11\\ \hline 2\\ \hline 1\\ \hline 3\\ \hline 1 \end{array} $	x V3 6 5 19 13 12 13 2 1 13 2 1 3 2	V4 1 2 13 25 23 22 6 4 20 7	V5 1 11 12 23 56 23 14 4 4 32 14	V6 1 22 23 25 9 8 20 6	V7 1 2 6 14 9 19 12 11 11	V8 1 4 4 8 12 12 4 8	V9 1 3 13 20 32 20 11 4 27 11	V10 1 2 7 14 6 11 8 11 16	V11 2 10 5 11 13 12 5 7	V12 1 6 2 3 2 2 2 3	V13 1 9 11 10 11 2 1 11 2	V14 1 9 11 10 11 2 1 11 2	V15 1 6 3 2 9 9 2 1 1 3 3 1	V16 4 3 6 1 1 1 1 1 1 1	Total 24 53 116 164 227 168 105 69 175 91
The 'd V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11	$ \begin{array}{c} C^{4,} \mathbf{r} \\ V1 \\ \hline V1 \\ \hline 4 \\ 3 \\ \hline 6 \\ \hline 1 \\ \hline 1 \\ \hline 1 \\ \hline 1 \end{array} $	$ \begin{array}{c} \text{matrix}\\ \overline{\text{V2}}\\ \overline{3}\\ \overline{14}\\ \overline{5}\\ 2\\ 11\\ 2\\ 1\\ 3\\ 1\\ \end{array} $	x V3 6 5 19 13 12 13 2 1 13 2 2 2	V4 1 2 13 25 23 22 6 4 20 7 10	V5 1 11 223 56 23 14 4 32 14 5	V6 1 2 13 22 23 25 9 8 20 6 11	V7 1 2 6 14 9 19 12 11 11 11 13	V8 1 4 4 12 12 12 4 8 12	V9 1 3 13 20 32 20 11 4 27 11 5	V10 1 2 7 14 6 11 8 11 16 7	V11 2 10 5 11 13 12 5 7 7 19	V12 1 6 2 2 2 2 2 2 3 6	V13 1 1 9 11 10 11 2 1 11 2 2 2	V14 1 9 11 10 11 2 1 11 2 2 2	V15 1 6 3 2 9 9 2 2 1 1 3 1	V16 4 3 6 1 1 1 1 1 1 1	Total 24 53 116 164 227 168 105 69 175 91 94
The '0 V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11 V12	C <sup>4,</sup> r V1 4 3 6 1 1 1 1	$ \begin{array}{c} \text{matrix} \\ \hline V2 \\ \hline 3 \\ \hline 14 \\ \hline 5 \\ \hline 2 \\ \hline 11 \\ \hline 2 \\ \hline 1 \\ \hline 3 \\ \hline 1 \\ \hline \end{array} $	$     \begin{array}{r} x \\     \hline                              $	V4 1 2 13 25 23 22 6 4 20 7 10 6	V5 1 11 223 56 23 14 4 32 14 32 14 5 5 2	V6 1 22 23 25 9 8 20 6 11 3	V7 1 2 6 14 9 19 12 11 11 13 2	V8 1 4 4 8 12 12 4 8 12 2	V9 1 3 13 20 32 20 11 4 27 11 5 2	V10 1 2 7 14 6 11 8 11 16 7 3	V11 2 10 5 11 13 12 5 7 7 19 6	V12 1 6 2 3 2 2 2 3 6 4	V13 1 9 11 10 11 2 1 11 2 2 1	V14 1 9 11 10 11 2 1 11 2 2 2 1	V15 1 6 3 2 9 9 2 1 1 3 1	V16 4 3 6 1 1 1 1 1 1	Total 24 53 116 164 227 168 105 69 175 91 91 94 33
The '0 V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11 V12 V13	$ \begin{array}{c}     C^{4}, \mathbf{r} \\     \overline{\mathbf{V1}} \\     \overline{\mathbf{V1}} \\     \overline{4} \\     \overline{3} \\     \overline{6} \\     \overline{1} \\   \end{array}   $	$ \begin{array}{c} \text{matrix} \\ \hline V2 \\ \hline 3 \\ \hline 14 \\ \hline 5 \\ \hline 2 \\ \hline 11 \\ \hline 2 \\ \hline 1 \\ \hline 3 \\ \hline 1 \\ \hline$	x V3 6 5 19 13 12 13 2 1 13 2 1 13 2 2 1 9	V4 1 2 13 25 23 22 6 4 20 7 10 6 11	V5 1 11 23 56 23 14 4 32 14 5 5 2 10	V6 1 22 23 25 9 8 20 6 11 3 11	V7 1 2 6 14 9 19 12 11 11 13 2 2	V8 1 4 4 12 12 4 8 12 2 2 1	V9 1 3 13 20 32 20 11 4 27 11 5 2 11	V10 1 2 7 14 6 11 8 11 16 7 3 2	V11 2 10 5 11 13 12 5 7 7 19 6 2	V12 1 6 2 3 2 2 2 3 6 4 1	V13 1 1 9 11 10 11 2 1 11 2 2 2 1 7	V14 1 9 11 10 11 2 1 11 2 2 2 1 7	V15 1 6 3 2 9 2 1 1 1	V16 4 3 6 1 1 1 1 1 1 1 1	Total 24 53 116 164 227 168 105 69 175 91 91 94 33 78
The 'd V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V10 V11 V12 V13 V14	$ \begin{array}{c} C^{4,} r \\ V1 \\ \hline V1 \\ \hline 4 \\ \hline 3 \\ \hline 6 \\ 1 \\ \hline 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\$	$ \begin{array}{c} \text{matrix} \\ \hline V2 \\ \hline 3 \\ \hline 14 \\ \hline 5 \\ \hline 2 \\ \hline 11 \\ \hline 2 \\ \hline 1 \\ \hline$	x V3 6 5 19 13 12 13 2 1 13 2 1 13 2 1 13 2 1 9 9 9	V4 1 2 13 25 23 22 6 4 20 7 10 6 11 11	V5 1 11 223 56 23 14 4 32 14 5 2 10 10	V6 1 22 23 25 9 8 20 6 11 3 11 11	V7 1 2 6 14 9 19 12 11 11 13 2 2 2 2	V8 1 4 4 12 12 4 8 12 2 1 1 1	V9 1 3 20 32 20 11 4 27 11 5 2 11 11	V10 1 2 7 14 6 11 8 11 16 7 3 2 2	V11 2 10 5 11 13 12 5 7 7 19 6 2 2	V12 1 6 2 3 2 2 2 3 6 4 1 1	V13 1 1 9 11 10 11 11 2 2 1 1 11 2 2 1 7 7	V14 1 9 11 10 11 2 1 1 11 2 2 2 1 7 7 7	V15 1 6 3 2 9 2 1 1 1 1 1	V16 4 3 6 1 1 1 1 1 1 1 1 1	Total 24 53 116 164 227 168 105 69 175 91 94 33 78 78
The '0 V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11 V12 V13 V14 V15	$ \begin{array}{c} C^{4}, \mathbf{r} \\ \overline{V1} \\ 4 \\ 3 \\ 6 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1$	$ \begin{array}{c} \text{matrix} \\ \hline V2 \\ \hline 3 \\ \hline 14 \\ \hline 5 \\ \hline 2 \\ \hline 11 \\ \hline 2 \\ \hline 1 \\ \hline 1 \\ \hline 1 \\ \hline 1 \\ \hline 6 \\ \end{array} $	x V3 6 5 19 13 12 13 2 1 13 2 1 13 2 1 9 9 3	V4 1 2 13 25 23 22 6 4 20 7 10 6 11 11 11 2	V5 1 11 12 23 56 23 14 4 4 32 14 4 5 2 10 10 9	V6 1 22 23 25 9 8 20 6 11 3 11 11 2	V7 1 2 6 14 9 19 12 11 11 13 2 2 2 1	V8 1 4 4 12 12 4 8 12 2 1 1 1 1	V9 1 3 13 20 32 20 11 4 27 11 5 2 11 11 3	V10 1 2 7 14 6 11 8 11 16 7 3 2 2 1	V11 2 10 5 11 13 12 5 7 19 6 2 2	V12 1 6 2 3 2 2 3 6 4 1 1	V13 1 9 11 10 11 2 1 11 2 1 7 7 1	V14 1 9 11 10 11 11 2 1 11 2 2 1 7 7 7 7 1	V15 1 6 3 2 9 2 1 1 3 1 1 1 4	V16 4 3 6 1 1 1 1 1 1 1 1 1 1	Total 24 53 116 164 227 168 105 69 175 91 91 94 33 78 78 78 35

# The 'C<sup>5</sup>' matrix

	<b>V1</b>	<b>V2</b>	<b>V3</b>	<b>V4</b>	<b>V5</b>	<b>V6</b>	V7	<b>V8</b>	<b>V9</b>	V10	V11	V12	V13	V14	V15	V16	Total
V1	4	14	6	2	11	2	1		3	1			1	1	6	4	56
V2	14	14	31	15	15	15	2	1	15	2	2	1	11	11	6	14	169
V3	6	31	23	28	76	28	16	4	39	16	5	2	13	13	19	6	325
V4	2	15	28	53	103	51	36	16	71	41	18	8	24	24	13	2	505
V5	11	15	76	103	116	103	33	19	104	31	32	14	56	56	13	11	793
V6	2	15	28	51	103	55	44	21	71	36	24	6	24	24	13	2	519
V7	1	2	16	36	33	44	37	33	30	22	43	11	14	14	2	1	339
V8		1	4	16	19	21	33	26	16	19	33	8	4	4	1		205
V9	3	15	39	71	104	71	30	16	75	28	26	11	33	33	13	3	571
V10	1	2	16	41	31	36	22	19	28	20	35	16	14	14	2	1	298
V11		2	5	18	32	24	43	33	26	35	35	8	5	5	2		273
V12		1	2	8	14	6	11	8	11	16	8	4	2	2	1		94
V13	1	11	13	24	56	24	14	4	33	14	5	2	11	11	9	1	233
V14	1	11	13	24	56	24	14	4	33	14	5	2	11	11	9	1	233
V15	6	6	19	13	13	13	2	1	13	2	2	1	9	9	4	6	119
V16	4	14	6	2	11	2	1		3	1			I	1	6	4	56
The	'С <sup>6</sup> '	matr	ix														
The	<sup>•</sup> C <sup>6</sup> , V1	matr	ix V3	V4	V5	V6	V7	' <b>V</b> 8	5 V9	V10	V11	V12	V13	V14	V15	V16	Total
The V1	*C <sup>6</sup> , <b>V1</b>	matr V2	ix <b>V3</b> 5 32	<b>V4</b> 2 15	<b>V5</b> 15	<b>V6</b>	<b>V7</b>	<b>V8</b> 2 1	<b>V9</b>	<b>V10</b>	<b>V11</b> 2 2	V12	<b>V13</b>	<b>V14</b>	V15	<b>V16</b>	<b>Total</b> 173
The V1 V2	*C <sup>6</sup> , <b>V1</b> 15 15	matr V2 5 15 5 62	ix V3 32 2 36	<b>V4</b> 2 15 5 32	<b>V5</b> 15 99	<b>V6</b> 15 32	<b>V7</b>	7 <b>V8</b> 2 1 3 4	<b>V9</b> 15 45	<b>V10</b>	<b>V11</b> 2 2 3 5	<b>V12</b>	<b>V13</b> 11 2 15	<b>V14</b>	<b>V15</b>	<b>V16</b> 5 15 2 15	<b>Total</b> 173 445
The V1 V2 V3	*C <sup>6</sup> , <b>V1</b> 15 15 32	matr V2 5 15 5 62 2 36	ix V3 32 36 129	<b>V4</b> 2 15 5 32 9 132	<b>V5</b> 15 99 145	<b>V6</b> 15 32 132	V7 22 18 37	7 <b>V8</b> 2 1 3 4 7 21	<b>V9</b> 15 45 133	V10 22 18 35	<b>V11</b> 2 2 3 5 5 36	V12	<b>V13 1 1 1 2 15 5 77</b>	<b>V14</b> 11 15 15 77	<b>V15</b> <b>1 6</b> <b>5 32</b> <b>7 2</b> <sup>2</sup>	<b>V16</b> 5 15 2 15 4 32	Total           173           445           1094
The V1 V2 V3 V4	*C <sup>6</sup> , <b>V1</b> 15 15 32 15	matr V2 5 15 5 62 2 36 5 32	ix V3 32 36 129 132	<b>V4</b> 2 15 5 32 9 132 2 218	<b>V5</b> 15 99 145 253	V6 15 32 132 212	V7 22 18 37 85	7 <b>V8</b> 2 1 3 4 7 21 5 54	<b>V9</b> 15 45 133 209	V10 22 18 35 80	<b>V11</b> 2 2 3 5 5 36 9 94	<b>V12</b>	<b>V13 1 1 1 2 15 5 77 2 104</b>	<b>V14</b> 11 5 15 7 7 104	<b>V15</b> <b>0</b> 5 32 7 24 4 28	<b>V16</b> 5 15 2 15 4 32 3 15	Total           173           445           1094           1677
The           V1           V2           V3           V4           V5	*C <sup>6</sup> , <b>V1</b> 15 15 32 15 15	matr <b>V2</b> 5 15 5 62 2 36 5 32 5 99	ix V3 32 36 129 132 132	<ul> <li>V4</li> <li>2</li> <li>15</li> <li>32</li> <li>32</li> <li>132</li> <li>218</li> <li>253</li> </ul>	V5 15 99 145 253 504	V6 15 32 132 212 255	V7 22 18 37 85 155	V8       2     1       3     4       7     21       5     54	<b>V9</b> 15 45 133 209 325	V10 22 18 35 80 150	V11 2 2 3 5 5 36 9 94 0 83	V12	V13           1           2           5           77           2           104           117	V14 11 5 15 7 77 104 7 117	<b>V15 1 6 5 32 7 24 4 28 7 7 7</b>	<b>V16</b> 5 15 2 15 4 32 3 15 7 15	Total           173           445           1094           1677           2406
The           V1           V2           V3           V4           V5           V6	*C <sup>6</sup> , <b>V1</b> 15 15 32 15 15 15 15 15 15	matr <b>V2</b> 5 15 5 62 2 36 5 32 5 99 5 32	ix V3 32 36 5 129 2 132 2 132 2 132	V4       2     15       5     32       0     132       2     218       5     253       2     212	V5 15 99 145 253 504 255	V6 15 32 132 212 255 221	V7 22 18 37 85 155	V8       2     1       3     4       7     21       5     54       5     65       6     69	<ul> <li>V9</li> <li>15</li> <li>45</li> <li>133</li> <li>209</li> <li>325</li> <li>211</li> </ul>	V10 22 18 35 80 150 81	V11 2 2 3 55 5 36 9 94 0 83 102	V12	V13           1         11           2         15           5         77           2         104           1         117           5         104	V14           11           5           7           7           104           104           104	<b>V15</b> 1 6 5 32 7 24 4 28 7 77 4 28	V16           5         15           2         15           4         32           3         15           7         15           3         15	Total           173           445           1094           1677           2406           1718
The           V1           V2           V3           V4           V5           V6           V7	*C <sup>6</sup> , <b>V1</b> 15 15 32 15 15 15 15 22	matr <b>V2</b> 5 15 5 62 2 36 5 99 5 99 5 32 2 18	ix <b>V3</b> 32 36 129 132 132 145 2132 37	V4       2     15       5     32       9     132       2     218       5     253       2     212       7     85	V5 15 99 145 253 504 255 155	V6           15           32           132           212           255           221           101	V7 18 37 85 155 101 123	V8       2     1       3     4       7     21       5     54       5     65       1     69       3     82	<ul> <li>V9</li> <li>15</li> <li>45</li> <li>133</li> <li>209</li> <li>325</li> <li>211</li> <li>114</li> </ul>	V10 22 18 35 80 150 81 91	V11 2 2 3 5 5 36 5 36 9 94 0 83 102 94	V12	V13           1           1           2           5           77           2           104           1           17           104           2           33	V14           11           5         15           7         77           104         104           3         33	V15 322 322 322 428 428 428 316	V16           5         15           2         15           4         32           3         15           7         15           3         15           5         2	Total           173           445           1094           1677           2406           1718           1008
The           V1           V2           V3           V4           V5           V6           V7           V8	*C <sup>6</sup> , <b>V1</b> 15 15 32 15 15 22 15 15 15 15 15 15 15 15 15 15	matr <b>V2</b> 5 15 5 62 2 36 5 32 5 99 5 32 2 18 1 4	ix V3 32 36 129 132 132 132 132 37 4 21	V4       2     15       5     32       0     132       2     218       5     253       2     212       7     85       5     54	V5 15 99 145 253 504 255 155 65	V6           15           32           132           212           255           221           101           69	V7 22 18 37 85 155 101 123 82	V8       2     1       3     4       7     21       5     54       5     65       1     69       3     82       2     68	<ul> <li>V9</li> <li>15</li> <li>45</li> <li>133</li> <li>209</li> <li>325</li> <li>211</li> <li>114</li> <li>56</li> </ul>	V10 22 18 35 80 150 81 91 58	V11 2 2 3 55 5 366 94 0 83 102 94 3 80	V12 1 1 1 1 1 1 1 1 1 1 1 1 1	V13           1         11           2         15           5         77           2         104           1         117           5         104           2         33           9         19	V14           11           5           7           104           104           104           333           19	V15           1         6           5         32           7         24           4         28           7         77           4         28           3         16           9         2	V16           5         15           2         15           3         15           7         15           3         15           5         2	Total         173         445         1094         1677         2406         1718         1008         620
The           V1           V2           V3           V4           V5           V6           V7           V8           V9	*C <sup>6</sup> , <b>V1</b> 15 15 32 15 15 15 15 15 15 15	$\begin{array}{c c} matr \\ \hline V2 \\ \hline 5 & 15 \\ \hline 5 & 62 \\ \hline 2 & 36 \\ \hline 5 & 32 \\ \hline 1 & 4 \\ \hline 5 & 45 \\ \end{array}$	ix V3 5 32 2 36 5 129 2 132 2 132 2 132 3 37 4 21 5 133	V4       2     15       5     32       9     132       2     218       5     253       2     212       7     85       1     54       3     209	V5 15 99 145 253 504 255 155 65 325	V6           15           32           132           212           255           221           101           69           211	V7 2 18 37 85 155 101 123 82 114	V8       2     1       3     4       7     21       5     54       5     65       1     69       3     82       2     68       4     56	<ul> <li>V9</li> <li>15</li> <li>45</li> <li>133</li> <li>209</li> <li>325</li> <li>211</li> <li>114</li> <li>56</li> <li>249</li> </ul>	V10 2 18 35 80 150 81 91 58 109	V11 2 2 3 5 5 36 9 94 102 102 94 8 80 94 94 94 94 94 94 94 94 94 94	V12 1 1 2 1 2 1 2 2 2 2 2 2 2 2 2 2 2 2	V13           1         11           2         15           5         77           2         104           1         117           5         104           2         33           9         19           3         105	V14           11           5         15           7         104           104         104           3         33           0         19           5         105	V15 1 (c) 5 32 7 24 4 28 7 77 4 28 3 10 9 4 5 39	V16           5         15           2         15           4         32           3         15           7         15           3         15           5         2           4         1           5         2           4         1           5         15	Total         173         445         1094         1677         2406         1718         1008         620         1832
The           V1           V2           V3           V4           V5           V6           V7           V8           V9           V10	*C <sup>6</sup> * <b>V1</b> 15 15 15 15 15 15 15 15 15 15	matrix         V2         5       15         5       62         2       36         5       32         5       32         5       32         1       4         5       45         2       18         1       4         5       45         2       18	ix V3 32 36 129 132 132 132 132 133 37 21 133 35 35	V4       2     15       32     132       2     218       5     253       2     212       7     85       1     54       3     209       5     80	V5 15 99 145 253 504 255 155 65 325 150	V6           15           32           132           212           255           221           101           69           211           81	V7 2 18 37 85 155 100 123 82 112 91	V8           2         1           3         4           7         211           5         54           5         65           69         82           3         82           68         56           5         56           5         56           5         56           5         56           5         56           5         56           5         58	V9 15 45 133 209 325 211 114 56 249 109	V10 22 18 35 80 150 81 91 58 109 95	V11         2       2         3       5         5       36         0       94         102       94         3       80         74       62	V12 16 16 42 31 36 22 22 25 28 28 21	V13           1         11           2         15           5         77           2         104           1         117           5         104           2         33           9         19           3         105           1         31	V14           11           5           7           7           104           104           104           104           104           104           104           104           104           105           105           105	V15           1         6           5         32           7         24           28         7           7         77           1         28           7         77           1         28           3         16           9         2           5         39           1         16	V16           5         15           2         15           4         32           3         15           3         15           5         2           4         15           5         2           4         15           5         2           4         15           5         2	Total         173         445         1094         1677         2406         1718         1008         620         1832         882
The           V1           V2           V3           V4           V5           V6           V7           V8           V9           V10           V11	*C <sup>6</sup> * <b>V1</b> 15 15 15 15 15 15 15 15 15 15	$\begin{array}{c c} matr \\ \hline V2 \\ \hline 5 & 15 \\ \hline 5 & 62 \\ \hline 2 & 36 \\ \hline 5 & 32 \\ \hline 5 & 45 \\ \hline 2 & 18 \\ \hline 2 & 18 \\ \hline 2 & 5 \\ \hline \end{array}$	ix V3 5 32 2 36 5 129 2 132 1 132 3 37 4 21 5 133 3 35 5 36	V4         2       15         32       132         2       218         5       253         2       212         7       85         1       54         3       209         5       80         5       94	V5 15 99 145 253 504 255 155 65 325 150 83	V6           15           32           132           212           255           221           101           69           211           81           102	V7 2 18 37 85 155 101 123 82 114 91 94	V8           2         1           3         4           7         21           5         54           5         65           69         82           3         82           2         68           4         56           5         58           4         80	V9         15         45         133         209         325         211         114         56         249         109         74	V10 22 18 35 80 150 81 91 91 58 109 95 62	V11         2       2         3       5         5       36         0       94         0       83         102       94         3       80         0       74         5       62         2       114	V12 1 1 1 1 1 1 1 1 1 1 1 1 1	V13           1         11           2         15           5         77           2         104           1         117           5         104           2         33           9         19           3         105           1         31           5         32	V14           11           5           7           104           104           104           104           105           105           105           105           105           105           105           105           105           105	V15           1         6           5         32           7         24           4         28           7         77           4         28           3         16           9         2           5         39           1         16           2         5	V16           5         15           2         15           2         15           3         15           7         15           3         15           2         1           5         2           4         1           5         2           5         2           5         2	Total         173         445         1094         1677         2406         1718         1008         620         1832         882         853
The           V1           V2           V3           V4           V5           V6           V7           V8           V9           V10           V11           V12	*C <sup>6</sup> * <b>V1</b> 15 15 15 15 15 15 15 15 15 15	$\begin{array}{c c} matr \\ V2 \\ \hline 5 & 15 \\ \hline 5 & 62 \\ \hline 2 & 36 \\ \hline 5 & 32 \\ \hline 5 & 45 \\ \hline 1 & 4 \\ \hline 5 & 45 \\ \hline 2 & 18 \\ \hline 2 & 5 \\ \hline 1 & 2 \\ \hline \end{array}$	ix V3 32 36 5 129 132 132 132 132 132 3 37 1 133 35 5 36 2 16	V4         2         15         32         132         2	V5           15           99           145           253           504           255           155           65           325           150           83           31	V6           15           32           132           212           255           221           101           69           211           81           102           36	V7 2 18 37 85 155 101 123 82 112 91 92 22	V8           2         1           3         4           7         211           5         54           5         55           65         65           3         822           68         56           4         56           5         56           65         1           68         4           56         1           58         4           56         1           58         4           50         1           58         1	V9 15 45 133 209 325 211 114 56 249 109 74 28	V10 22 18 35 80 150 81 91 58 109 95 62 21	V11           2         2           3         5           5         36           0         94           102         94           3         80           74         5           5         62           114         36	V12 1 1 1 1 1 1 1 2 1 1 2 2 2 2 2 2 2 3 6 1 2 2 2 2 2 2 2 2 2 2 2 2 2	V13           1         11           2         15           5         77           2         104           1         117           5         104           2         33           9         19           3         105           1         31           5         32           7         14	V14           11           5           15           104           105	V15           1         6           5         32           7         24           1         28           7         77           1         28           3         16           9         2           5         39           1         16           2         5           4         22	V16           5         15           2         15           4         32           3         15           3         15           5         2           4         1           5         2           5         2           5         2           5         2           1         1	Total         173         445         1094         1677         2406         1718         1008         620         1832         882         853         302
The           V1           V2           V3           V4           V5           V6           V7           V8           V9           V10           V11           V12           V13	*C <sup>6</sup> * <b>V1</b> 15 15 15 15 15 15 15 15 15 15	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	ix V3 5 32 2 36 5 129 2 132 1 132 2 132 2 132 3 37 5 36 5 36 2 16 5 77	V4         2         15         32         132         2	V5 15 99 145 253 504 255 155 65 325 150 83 31 117	V6           15           32           132           212           255           221           101           69           211           81           102           36           104	V77 22 188 377 855 100 1223 822 112 91 92 222 33	V8           2         1           3         4           7         21           5         54           5         54           5         65           69         82           2         68           4         56           5         58           4         80           2         19           3         19	V9 15 45 133 209 325 211 114 56 249 109 74 28 105	V10 22 18 35 80 150 81 91 58 109 95 62 21 31	V11         2       2         3       5         5       36         0       94         0       83         102       94         3       80         74       5         5       62         114       36         32       32	V12 1 2 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2	V13           1         11           2         15           5         77           2         104           1         117           5         104           2         33           9         19           3         105           1         31           5         32           7         14           4         57	V14           11           5           15           104           104           104           104           104           105	V15           1         6           5         32           7         24           1         28           7         724           1         28           7         77           1         28           3         16           2         5           3         2           1         16           2         5           4         22           4         22           4         22           4         22           4         22           4         22	V16           5         15           2         15           2         15           3         15           7         15           3         15           5         2           4         1           5         2           5         2           1         1           3         11	Total         173         445         1094         1677         2406         1718         1008         620         1832         882         853         302         800
The           V1           V2           V3           V4           V5           V6           V7           V8           V9           V10           V11           V12           V13           V14	*C <sup>6</sup> * <b>V1</b> 15 15 15 15 15 15 15 15 15 15	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	ix V3 32 36 129 132 132 132 132 132 133 37 21 337 21 337 21 337 21 337 21 337 21 35 36 37 37 37 37 37 37 37 37 37 37	V4         2       15         5       32         0       132         2       218         5       253         2       212         7       85         1       54         3       209         5       80         5       94         5       42         7       104         7       104	V5 15 99 145 253 504 255 155 65 325 150 83 31 117 117	V6           15           32           132           212           255           221           101           69           211           81           102           36           104	V77 22 188 377 855 101 122 822 112 91 92 222 33 33	V8           2         1           3         4           7         211           5         54           65         65           5         65           69         82           2         68           4         56           5         58           4         56           5         58           4         800           2         19           3         19           3         19	V9 15 45 133 209 325 211 114 56 249 109 74 28 105 105	V10           22           18           35           80           150           81           91           58           109           95           62           21           31           31	V11           2         2           3         5           5         36           0         94           102         94           3         800           74         94           3         800           74         36           3         32           32         32	V12 2 16 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	V13           1         11           2         15           5         77           2         104           1         117           5         104           2         33           0         19           3         105           3         105           3         105           4         57	V14           5         15           5         15           7         77           104         104           7         117           104         104           104         104           104         104           105         105           105         105           105         105           105         105           104         104           105         105           105         105           105         105           105         105           107         57           107         57	V15           1         6           5         32           7         24           4         28           7         77           4         28           5         39           1         16           2         5           4         2           4         2           5         39           1         16           2         5           4         2           7         13           7         13	V16           5         15           2         15           4         32           3         15           3         15           2         1           3         15           2         1           5         2           4         1           9         15           5         2           2         1           3         11           3         11	Total         173         445         1094         1677         2406         1718         1008         620         1832         882         883         302         800         800
The           V1           V2           V3           V4           V5           V6           V7           V8           V9           V10           V11           V12           V13           V14           V15	C <sup>6</sup> V1           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           15         15           16         11           17         11           18         11	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	ix V3 32 36 129 132 132 132 132 132 132 133 37 21 33 37 21 33 37 21 35 36 37 21 37 51 29 21 32 21 32 37 51 29 21 32 37 51 29 21 32 51 29 21 32 51 29 21 32 51 29 21 32 51 29 21 32 51 29 21 32 51 29 21 32 51 29 21 32 51 52 52 52 52 52 52 52 52 52 52	V4         2         15         32         132         3         2         3         2         3         2         3         2         3         2         3         2         3         2         3         4         2 <td>V5 15 99 145 253 504 255 155 65 325 150 83 31 117 117 77</td> <td>V6           15           32           132           212           255           221           101           69           211           81           102           36           104           28</td> <td>V77 2 18 37 85 10 123 10 123 10 123 112 22 22 33 33 16</td> <td>V8       2     1       3     4       4     5       5     54       5     54       5     54       5     54       5     54       69     82       8     56       5     56       5     56       68     56       5     58       4     56       5     4</td> <td>V9 15 45 133 209 325 211 114 56 249 109 74 28 105 105 39</td> <td>V10           22           18           35           80           150           81           91           58           109           95           62           21           31           31           16</td> <td>V11           2         2           3         5           5         36           0         94           0         94           102         94           3         80           74         36           2         114           36         32           32         32           5         5</td> <td>V12 1 1 1 1 1 1 1 2 2 1 2 2 2 1 2 2 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2</td> <td>V13           1         11           2         15           5         77           2         104           1         117           5         104           2         33           9         19           3         105           3         105           3         105           4         57           4         57           2         13</td> <td>V14           11           5           15           104           104           104           104           104           104           104           104           104           104           104           104           104           104           105</td> <td>V15           1         6           5         32           7         24           28         7           7         77           4         28           7         77           4         28           7         77           4         28           6         39           2         5           4         22           5         39           1         16           2         5           4         22           5         39           1         16           2         5           3         20</td> <td>V16           5         15           2         15           2         15           3         15           3         15           3         15           3         15           5         2           4         1           5         2           5         2           1         1           3         11           3         11           0         6</td> <td>Total         173         445         1094         1677         2406         1718         1008         620         1832         882         853         302         800         800         329</td>	V5 15 99 145 253 504 255 155 65 325 150 83 31 117 117 77	V6           15           32           132           212           255           221           101           69           211           81           102           36           104           28	V77 2 18 37 85 10 123 10 123 10 123 112 22 22 33 33 16	V8       2     1       3     4       4     5       5     54       5     54       5     54       5     54       5     54       69     82       8     56       5     56       5     56       68     56       5     58       4     56       5     4	V9 15 45 133 209 325 211 114 56 249 109 74 28 105 105 39	V10           22           18           35           80           150           81           91           58           109           95           62           21           31           31           16	V11           2         2           3         5           5         36           0         94           0         94           102         94           3         80           74         36           2         114           36         32           32         32           5         5	V12 1 1 1 1 1 1 1 2 2 1 2 2 2 1 2 2 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2	V13           1         11           2         15           5         77           2         104           1         117           5         104           2         33           9         19           3         105           3         105           3         105           4         57           4         57           2         13	V14           11           5           15           104           104           104           104           104           104           104           104           104           104           104           104           104           104           105	V15           1         6           5         32           7         24           28         7           7         77           4         28           7         77           4         28           7         77           4         28           6         39           2         5           4         22           5         39           1         16           2         5           4         22           5         39           1         16           2         5           3         20	V16           5         15           2         15           2         15           3         15           3         15           3         15           3         15           5         2           4         1           5         2           5         2           1         1           3         11           3         11           0         6	Total         173         445         1094         1677         2406         1718         1008         620         1832         882         853         302         800         800         329