

# SUSTAINABLE TRANSPORT

## TRANSPORTATION NETWORKS SYSTEM INDICATORS

**Dr. Thaeer Sh. Mahmood**



# Transport indicator categories

There are various types that could be utilized to define transport indicators. Some are assembled roughly as economic, social, environmental and system indicators. Others are also assembled as demand and supply based indicators.

Conventional transport indicators measure frequently traffic circumstances. These contain roadway (LOS), average travel speed, average congestion delay, system-wide travel time, unused capacity in the network and volume to capacity ratio.

There are no uniform indicators set for comprehensive transport planning Each institution improves their own set of indicators based on the need and institutions capabilities.



:Types of indicators are

Connectivity .1

2. Elementary graph theory measures.

3. First betty index

4. Grid-Tree pattern index

5. Detour index

6. Correlation index



## Elementary graph theory measurers

To understand the requirements of any road network, it is important to simplify the number of straight lines (links) and nodes of the road network, was identified as topological diagram where Garrison is the first person who used the graph theory for analyzing the transportation structure.

The topological is one of the quantity geometry being positions and relations between points, lines and areas without interested in distance between points or direction of lines or area of zones

By reducing circuit networks to graph, it can be capable of using measures that are established in graph theories to compare sets of networks. In any graph, four basic quantities (using the graph theory terminology) can be determined as following

- e**: the number of edges (links) •
- **v**: the number of vertices (nodes)
- **p**: the number of separate non-connecting sub-graphs
- **m**: the total network length

The measured developed in graph theory are

1.  **$\alpha$**  (Alpha) Index
2.  **$\beta$**  (Beta) Index
3.  **$\eta$**  (Eta) Index
4.  **$\gamma$**  (Gamma) Index



## **$\alpha$ (Alpha) index .1**

The  $\alpha$  index is calculating as follows :(

$$\alpha = (e-v+p) / (2v-5) \dots\dots\dots(1)$$

The  $\alpha$  index compares the number of closed circuits in a network ( $e-v+p$ ) against

the maximum possible circuits, which might have  $(2v-5)$  and it is measuring of rotation (density of road network number of in specific

area). The value ranges between zero and unity. A higher value of  $\alpha$

.Indicates a higher possible level of connectivity



## **$\beta$ (Beta) index .2**

It is also identified as the link-node ratio, which measures the "completeness" of a graph. This index determines the level of connectivity of the transport network. The  $\beta$  index is determined as follows :

$$\beta = e/v \dots\dots\dots(2)$$

Its value is zero and three for most route networks; a value of  $\beta$  less one shows a branching like network, whereas a value of higher than one

shows an increasing complexity (very well connected network).

Thus,  $\beta$  index distinguishes simple topological structures from complex .topological structures



## **η (Eta) index .3**

This index uses for measuring the real lengths of links between the

nodes as indicated below:

$$\eta = m/e \dots\dots\dots(3)$$

The  $\eta$  index, which calculates the total length, introduces some notices of geographic scale; the more densely a network is packed into a

region and the greater the number of junctions the shorter will edge

length become. This value starts from zero. If this value is zero, this

means that no spreading for the networks in spatial urban (i.e. this network is without access) . Therefore,  $\eta$  is expected to be high in ill developed

.networks and low in well-developed networks



## $\gamma$ (Gamma) index .4

The  $\gamma$  index is calculating as follows :

$$\gamma = e / 3(v-2) \dots\dots\dots(4)$$

The  $\gamma$  index compares the actual number of edges in a network,  $e$ , against the maximum possible number of circuits which might have  $3(v-2)$  and it is measuring the connection for road network. The value ranges between zero and unity. A value closer to zero indicates a simpler network with fewer links where a value closer to unity indicators a better connected .network with more links



## **First betty index**

This index is used to measure the level of spreading in its region.

The value of this index ranges from one and more, and if this value is zero this means no spreading. This index is determined from the following equation:

$$\text{Betty index} = e - v + 1 \dots \dots \dots (5)$$



## Grid-Tree Pattern index(GTP)

The grid-tree pattern (GTP)( index for road connectedness is carefully chosen from existing pattern indices.

Different indices representing the relationship between the number

of roads and the number of intersections have been proposed in the

field of quantitative geography). An index for connectedness is expanded to make it possible to evaluate the

relationship in a square grid road network, and is determined as the

GTP index as:

$$\text{GTP index} = \frac{e - v + p}{(\sqrt{v} - 1)^2} \dots\dots\dots(6)$$



# Detour index

The shortest distance is the straight one, so the best roads which are straightly extended; however, most roads deviate either right or left and ascend or descend under different conditions. This leads to increase the lengths of these roads, which is called detour index.

This index is used to evaluate the efficiency of roads by knowing the lengths of roads in transportation network in addition to the straight lengths. Consequently, this will help know where you have to add or cancel some links in the network under study.

The value of this index could be determined according to the following equation:

$$\text{Detour index} = \left( \frac{\text{the actual length of the road}}{\text{the straight length of the same road}} \right) * 100 \dots \dots \dots (7)$$



## Correlation index

This index represents the correlation degree between links in the

network. This index is calculated as:

**Correlation index = no. of links / max. no. of possible links.....(8)**

Where;

The max possible links =  $1/2(n^2 - n)$

n = no. of nodes.

The value for this index is zero, which represents there is no link in

the network. Whereas, when the value is one this represents that the

.number of links is the max possible number



# Road density computation

Road density depends on the multi factors such as geography, economy and history of the region. The network density could give better another important prediction of the road network measures.

Therefore, computing the density of road is considered one of the important economic criteria that reflect the economic development of roads and evaluates the efficiency of road network and availability and decreases of it in the cities



**A. Road density according to the area= total roads in  
km ÷ Area kilometers in square**

**B. Road Density for the total number of population  
Network density for the population = total roads in km \* 100 ÷  
Population...(10)**



Where the number of population for each year can be calculated from the

Equation of growth:

$$P_{t+1} = P_t (1+r)^n \dots\dots\dots(11)$$

$P_{t+1}$ : The total number of population for the next year

$P_t$ : The total number of population for the last year

$n$ : Number of years between the last and the next year

$r$ : The rate of growth

