Sistem transportasi - AKSESIBILITAS

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STUDY PLAN

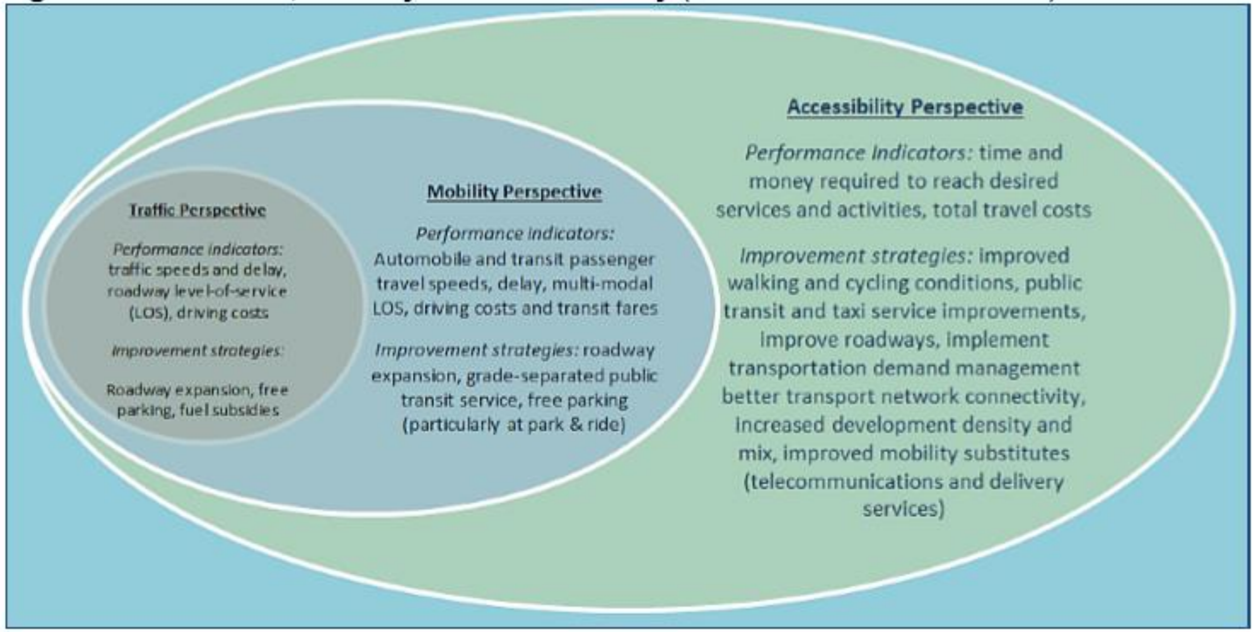
ACCESSIBILTIY

Definition

Indicators and measurements

ACCESSIBILITY AND MOBILITY

Figure 1 **Traffic, Mobility and Accessibility** (Duranton and Guerra 2016)



Transportation can be viewed from various perspectives: ***vehicle traffic*** *is a subset of* ***mobility****, which is a subset of* ***accessibility****. Accessibility is the broadest perspective and so offers the most potential solutions to transport problems, including more accessible land use development and mobility substitutes such as improved telecommunications and delivery services.*

(As in Litman, T. , 2017, p. 4).

Mobility concerns with the performance of transport systems in their own right,
Accessibility adds the interplay of transport system and land use patterns as a further layer of analysis.

Table 1 **Transportation Evaluation Perspectives** (Litman 2003)

	Vehicle Travel	Mobility	Accessibility
Definition of *Transportation*	Vehicle travel	Person and goods movement	Ability to obtain goods, services and activities
Measurement units	Vehicle miles	Person-miles and ton-miles	Trips, generalized costs
Modes considered	Automobile and truck	Automobile, truck and transit	Automobile, truck, transit, cycling and walking
Common indicators	Vehicle traffic volumes and speeds, roadway Level of Service, costs per vehicle-mile, parking convenience	Travel distance and speeds, road and transit Level of Service, cost per person-mile, travel convenience	Quality of available transportation choices. Distribution of destinations. Cost per trip
Consumer benefits considered	Maximum motor vehicle travel and speed	Maximum personal travel and goods movement	Maximum transport choice and cost efficiency
Consideration of land use	Treats land use as an input, unaffected by transportation decisions	Recognizes that land use can affect travel choice	Recognizes that land use has major impacts on transportation
Favored transportation improvement strategies	Roadway and parking facility improvements to increase capacity, speed and safety	Transportation system improvements that increase capacity, speeds and safety	Management strategies and improvements that increase transport system efficiency and safety
Transportation Demand Management (TDM)	Generally considers vehicle travel reductions undesirable	Supports TDM strategies that improve personal and freight mobility	Supports TDM whenever it is cost effective

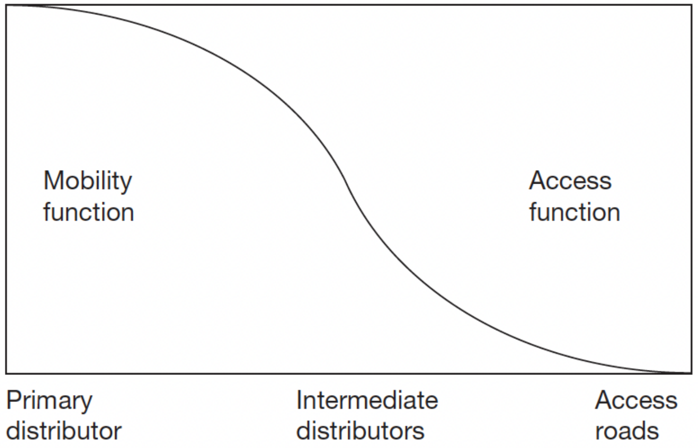
This table compares three common perspectives used to measure transportation.

Example: the significance of public transport for urban mobility in developed cities varies greatly from just over 2% of all trips in Atlanta and Los Angeles to between 26% and 31% of all trips in Barcelona, Vienna and Singapore. Australian cities range between 4% and 10% of all trips.

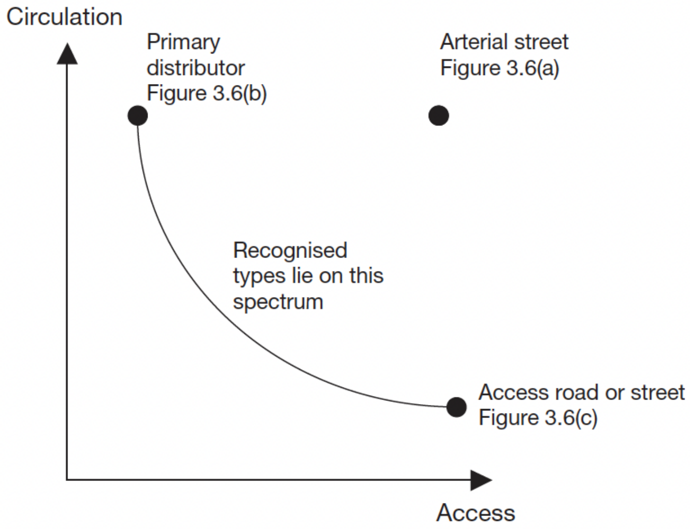
Example: The Public Transport Accessibiity Level (PTALS) tool (London): assist in decision making in locating development and setting development control standards. PTALS produces contour maps which indicate the relative accessibility of places to the public transport network (walking tine, waiting time, frequency, reliability of the services).

ELEMENT OF MOBILITY AND ACCESSIBILITY

Understanding street pattern and hierarchy



3.4 • The classic inverse relationship between mobility and access. The two variables are *dependent*: hence effectively only one 'dimension' of classification.



3.5 • The conventional classification has no place for the traditional arterial street. The traditional arterial street does not lie on the spectrum from primary distributor to local access road.

Table 3.1 **Examples of institutional hierarchies**

***Traffic in Towns*, UK**	**ITE, USA**
Primary distributor	Freeway
District distributor	Expressway
Local distributor	Major arterial
Access road	Collector street
	Local street
	Cul-de-sac

Conventional road hierarchy

Conventional road hierarchy is not only to do with the functional efficiency of traffic flow, but is also concerned with the safety, amenity and the environmental quality of urban areas.[5] It therefore does take account of non-traffic considerations in the urban context, although it often appears to do so by putting the traffic first, and fitting the other concerns around that.

The kind of road hierarchy in the UK is typical of many kinds of road classification and hierarchy in use around the world. Table 3.1 shows a range of formal classification systems used in institutional standards, such as national guidelines or local authority codes of practice.

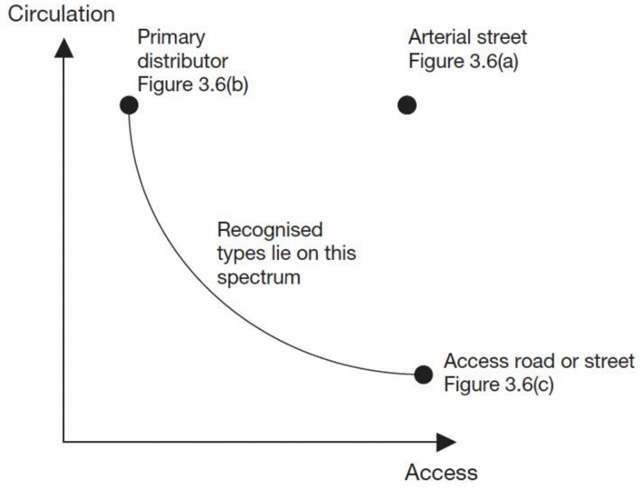
While the terminology differs in each case, the basic principles follow the same general pattern, with a spectrum from major roads to minor roads. Major roads tend to be associated with strategic routes, heavier traffic flows, higher design speeds, with limited access to minor roads with frontage access. Minor roads tend to be associated with more lightly trafficked, local routes, with lower design speeds and more frequent access points and with access to building frontages.

Stephen Marshall, Streets and Patterns, Spon Press, London & New York, 2005

(a)

(b)

(c)



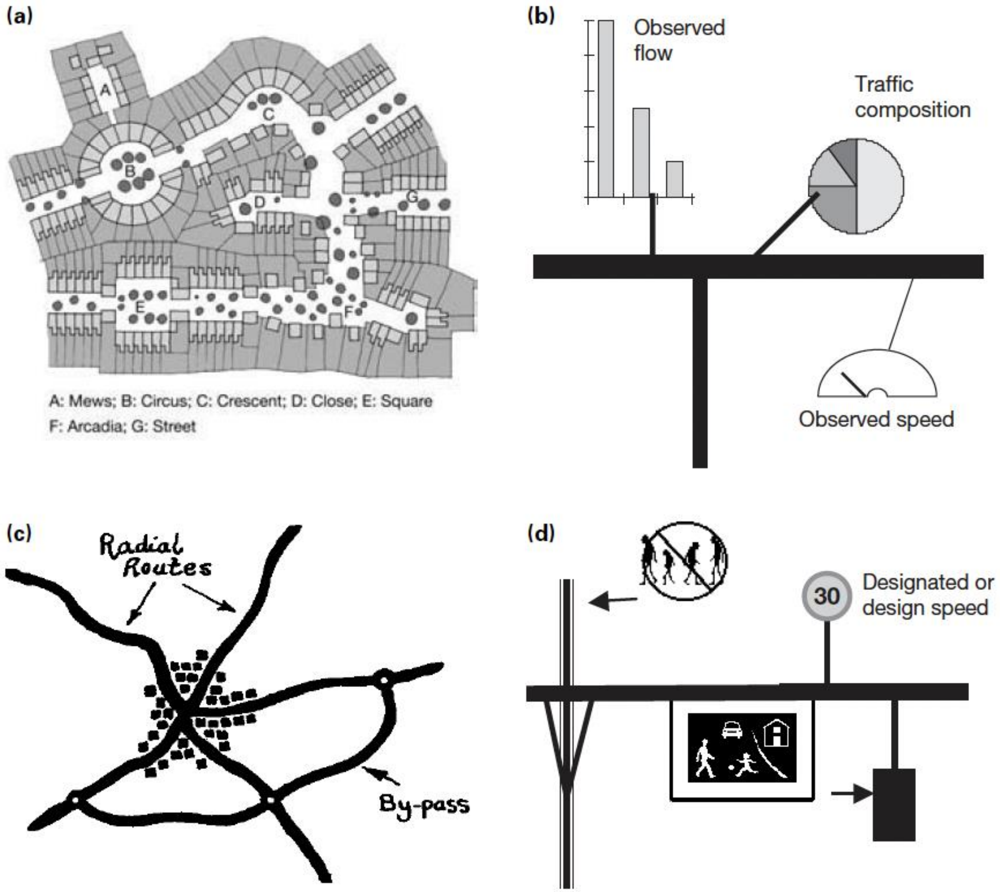
3.6 • The misfit arterial. (a) Traditional arterial street combining traffic movement and frontage access. (b) Distributor road – dedicated to traffic movement. (c) Access road – combines traffic and pedestrian movement with access to buildings.

In order to start exploring alternative ways in which hierarchy might be reformulated towards today's streets-oriented urban design agenda, we can take a look at a wider range of kinds of classification used in a broader range of contexts, and explore further the concepts of 'function' and the basis for hierarchical ordering.

Stephen Marshall, Streets and Patterns, Spon Press, London & New York, 2005

Analysis of classification themes

3.9 • Four categories of classification theme. See Table 3.3. (a) Types defined by form. (b) Types defined by use. (c) Types defined by relation. (d) Types defined by designation.



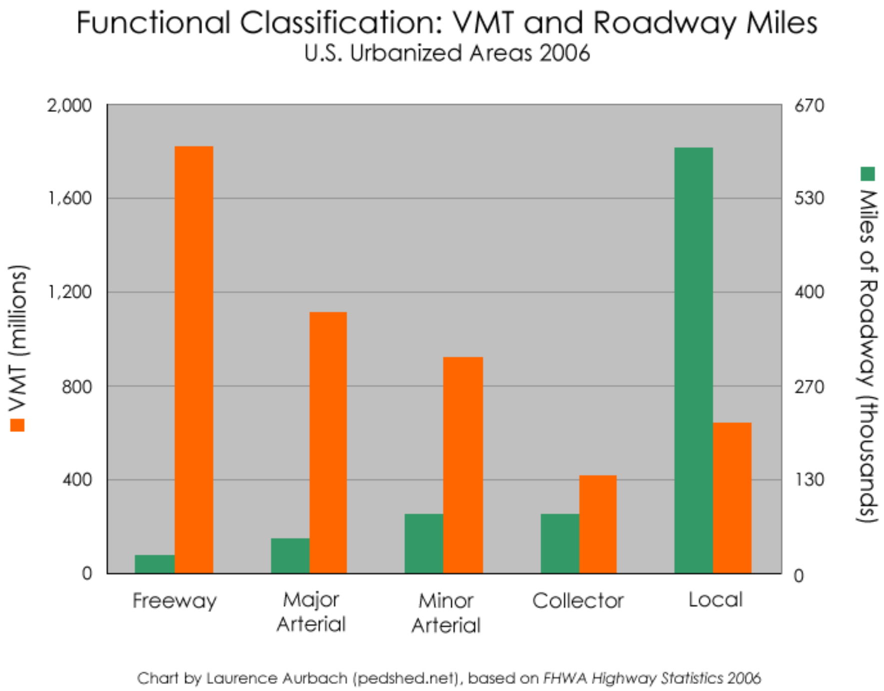
Form here refers to the physical characteristics that, in principle, can be described or recorded for any section of street. *Use* refers to the activity on a street; again, in principle, this could be described or recorded for any section of street, although in this case it is likely to vary significantly by time as well as space. We could say that form relates to supply and use relates to demand. Form and use are quite straightforward and could be observed empirically by an outside agency (such as an observer from space), oblivious to the supposed 'purpose' of the street.

The third main category is termed *Relation*. This refers to the relative position of a street with respect to other urban or network elements, rather than (solely) referring to characteristics of a particular street section under consideration. For example, a 'radial' is essentially defined in relation to a set of routes converging to a centre, and is in principle independent of road form or patterns of use. A radial could be a quiet lane or a bustling boulevard.

The final category – *Designation* – refers to classification themes determined purely by allocation or assignation: it relates to properties that could be applied abstractly to a map of a road network. A typical example would be administrative status (e.g. ownership) or recommended traffic route (e.g. tourist route). Such properties might relate to form, use or relation, but in principle need not be fixed to these. Changes to these types of designation can take place without any change on the ground, and vice versa. (An observer from space could not directly detect a change in designation.)

Stephen Marshall, Streets and Patterns, Spon Press, London & New York, 2005

FUNCTIONAL CLASSIFICATION: EXAMPLE



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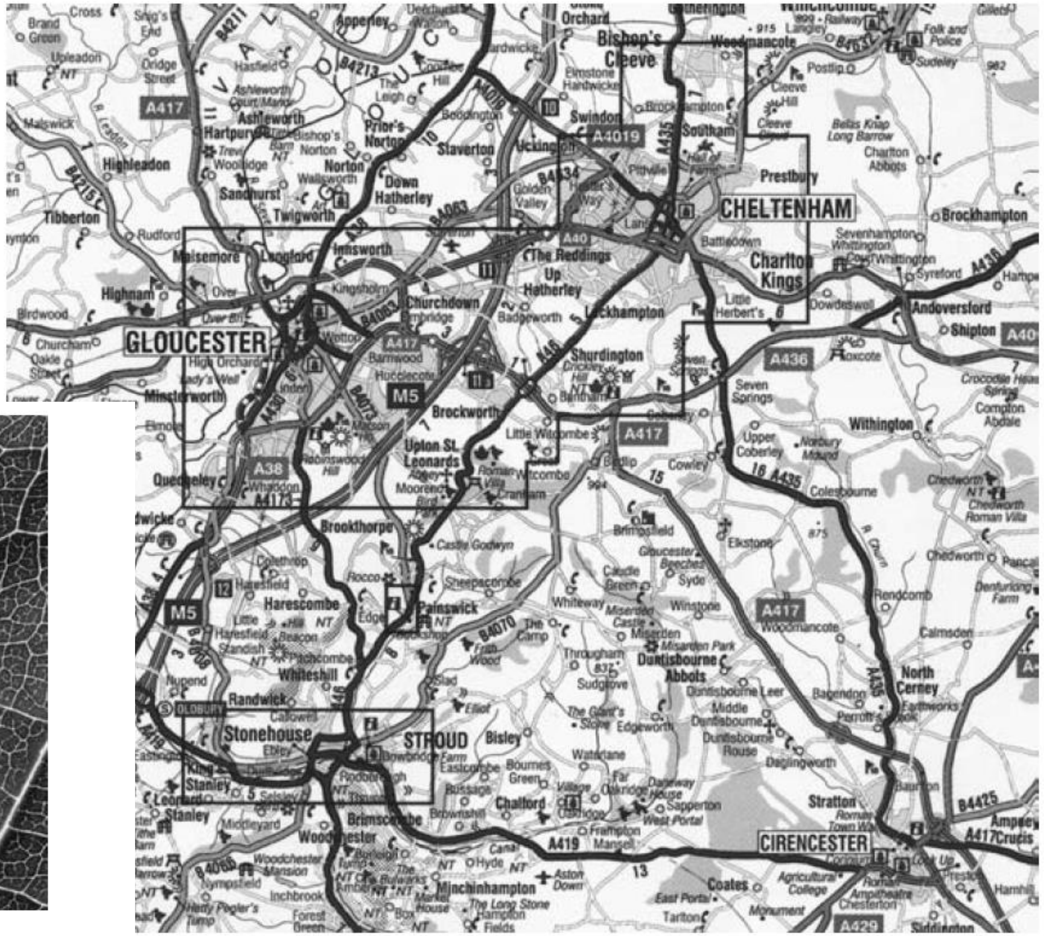
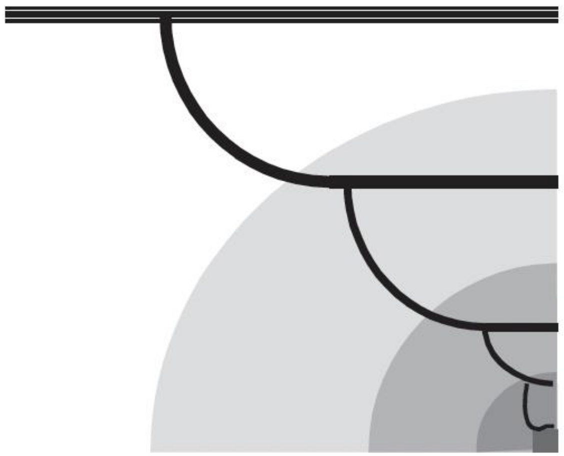
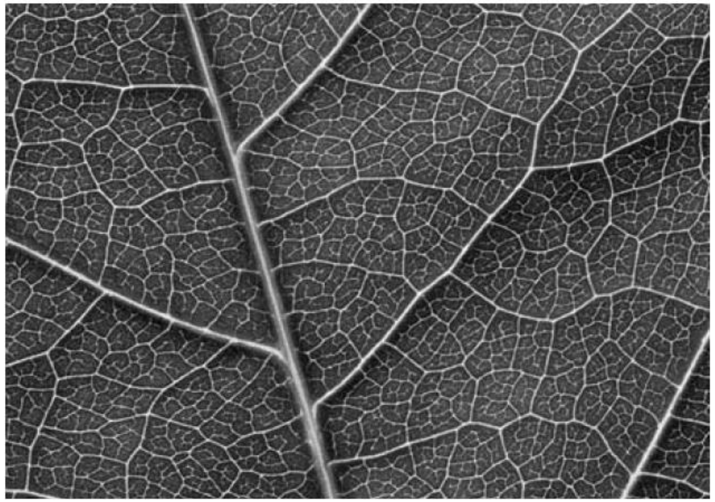
THE EXAMPLE OF ARTERIALITY



3.15 • Typical road network possessing arteriality. For a given frame of reference, arteriality applies if the set of routes from the top down to any given level forms a complete, contiguous network. See Box 3.



3.20 • A hierarchy of roads and areas. Road types are closely associated with the spatial scale of the area they serve.



3.21 • The 'arterial' pattern of a leaf. We can recognise that the pattern of veins on a leaf possesses arteriality although we may know nothing of the 'flows' along them. The assignation of links to the strategic road network is similarly abstract.

ACCESSIBILITY CONCEPT

Definition and measurement

ACCESSIBILITY AND/OR MOBILITY (1) **DEFINITION**

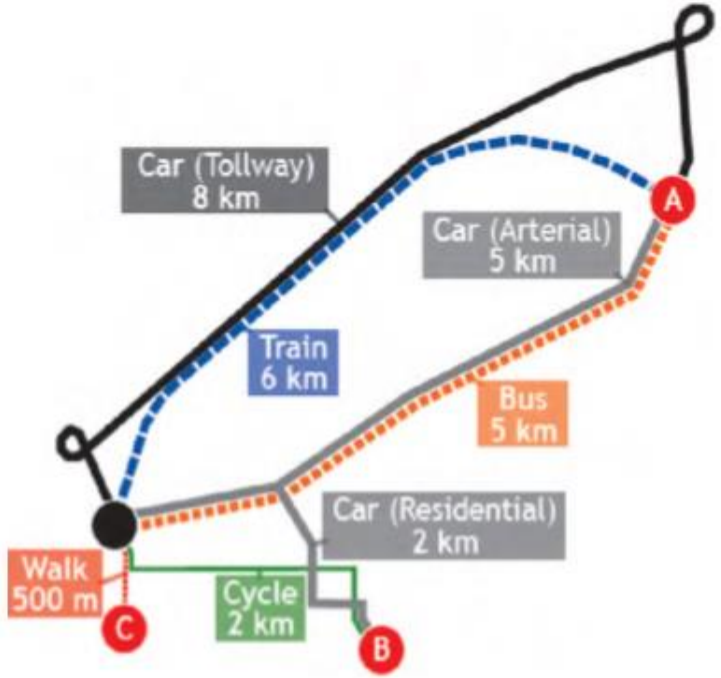
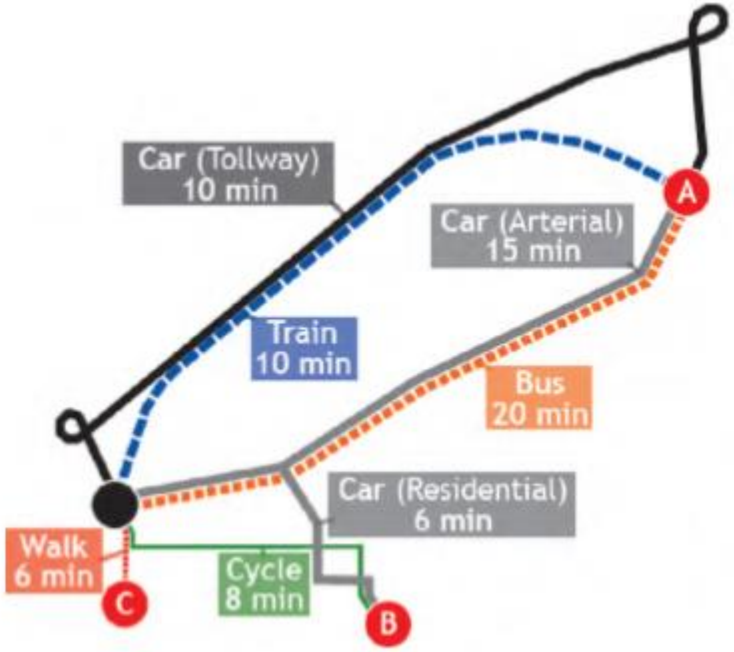
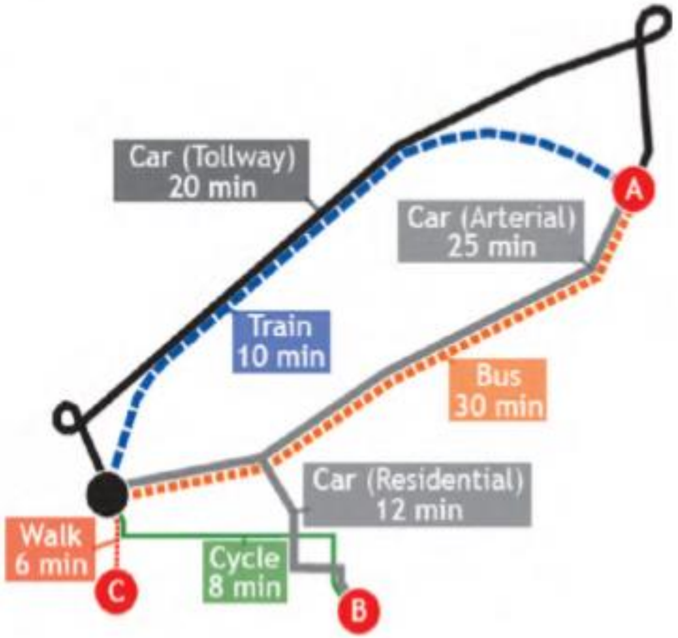


Fig. 1. Travel impediment measures from origin (black dot) to various destinations (A, B and C), using metric network distance.
Curtis & Scheurer, 2010, p. 58)



Travel impediment measures from origin (black dot) to various destinations (A, B, C) using kerb-to-kerb travel time under flow condition (Curtis & Scheurer, 2010, p. 61)



Travel impediment measures from origin (black dot) to various destinations (A, B, C) using kerb-to-kerb travael time during congestion (Curtis & Scheurer, 2010, p. 61)

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ACCESSIBILITY

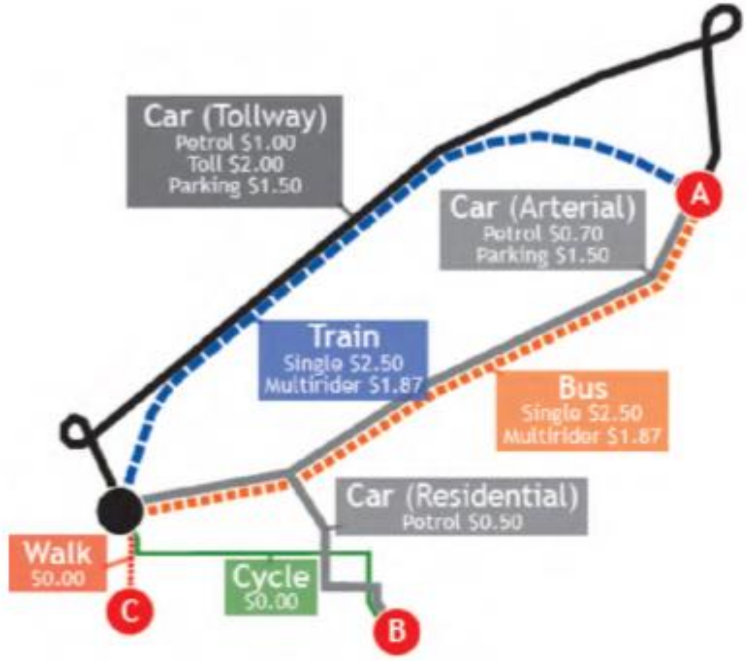

Fig. 4. Travel impediment measures from origin (black dot) to various destinations (A, B and C), using variable user cost.

Curtis & Scheurer, 2010, p. 61)

ACCESSIBILITY
(1) DEFINITION

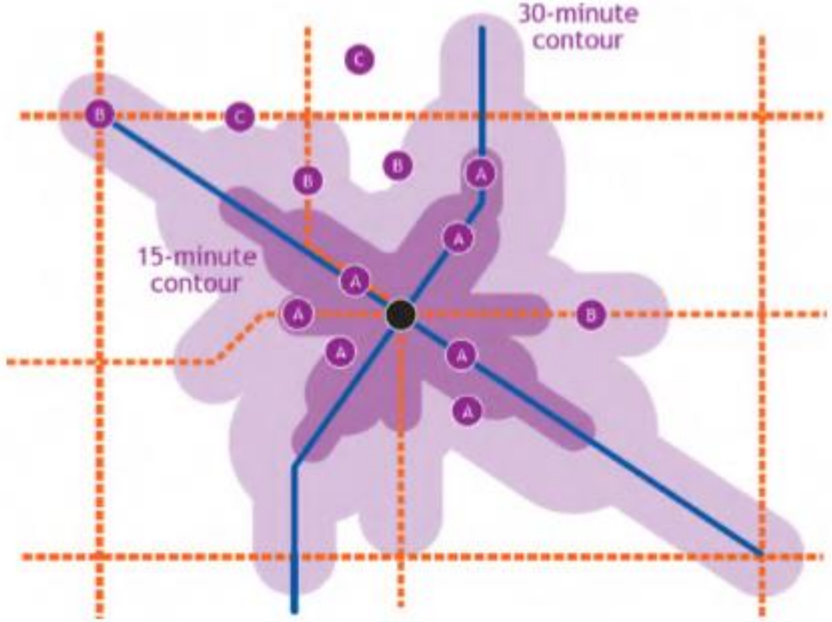

Fig. 5. Contour Measure. Opportunities (purple dots) are classified by travel time zones (A = up to 15 min, B = 15–30 min, C = over 30 min) from the point of reference (black dot).

Curtis & Scheurer, 2010, p. 62)

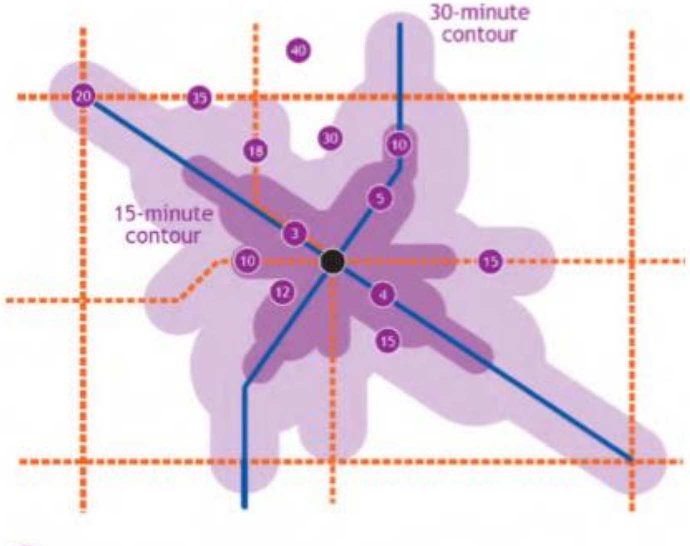

Fig. 6. Gravity Measure. Opportunities (purple dots) are represented by actual travel time in minutes from the point of reference (black dot).

Curtis & Scheurer, 2010, p. 62)

What types of accessibility shown in these two figures?

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ACCESSIBILITY (1) DEFINITION

The extent to which the land-use transport system enables (groups of) individuals or goods to reach activities or destinations by means of a (combination of) transport mode(s) (Geurs and Eck, 2001, p. 36).

Accessibility is a measure of the ease of an individual to pursue an activity of a desired type, at a desired location, by a desired mode, and at a desired time (Bhat et al, 2000, p. 1).

Access is used when talking about a person's perspective, accessibility when using a location's perspective (Geurs and van Wee, 2004, p. 128).

ACCESSIBILITY

(1) DEFINITION

The amount and diversity of places that can be reached within a given travel time and/or cost (Bertolini, LeClercq and Kapoen, 2005, p. 209)

Sustainable accessibility: with as little as possible use of non-renewable or difficult to renew, resources, including land and infrastructure (Bertolini, LeClercq and Kapoen, 2005, p. 212)

ACCESSIBILITY (1) DEFINITION

Four components of accessibility (Geurs' and Eck's (2001):

1. The transport component: concerned with measures such as travel time, costs and effort of movement in space.

2. the land use component: measures the spatial distribution of activities or opportunities and contains an assessment of the competitive nature of demand for activities at destinations, and of supply of potential users.

3. the temporal component: examines the time constraints user experience for their activity patterns, and the availability of activities or opportunities according to the time of the day, week or year.

4. the individual component: investigates the needs, abilities, and opportunities of transport users and thus takes in socio-economic and demographic factors.

ACCESSIBILITY
(2) MEASUREMENTS

There is no single perfect accessibility measure

Infrastructure based accessibility: the easiest way to measure, limited when it comes to capturing the interplay of LUTI

Activity based accessibility: it included the land use component from the outset, but tends to me more complex and sometimes poorer legibility.

Utility based accessibility: it crosses over into economic and social disciplines, land use and transport, it is an emerging model still required substantial RnD.

CRITERIA FOR AN ACCESSIBILITY INDICATOR

Accessibility should relate to changes in travel opportunities or quality or impediment. *If the service level of any transport mode in an area increases, accessibility should increase to any activity in that area or from any point within that area.*

Accessibility should relate to changes in land use. *If the number of opportunities for an activity increases anywhere, accessibility to that activity should increase from any place.*

Accessibility should relate to changes in constraints on demand for activities: *if the demand for opportunities for an activity with certain capacity restrictions increases, accessibility to that activity should increase.*

Accessibility should relate to personal capabilities and constraints: *an increase of the number of opportunities for an activity at any location should not alter the accessibility to that activity for an individual (or groups) not able to participate in that activity given the time budget.*

Accessibility should relate to personal access to travel and land use opportunities: *Improvements in one transport mode or an increase of the number of opportunities for an activity should not alter the accessibility to any individual or groups with insufficient abilities or capacities (driver's license, education level) to use that mode or participate in that activity.*

ACCESSIBILITY INDICATORS OR MEASURES
(1). SPATIAL SEPARATION MEASURES:

included into the infrastructure based measures. It only uses the physical distance between infrastructure elements as input, is thus suitable for the analysis of nodes and network structure. Named also as the travel cost approach.

There is no reference to land use patterns, spatial distribution of opportunities, or to network constraints to do with travel speed or other sources of resistance.

It does not take into account the behavioral aspects of travel choice.

Analysis of accessibility ofr public transport is not well served by a travel cost measure based on physical distance (not incl. travel time and user costs)

Example: kerb-to-kerb travel time is the time which a motorist or public transport user or cyclist spends within the publicly accessible infrasturcutr of the mode, thus, access times to stations or bus stops, time spent cruising for a parking spaces etc are discounted.

Door to door travel time incorporates these secondary effects into account

Accessibility (1) Definition

	Methodological category	Approach/measure	Pros and Cons
1) Spatial separation measures	Spatial Separation Model (Bhat et al., 2000) Infrastructure Measures (Geurs & van Eck, 2001) Travel Cost Approach (Baradaran & Ramjerdi, 2001)	Measures travel impediment or resistance between origin and destination, or between nodes. Travel impediment measures can include: Physical (Euclidean) distance Network distance (by mode) Travel time (by mode) Travel time (by network status—congestion, free-flow, etc.) Travel cost (variable user cost or total social cost) Service quality (e.g. public transport frequency)	Data is generally easily available from digital mapping material and other public sources. No consideration of land use patterns and spatial distribution of opportunities. See Box 1 for a detailed discussion.

TRAVEL COSTS DERIVATIONS

(1). The variable user costs per tirp: petrol, parking, possible road tolls for motorist, fars for public transport users.

(2). Walking and cycling are considered free of cost.

(3) extension: to include the fixed cost of car purchase, registration and maintenance, or external costs to the public such as infrastructure provision, financial subsidies, tax breaks to public transport operators, etc.

(4). The physical speed of different modes of transport (informing the travel time above mentioned) can be modified into a social speed or effective speed that considers the time individuals spend on tasks associated with vehicle ownership, and on earning the income required to afford it.

ACCESSIBILITY MEASURES (2). CONTOUR MEASURES:

ACCESSIBILITY (1) DEFINITION

Equals to the cumulative opportunity model

It uses the element of travel time in the composition of the indicator

It defines thresholds of maximum desirable travel times for different types of activities: catchment areas of jobs, employees, customers, visitors and others are mapped out as contours for each node under considerations.

Incorporates both the land use patterns and the infrastructure constraints.

This indicator, once there is a rigid boundary to the catchment area definition, is not capable of differentiating between opportunities inside this area, despite the fact that actual travel times vary among activities within the same contour bracket (the isochrones).

The measurement treats activities as equal regardless of their cost or desirability for users.

The contour brackets chosen for each type of activity are almost invariably arbitrary, not necessarily reflecting the real drivers of trip making from a user perspective.

This indicator is highly sensitive to the choice demarcation area. A 30 mins Itime limit is recommendated to be taken separately for each mode and for different network conditions (car free flow, car congestion, mode types). Example: the average one-way commuting time in the Netherlands is 28 min; people d on average not spend more than 1 hour travelling per day for Europe.

2) Contour measures	Contour Measures (Geurs & van Eck, 2001) Cumulative Opportunity Model (Bhat et al., 2000)	Defines catchment areas by drawing one or more travel time contours around a node, and measures the number of opportunities within each contour (jobs, employees, customers, etc).	Incorporates land use and attends to infrastructure constraints by using travel time as indicator for impediment. Definition of travel time contours may be arbitrary and does not differentiate between activities and travel purposes. Methodology cannot capture variation in accessibility between activities within the same contour.

ACCESSIBILITY MEASURES (3). GRAVITY MEASURES:

ACCESSIBILITY (1) DEFINITION

Equals to potential accessibility, to overcome the rigit or arbitrary contour bracket by treating opportunities differently along a continuum of time and distance.

Identifying the actual travel time for each opportunity, enabling different opportunities to be listed by actual travel time and compared (destinations are identified by actual travel time and compared).

A distance decay function is used as a proxy for disutility

It treats every transport user equally disregards variations in individual preferences in relation to the desirability of activities.

3) Gravity measures	Gravity Model (Bhat et al., 2000) Potential Accessibility Measure (Geurs & van Eck, 2001)	Defines catchment areas by measuring travel impediment on a continuous scale.	More accurate representation of travel resistance than in contour measure, but tends to be less legible. Does not differentiate between travel purposes and individual drivers for travel.

ACCESSIBILITY MEASURES (3). NETWORK MEASURES:

Accessibility based on analysis the entire movement networks.

Two approaches: each approach is based on the identification of nodes and edges

- Primal approach: street segments re considered as edges and street intersections are considered as nodes.
  - It is simple, intuitive.
  - It is most suited to capture distance: it included a measure proportional to the physical distance or other impediment of movement paths.
  - It still contain the topological measures (it identified path lengths as numbers of edges traversed) → analogue to "six degrees separation" theory in Milgram (1967) (social network→ it is not expressed by a measure of length to the relationship but as by counting the number of direct relationship in the chain that connects any two individuals in the sample (degree of separation)
- Dual approach: the other way around.

DUAL APPROACH

It is derived from the space syntax methodology

It is originally used to identify the continuity of streets over a multiplicity of intersections as a key attribute of the legibility and functionality of movement networks.

The dual approach is sensitive to the definition of node (street segment) continuity.

Porta (2006) tests accessibility indexes based on dual approach on a number of real world urban street systems of different character (such as Venice)→ the application of primal approach leads to more comprehensive, objective, and realistic analytical results than the dual approach.

Study from Porta inspired the urban designer about the public space usage → the ability of urban spaces to attract and support human activities in relation to their position on the movement network and the surrounding private land uses.

CONCEPT OF ACCESSIBILITY INDICES AS A NETWORK MEASURES

The degree of a node k = the number of edges converging in node i.

The average degree of nodes within a network, and the distribution of degree values across all nodes

The characteristic path length L= the average distance or degree of separation between any two nodes I and j within the network.

The global efficiency= the inverse average shortest path length between any two nodes in the network.

ACCESSIBILITY INDEXES FOR NETWORK NODES

Degree centrality: the proportion of nodes directly connected to a node i out of all nodes (other than i) within the network

Closeness centrality: the average distance between node i and all nodes (other than i) within the network.

Betweenness centrality: the proportion of paths between any two nodes within the network that traverse node *i*, out of the total number of possible paths on the network.

Information centrality: the relative drop in network efficiency in case node *i* is removed from the network.

ILLUSTRATION

Jumlah segmen rute yang terkoneksi dengan masing-masing persimpangan (node).
Pengukuran: topologi, primal.

Network Property Measure	Example (Metro Network of Lyon)
1) Degree of nodes (primal graph) This indicator measures the number of route segments converging in each intersection. **K(i) = ∑j** where: **j**∈**N(i)** and **i≠j** **N(i) =** intersections linked to intersection i by one route segment (nearest neighbours) **Example:** The node at the far right end of the red route has only one route segment accessing it – so is labelled '1'. The more routes converging in the node, the higher the accessibility.	

NILAI INVERSE (PERBANDINGAN TERBALIK) JARAK DARI SUATU NODE YANG DIUKUR ATAU YANG DITINJAU TERHADAP SELURUH TITIK NODES YANG LAINNYA PADA JARINGAN NETWORK.
PENDEKATAN: **PRIMAL, METRIC**

Global Efficiency (metric)

This indicator measures the average inverse metric distance to all other nodes in the network.

$E_g(i) = \sum(1/d_{ij})/(N-1)$

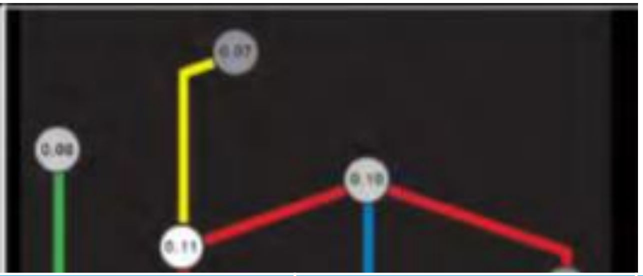
where:

d_{ij} = metric distance between nodes i and j

N = all nodes in the network

Global Network Efficiency $E_g(G) = 0.09$

Example: A measure of 0.10 is saying that th
this node to any other node in the network is a
minutes (1/10 = 0.10). The higher the number,
is showing the ability to connect to a larger nu
shorter distance).



Node	1	2	3	Global eff
1		0.5 km (3 minutes)*	2 km (5 minutes)*	((1/0.5)+(1/ /2)
2	0.5 km (3 minutes)*		5 km (10 minutes)*	
3	2 km (5 minutes)*	5 km (10 minutes)*		

PROPORSI JUMLAH NODES YANG DAPAT DIJANGKAU DARI SUATU TITIK YANG DITINJAU TANPA MEMERLUKAN TRANSFER (BERGANTI MODA, **<u>BERHENTI, BERGANTI JALUR/RUTE)</u>**

<u>PENDEKATAN: PRIMAL, TOPOLOGY.</u>

Degree Centrality (transfer-free links)

This indicator measures the proportion of other nodes within the network that are accessible by way of a *transfer-free journey*.

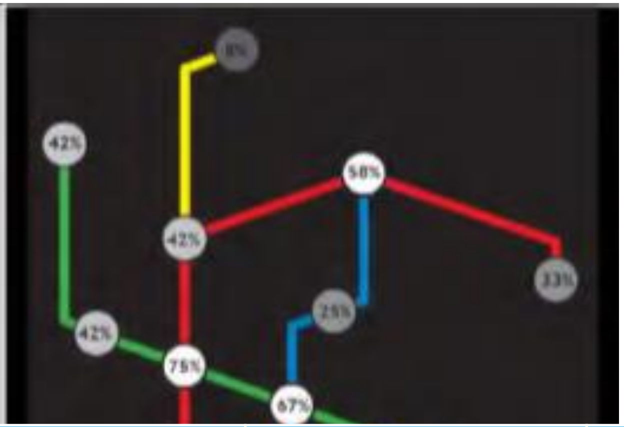
$CD_{i,tf} = \sum a_{ij}/(N-1)$

where:

a_{ij} = transfer-free link between nodes i and j, with $j \in N$ and $i \neq j$

N = all nodes in the network

Example: The degree centrality for the node where the green an lines intersect (75%) is showing that from here you can get to all nodes of the green line and all those on the red line without chan – ie. 9 nodes out of 12 (or 75%). So this shows a different view c accessibility more useful for public transport.



Node		The number of transfer free link	Degree of centrality
1	N= 13	5	5/12=.. %
2	N= 13	8	8/12= %
3	N=13	10	10/12= %

JARAK RATA-RATA WAKTU TEMPUH DARI SUATU NODE ATAU TITIK YANG DITINJAU UNTUK MENGAKSES SELURUH NODES LAINNYA PADA NETWORK. PENDEKATAN: PRIMAL, METRIC.

Closeness Centrality (metric – primal graph)

This indicator measures the average distance in terms of travel time to access the other nodes on the network, as a proxy for metric journey length.

$$CC_{i,m} = \sum L_{ij}(m)/(N-1)$$

where:

$L_{ij}(m)$ = travel time in minutes between nodes i and j, with $j \in N$ and $i \neq j$

N = all nodes in the network

The distance (travel time in minutes) of each network segment is marked on the graph.

Example: From the node where the green and red lines intersect (metric closeness centrality = 7.5), the average distance to the other twelve nodes in the network is 7.5 minutes of travel time (not including transfer time).

JUMLAH SEGMEN RATA-RATA DARI SUATU NODE YANG DIUKUR ATAU YANG DITINJAU UNTUK MENJANGKAU NODES LAINNYA DI SELURUH NETWORK.
PADA CONTOH DI DALAM ILUSTRASI:
DARI TITIK YANG DIOBSERVASI (TITIK PERTEMUAN RUTE WARNA MERAH DAN HIJAU),
DIPERLUKAN UNTUK MENJANGKAU NODES LAINNYA SEBAGAI BERIKUT:

- NODE YANG DIJANGKAU LANGSUNG = 1, 1, 1, 1 = 4 SEGMEN
- NODE PADA RUTE HIJAU HARUS MELEWATI = 2 SEGMEN, 2 SEGMEN, 3 SEGMEN = 7 SEGMEN
- NODE PADA RUTE KUNING= HARUS MELEWATI 2 SEGMEN = 2 SEGMEN
- NODE PADA RUTE MERAH= HARUS MELEWATI 2 SEGMEN, 3 SEGMEN = 5 SEGMEN
- NODE PADA RUTE BIRU = 2 SEGMEN, 2 SEGMEN = 4 SEGMEN
- TOTAL RATA-RATA UNTUK MENJANGKAU SELURUH NODES LAINNYA = (4+7+2+5+4)/12 = 22 SEGMEN/12 NODE = 1.8 NETWORK SEGMENT

Closeness Centrality
(topological – primal graph)

This indicator measures the average number of network segments to access the other nodes on the network, regardless of their metric length in number of stations.

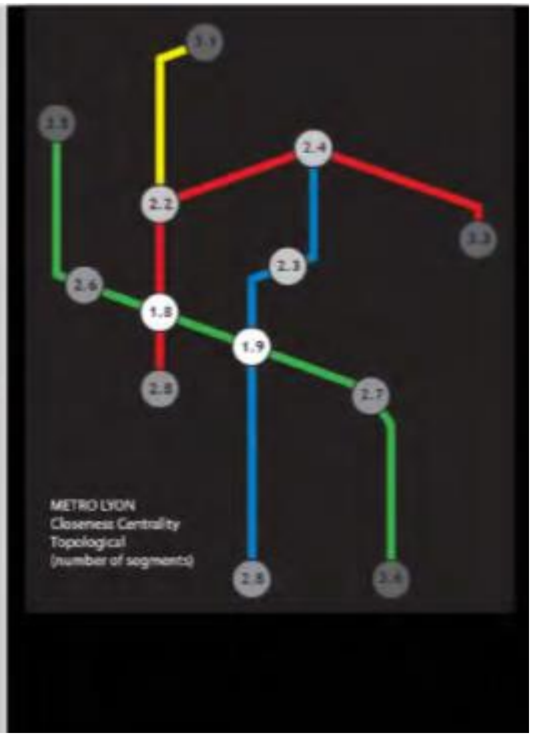
$$CC_{i,t} = \sum L_{ij}(t)/(N-1)$$

where:

$L_{ij}(t)$ = number of network segments between nodes i and j, with j? N and i≠j

N = all nodes in the network

Example: From the node where the green and red lines intersect (topological closeness centrality = 4.9), the average distance to the other twelve nodes in the network is 1.8 network segments.



LESSON LEARNED

There is no single perfect accessibility measure.

It is critical to apply several measures in combination.

There is a need to apply measures framed around the way individuals make decisions in their travel plans, particularly in choosing between car and public transport.

The inputs and outputs of accessibility tools need to be communicated in an "accessible" way.

The dissemination of accessibility measures visually can significantly enhance understanding and may contribute to a productive discourse on future directions of urban form and mobility.

THE USE OF ACCESSIBILITY ANALYSIS

"How could we distinguish between three locations by their accessibility characteristics?

Improving the sustainability of cities and of achieving more sustainable transport outcomes

Limiting urban sprawl (spatial extent and limiting the scattered dispersal of activities within the urban area instead of concentrating activities around public transport

Providing for a range of travel choices as an alternative to the car

Accessibility measures are capable of assessing feedback effects of transportation infrastructure and modal participation on the one hand, and urban form and the spatial distribution of activities on the other hand.

Some accessibility measures include behavioral determinants for activity patterns in space and time and the responses of transport users to physical conditions.

Example: TOD: creating the integration between urban development and public transport system by creating places in which public transport is readily accessible for many activities.

FUTURE RESEARCH IN ACCESSIBILITY STUDIES

Set standards for the state of public transport accessibility for comparisons between cities

Set standards for the state of public transport accessibility for comparisons between stages of development.

TERIMA KASIH