Southeast University
School of Transportation

交通规划理论与方法
Urban Transportation Planning

Chinese-English course (2019)

Lecturer: Dr. Qiong Bao

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9:50AM, Friday, 28th April

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About your lecturer

Dr. Qiong Bao

- Educational experience:
  - 2000-2004, Shandong University, Information & Computational Science, Bachelor of Science.
  - 2005-2008, East China University of Science & Technology, Control Theory & Control Engineering, Master of Engineering.
  - 2008-2010, Hasselt University, Traffic Safety, Master of Transportation Sciences.
  - 2010-2015, Hasselt University, Transportation science, Doctor of Transportation Sciences.
  - 2015-2017, Hasselt University, Transportation Research Institute (IMOB), Research assistant.
  - 2017-present, Southeast University, Assistant professor

About your lecturer

Dr. Qiong Bao

- Research direction:
  - Activity-based travel demand modelling and forecasting;
  - Travel behavior analysis;
  - Transportation modelling;
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Lecture schedule

Lecture	Week	Date/Time	Topic
1	9	28 April 9: 50-12: 15	Transportation planning & demand and supply & trip-based model
2	10	5 May 9: 50-12: 15	ABM: data process
3	11	10 May 9: 50-12: 15	ABM: scheduling
4	12	17 May 9: 50-12: 15	ABM: uncertainty analysis
5	13	24 May 9: 50-12: 15	ABM: sensitivity analysis
6	14	31 May 9: 50-12: 15	Project Evaluation I
7	15	7 June 9: 50-12: 15	Festival
8	16	14 June 9: 50-12: 15	Project Evaluation II

Outline

- Transportation Planning:
  - (Motivation) why we need transportation planning?
  - (Definition) what is transportation planning?
  - (Function) what kind of problems could be solved?
  - (Process) How to do transportation planning?
  - (Approach) what approaches are commonly used?
  - (Evaluation) how much we can believe in the final results and what kind of methods can be applied for the assessment?
- Equilibrium of supply and demand
- Major policy and planning issues

Transportation Systems

- Transportation plays an important role in our daily life.

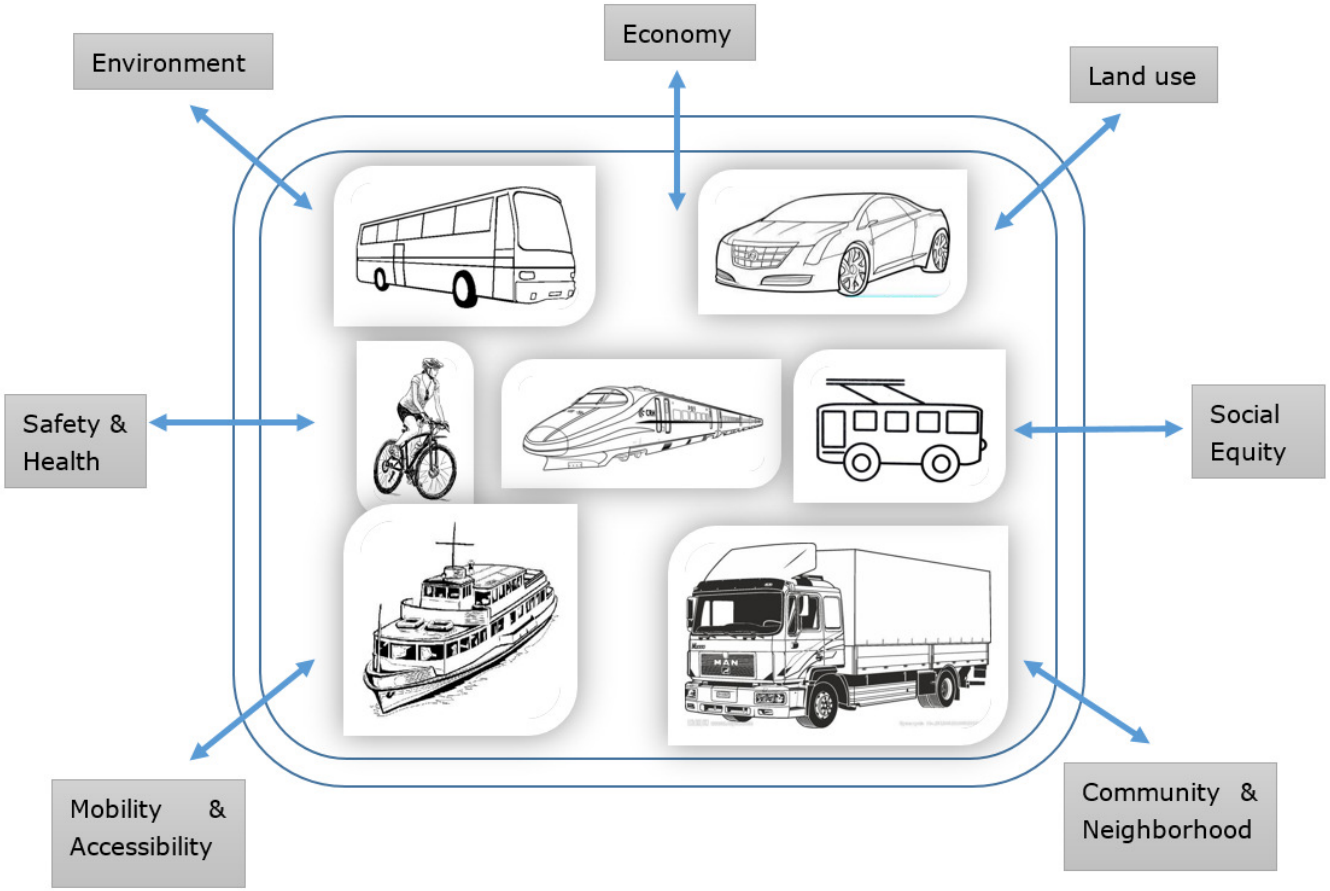


Transportation Systems

- Recent years, the transportation systems have experienced an accelerated expansion due to ever increasing population, rapid motorization, and rising incomes.
- However, rapid growth of traffic volume has also resulted in continuously increasing social, economic and environmental problems, such as traffic congestion, traffic accidents, energy dependence, greenhouse gas emissions, and air pollution.
- To achieve a sustainable development of our transportation systems, more and more attention has been paid to transportation planning analysis.

Links between transportation and social goals

- The role of transportation planning is to identify the relationships between transportation systems and our social goals and further make well-informed decisions.



Why transportation plan could influence our social goals?

- Understand a wider impact of transportation planning.
  - Three levels of impacts from transportation planning:
    - First level:

      Direct impacts or changes in travel conditions and costs.
    - Second level:

      Current indirect impacts or changes in travel behavior, tax revenue, and external impacts.
    - Third level:

      Long-term indirect impacts or changes in land use, economic development.

      (Source: three levels of impacts from TP defined by Litman.)

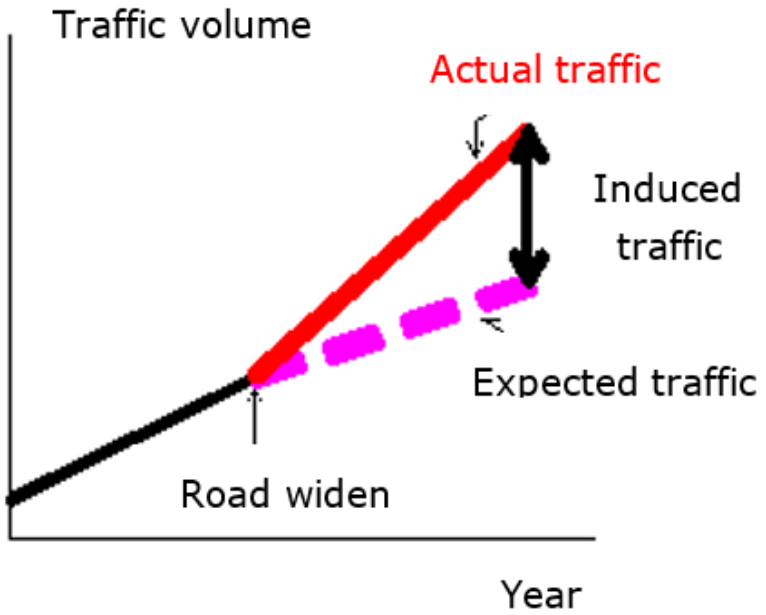
An example of three-level impacts of a transportation plan

- Transportation plan: increasing the road capacity of city center
- Expected three-levels impacts:
  - First level:
    - Increasing road capacity can initially reduce traffic congestion and increase vehicle traffic speed.
  - Second level:
    - The increased traffic capacity may attract additional travel from other routes and time periods, and it may create barriers to non-motorized modes.
  - Third-level:
    - Over a long time run, land use patterns become more dispersed and automobile dependent. (Land-use impact)

Motivation of Transportation Planning

- Due to the smooth traffic, the economic development of the region is more rapid.
- The emissions increase resulted from the rapid growth of traffic volume, which will reduce the air quality of the area.

- This is one source of 'induced traffic': traffic over the expected value from just extrapolating from the past rate of growth.



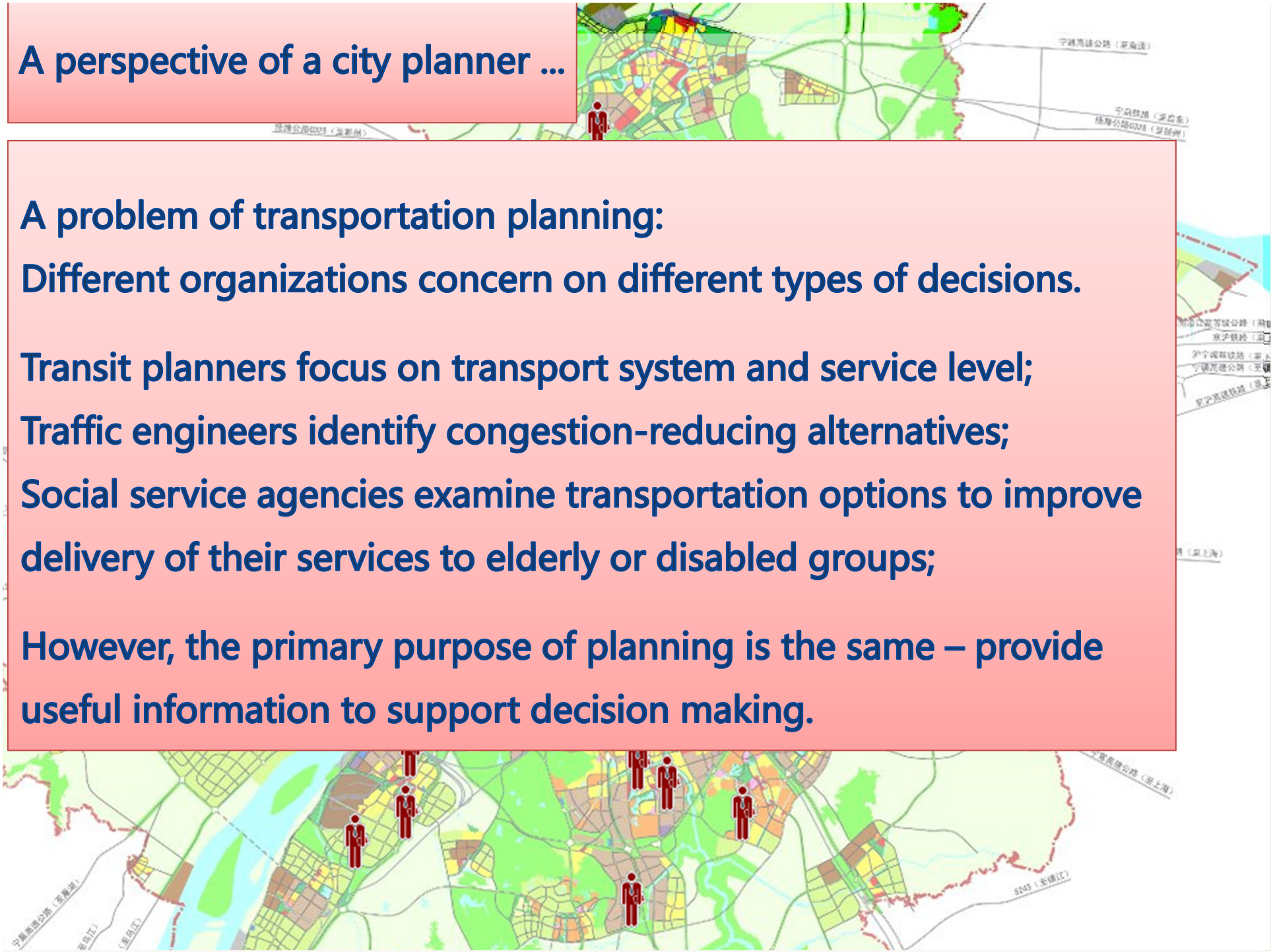
- By linking transportation goals to other social goals, transportation planning could be used as an effective tool to improve people's quality of life.

Road Congestion

Air Pollution

Traffic Accident

A perspective of a city planner …



A problem of transportation planning:

Different organizations concern on different types of decisions.

Transit planners focus on transport system and service level;

Traffic engineers identify congestion-reducing alternatives;

Social service agencies examine transportation options to improve delivery of their services to elderly or disabled groups;

However, the primary purpose of planning is the same – provide useful information to support decision making.

Definition of Transportation Planning

- Planning is a process of deciding what to do and how to do it.
  - Planning occurs everyday at different levels, from simple decisions made by individuals to major decisions made by government and business which might have comprehensive, long-term impacts on society.
  - A basic principle of good planning is that separate, short-term decisions are coordinated in supporting strategic, long-term objectives.
  - Effective planning allows people's requirements, preferences and values to be reflected in decisions.

Definition of Transportation Planning

- What is Transportation Planning?
  - It's a process that help make decisions on the future development and management of transportation systems;
  - and related to the operation of the transportation infrastructure supply and the management of travel demand.
- Objective:
  - to deliver a systematically planned transportation infrastructure network such that the transportation supply could efficiently fulfill the travel demand via a rigorous analysis and evaluation.
  - A good transportation planning should support a sustainable development of our transportation system with the economic and social improvement.

Function of Transportation Planning

- General function in practice:
  - We can apply transportation planning to determine the new or expanded infrastructures *(e.g. build metro system, pedestrian overpass or underpass project, or expand a 4-lane street to 8-lane street);*

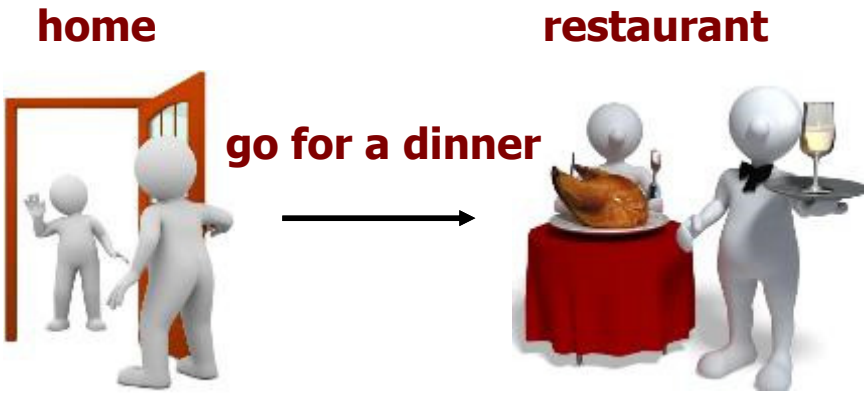
(In principle, the more significant the project is, the more intensive and long-term the planning will be. For large transportation projects, planning normally starts 20 years before the construction.)

  - manage the travel demand within the available transportation supply.

(This is usually related to the policy issues. e.g., congestion charging as a political measure)

Travel demand

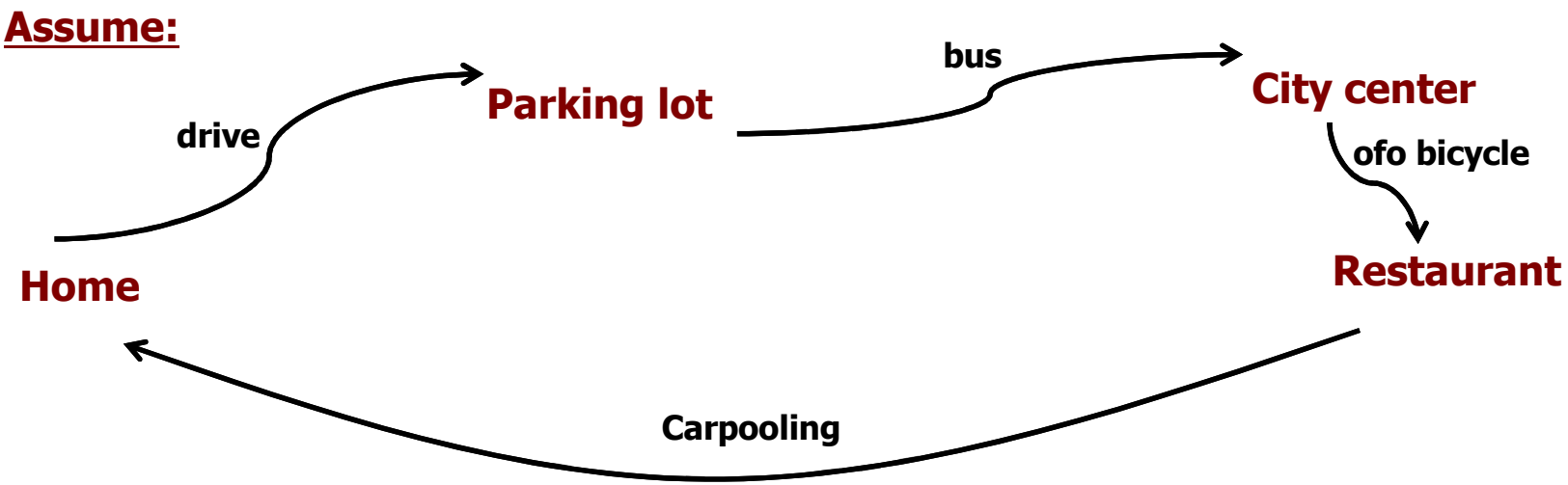
- Travel demand derived from:
  - The travel demand comes from commuting, going to school, bring/get children, shopping activity, social activity and so on.
  - Travel demand occurs as a result of thousands of individual travelers making individual decisions on how, where and when to travel. These decisions are affected by many factors such as the choices (destination, route and mode) available for the trip.
  - Understanding and predicting the individual's travel behavior is useful to make transportation planning decisions.



How to go?

Transportation supply

- Supply:
  - Infrastructure supply;
  - Public transport supply;



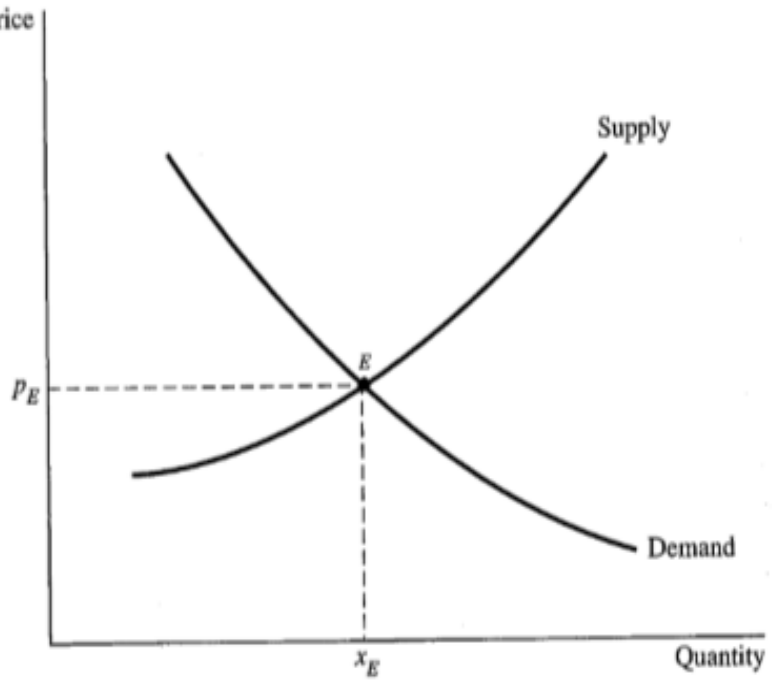
To fulfill the travel demand: private car, public bus, public ofo bicycle

Infrastructure supply: parking lot, bus stop
Public transport supply: bus, ofo bicycle

Equilibrium of supply and demand

Economics:

Transportation supply is regarded as one kind of goods that could be provided by the producers.



Equilibium of supply and demand

Supply curve:

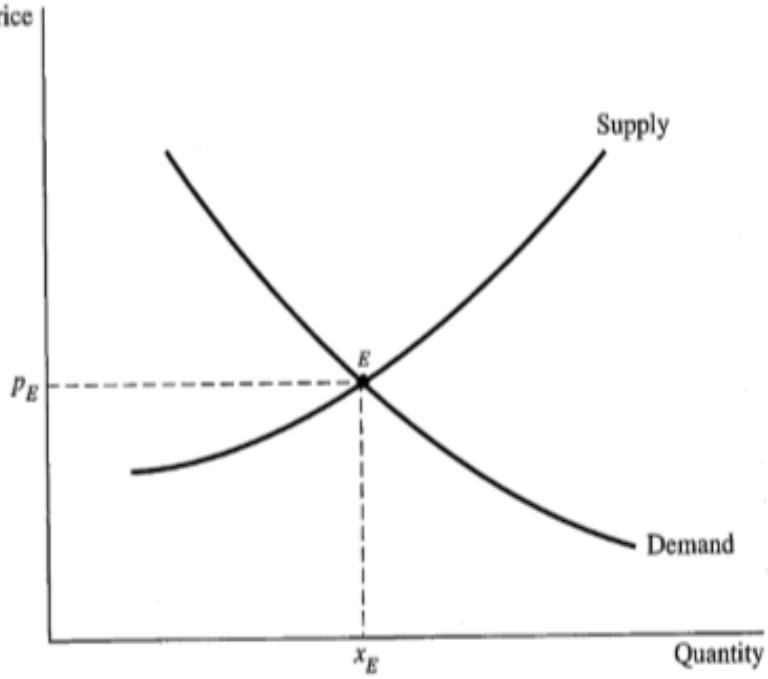
A graphical representation of the correlation between the cost of a good or service and the quantity supplied for a given period.

- It is usually upward sloping to the right, indicating the producer's ability to supply a greater quantity of the good at any given price.
- With the increase of the quantity supplied, the quantity demanded will decrease inversely.

Equilibrium of supply and demand

Equilibrium:

Transportation systems tend to be in a state of equilibrium or, at least, would arrive at such a state if left undisturbed for a sufficient period of time.



Equilibium of supply and demand

Equilibrium point:

The point of intersection between the demand and supply curves is known as the equilibrium point. At equilibrium, the quantity demanded is equal to the quantity supplied: $Q_D = Q_S = Q_E$

- If excess demand exists (i.e., $Q_D > Q_S$), the price would likely rise. In turn, more producers would enter the market and yield a decrease in Q_D. As fewer people would be willing to purchase the good at a higher price, thus driving the market toward the equilibrium point.

The role of supply analysis in transportation planning

- Developing and managing the supply of transportation is a primary focus of an effective transportation planning process.
  - Supply analysis determines equilibrium flow patterns on a road or transit network. Based on a set of the performance functions, the overall performance of the transportation network could be estimated.
  - The supply analysis could reflect the operational planning, e.g., How should a transit route be modified to improve performance? How can traffic signals be better coordinated to reduce vehicle delay?
  - In scheduling of transportation services (e.g., bus), supply analysis could be applied to minimize operating costs.

The role of demand analysis in transportation planning

- Estimating expected travel demand (passenger and goods) at some future date for transportation facilities and services is one of the most important tasks in transportation planning.
  - Without demand analysis, transportation planning couldn't occur.
  - Travel demand relates to changes in transportation supply. When additional capacity or pricing policy is available, demand will shift in response. This shift is known as induced demand.
  - Travel demand is not the objective of individual; it is the way to realize the participation in various social activities. Therefore, the socioeconomic activity system must to be considered to perform the demand analysis.
  - Travel decisions could be made based on the individual's assessment of the 'pros and cons' (e.g., travel cost) of various transport modes.

Major policy and planning issues

- Some common transportation issues:
  - Although the transportation planning process is concerned primarily with the issues facing a particular metropolitan area, there are many issues common to all parts of the country. This section addresses 6 common transportation topics.

1. Congestion management issue
2. Freight transportation issue
3. Land use issue
4. Safety issue
5. Security issue
6. System management and operations issue

Congestion management issue

- What is the congestion management process (CMP)?
  - The congestion management process is a way of systematically considering congestion-related issues using a set of technical tools, and basing evaluations on a discrete set of locally determined performance measures.
  - A CMP provides for the systematic review of performance of multimodal transportation systems.
  - A CMP is intended to address congestion based on the use and operation of facilities and services.
  - The objective of a CMP is achieve an effective management and operations based on cooperatively developed travel demand reduction and operational management strategies.

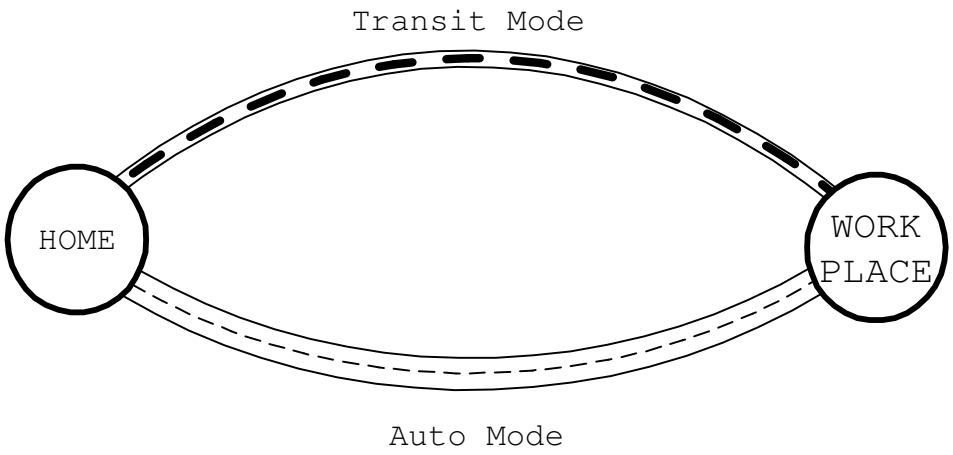
Congestion management issue

- How does Transportation Demand Management (TDM) relate to the Congestion Management Process?
  - Transportation Demand Management (TDM) is actions designed to influence the intensity, timing, and distribution of transportation demand, in order to reduce traffic congestion or enhance mobility.
  - Such actions can include:
    - offering commuters alternative transportation modes or services;
    - providing incentives to travel on other modes or at non-congested hours;
    - providing opportunities to link or "chain" trips together;
    - and incorporating growth management or traffic impact policies into local development decisions.

Example 1: Evaluation of the impact of Congestion Pricing on Modal Split

REMARKS: this example is closely related to the Cross Harbor Transport Systems where two major travel modes of automobile (private cars) and transit (mass transit railway) serve the traffic demand between Kowloon and Hong Kong Island.

One may think adjusting Tunnel toll charge for restraining car use and balancing the usage of the three tunnels. The revenue from congestion charging can be used partially for public transport improvement, and thus reduces the costs of severe cross harbor tunnel traffic congestion to achieve socially optimal modal split.



A Simple Corridor Network

We consider a simplified corridor network, as shown above. This network comprises two types of modes to provide transportation service from origin (home) to destination (workplace). **Mode 1 represents a rapid transi**t and **mode 2 represents a highway**. It is assumed that a certain number of homogenous commuters could either travel on the highway by car (auto mode) or travel by transit (transit mode). **The capacity of auto mode is finite due to its physical conditions, while the capacity of transit mode is unlimited by assuming the transit service (frequency etc.) will be provided in response to demand**. This assumption means that travel time by transit mode (including access and egress time) is **constan**t, while **travel time by auto mode will monotonically increase with the auto volume** on the road due to traffic congestion and queuing.

- Suppose each mode is characterized by a generalized cost function. The cost that a transit mode user incurs from his/her trip is defined as

$$C_T = \alpha T_T + P_T \qquad (1)$$

where P_T is a flat fare for use of transit mode, α is the value of time and αT_T is the time cost of travel, being a constant specific to transit mode (including in-vehicle time, access time from home to transit station and egress time from transit station to workplace. For simplicity, the total travel and waiting time for a transit user is assumed to be constant (T_T is fixed) even if transit frequency is changed slightly.

- On the other hand, the generalized cost that an auto user incurs will consist of time cost of travel and auto toll:

$$C_A = \alpha T_A + P_A \qquad (2)$$

where αT_A is the time cost of travel by auto, P_A is the auto toll. Note that due to congestion and queuing effect, T_A is assumed to be a continuous, monotonically increasing function of traffic volume: $T_A = T(Q_A)$, where Q_A is the auto volume (veh/hr) on the highway.

- Suppose at equilibrium, the mode split at aggregate demand level is governed by a logit formula specified below (suppose car occupancy is 1.0, one car one person).

$$Q_T = Q \times \frac{\exp(-\beta C_T)}{\exp(-\beta C_T) + \exp(-\beta C_A)} = \frac{Q}{1 + \exp\{-\beta(C_A - C_T)\}}, \qquad (3)$$

$$Q_A = Q \times \frac{\exp(-\beta C_A)}{\exp(-\beta C_T) + \exp(-\beta C_A)} = \frac{Q}{1 + \exp\{-\beta(C_T - C_A)\}} (= Q - Q_T) \qquad (4)$$

where β is a positive parameter, Q is the total demand for travel and Q_T is the number of transit commuters.

- Supposing the following set of input data are used: (for examples 1 and 2)

$\beta = 0.1$, $\alpha = 2.0$ (HK$/min), $Q = 2.0 \times 10^4$ (trips/h),

$T_T = 45.0$ (min), $T_A = 30.0 + 2.0 \times 10^{-6} \times Q_A^{\,2}$ (min).

Q1. If $P_T = 3.0$HK$, $P_A = 10.0$HK$, determine auto and transit demand Q_A and Q_T, respectively.

Q2. Determine the required auto toll charge P_A in order to reduce auto volume to an optimal level $Q_A = 2.5 \times 10^3$ (veh/hr).

Solution of Example 1

1) $C_T = \alpha T_T + P_T = 2.0(\text{HK\$/min}) \times 45.0(\text{min}) + 3.0(\text{HK\$})$

$= 93.0(\$)$ (Constant)

$C_A = \alpha T_A + P_T = 2.0 \times (30.0 + 2.0 \times 10^{-6} Q_A) + 10.0$

$= 70.0 + 4.0 \times 10^{-6} Q_A^2 (\$)$ (function of Q_A)

$$Q_A = \frac{Q}{1 + \exp\{-\beta(C_T - C_A)\}}$$

$$= \frac{2.0 \times 10^4}{1 + \exp\{-0.1 \times (93.0 - 70.0 - 4.0 \times 10^{-6} Q_A^2\}}$$

$$= \frac{2.0 \times 10^4}{1 + \exp\{4.0 \times 10^{-7} Q_A^2 - 2.3\}}$$

Therefore, Q_A can be obtained by solving

$$Q_A = \frac{2.0\times10^4}{1+\exp\left\{4.0\times10^{-7}Q_A^2 - 2.3\right\}} \qquad (1)$$

$$f'(x_n) = \frac{\Delta y}{\Delta x} = \frac{f(x_n) - 0}{x_n - x_{n+1}}.$$

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}.$$

Using Newton's Method, we can get the results:

$$Q_A = 3156(\text{Veh/hr}) \qquad Q_T = 16844(\text{person/hr})$$

Using Newton's Method to solve equation (1)

Let

$x = Q_A \times 10^{-3}$ or x represents auto volumes in thousand

then (1) reduces to

$$x = \frac{20.0}{1.0 + \exp(0.4x^2 - 2.3)}$$

$$Let \quad f(x) = x - \frac{20.0}{1.0 + \exp(0.4x^2 - 2.3)}$$

$$then \quad f'(x) = 1.0 + \frac{16.0x\exp(0.4x^2 - 2.3)}{\left[1.0 + \exp(0.4x^2 - 2.3)\right]^2}$$

Based on iterative formula:

$$x^{(k+1)} = x^{(k)} - \frac{f(x^{(k)})}{f'(x^{(k)})}$$

k	$x^{(k)}$	$f(x^{(k)})$	$f'(x^{(k)})$
0	2.0	-11.3637	8.0949
1	3.4038	1.6375	28.9889
2	3.3473	1.3193	5.8800
3	3.1229	-0.2339	6.9777
4	3.1564		

$x^{(4)} - x^{(3)} = 3.1564 - 3.1229 = 0.0335$ (Small enough or Converged)

2) $C_T = 93.0(\$)$ (no change)

$Q_A = 2.5\times10^3 (\text{veh/hr})$

So $C_A = \alpha T_A + P_A$

$$=2.0\left[30.0+2.0\times10^{-6}\times(2.5\times10^3)^2\right]+P_A$$

$$=85.0+P_A \ (\$)$$

From $Q_A = \dfrac{Q}{1.0+\exp\{-\beta(C_T - C_A)\}}$

We have

$$2.5\times10^3 = \frac{2.0\times10^4}{1.0+\exp\{-0.1(93.0-85.0-P_A)\}}$$

$$=\frac{2.0\times10^4}{1.0+\exp\{0.1P_A-0.8\}}$$

$$P_A = 27.50(\text{HK\$})$$

To increase auto toll from 10.0HK$ to 27.50HK$ in order to reduce auto volume from 3156(veh/h) to 2500(veh/h)

Freight transportation issue

- What is the role of freight movement in transportation?
  - The movement of freight is an important part of a fully functioning transportation system. The efficient movement of freight within and through a region is critically important to industry, retail, agriculture, international trade, and terminal operators.
  - Coastal ports, air cargo airports, intermodal freight yards, large trucking terminals, and shipyards, are especially affected by freight movement issues.

Freight transportation issue

- What are some freight-transport tactics that transportation decision makers might consider?
  - Truck restrictions (e.g., peak period bans, route diversions, noise ordinances, and hazardous materials route restrictions)
  - Road design and construction (e.g., improved entry/exit ramps and merges, and capacity or safety improvements)
  - Road pricing (e.g., freeway permits, and peak period tolls)
  - Traffic engineering (e.g., lane design restrictions, wider lanes, variable message signs, and speed restrictions)
  - Shipper/receiver actions (e.g., voluntary and mandatory off-peak operations)
  - Inspection/enforcement (e.g., automated surveillance)

Land use issue

- What is the relationship between land use and transportation?
  - Land use and transportation are symbiotic: development density and location influence regional travel patterns, and, in turn, the degree of access provided by the transportation system can influence land use and development trends.
  - Urban or community design can facilitate alternative travel modes. For example, a connected system of streets with higher residential densities and a mix of land uses can facilitate travel by foot, bicycle, and public transportation, in addition to automobile. Conversely, dispersed land development patterns may facilitate vehicular travel and reduce the viability of other travel modes.

Safety issue

- What makes safety an important factor in transportation planning?
  - Transportation fatality rate is related to many factors, such as car conditions, tougher police enforcement, usage of seat belts, air bags, and child safety seats. Recent years, in many accident categories, the actual number of crashes has increased because more people are using the transportation system.
  - In addition, there are large economic costs associated with crashes, incurred both by those involved and by other travelers affected by the traffic delay caused by crashes.
  - Maintaining high performance in transportation safety requires coordination of activities and funding among multiple partners.

Safety issue

- What are the requirements for incorporating safety into transportation planning?
  - Improving the safety level of the transportation system is one of the planning factors that explicitly requires to be considered in the transportation planning process.
  - Short- and long-range plans should have a safety element as part of the plan, and when projects and strategies are evaluated in the transportation plan, safety should be a factor in the rating table.

Security issue

- What is transportation security?
  - Transportation system security can be defined as the freedom from intentional harm and tampering that affects both motorized and nonmotorized travelers, and may also include natural disasters.
  - Security goes beyond safety and includes the planning to prevent, manage, or respond to threats of a region and its transportation system and users.
  - With the increased man-made and natural security concerns, and considering the vulnerability of the transportation system and its use in emergency evacuations, it's better to initiate security within the transportation planning activities.

System management and operations

- What is system management and operations?
  - System management and operations (M&O) aim at improving service efficiency, enhancing public safety and security, reducing traveler delays, and improving access to information for travelers.
  - It is important to understand what users want to improve system performance. e.g., user-oriented performance measures w.r.t some important indicators of how well the transportation system is operating: average trip travel time, the reliability of trip.

System management and operations

- Example of system management and operation tools
  - Intelligent Transportation Systems (ITS) are technological tools that can help to facilitate better system M&O. For example, roadway video surveillance allows better responses to changes in network conditions, such as clearing an accident faster to keep traffic moving.
  - ITS technologies can also be used to collect real-time data, like travel speeds, which can be used to monitor system performance over time.
  - These M&O strategies and tools focus on optimizing the performance of the transportation system.

The collaborative agencies and organizations

Transportation planning must be cooperative because no single agency has responsibility for the entire transportation system.

- The collaborative participation of relevant transportation-related agencies and organizations:
  - Local government and transportation agencies with authority and responsibility in planning areas.
  - such as transit agency (bus/railway company), local highway department, airport authorities, maritime operators, freight operators, port operators, and private providers of public transportation (private parking lot opening for public).

Attentions

- To achieve an effective transportation planning, pay attentions to some basic concepts:
  1. Confusion between goals and objectives
  2. Confusion between development and growth
  3. Overlooking the broader impacts of transportation plans
  4. Planning based solely on projection of past trends
  5. Focusing only on those issues that are easy to measure
  6. Focusing on mobility and not accessibility

Attentions

1. Confusion between goals and objectives
   - Goals are desired outcomes to be achieved, such as health, equity and happiness.
   - Objectives are ways to achieve goals.

   During a planning process it is helpful to ask regularly, "What are we trying to achieve?" The 'what' is the goal – we develop objectives to achieve this goal.

- It is important not to confuse goals and objectives because
  - Goals are fundamental – we can't just substitute one goal for another.
  - On the other hand, different objectives can be employed to achieve a given goal. It is important to keep our options open and selective the objective that is best for the situation.

Attentions

2. Plan for development, not for growth

   - Planners must make a distinction between growth (increased quantity) and development (increased quality).
   - In other words, growth means getting bigger, while development means getting better.
   - Transportation plans should contribute to the development of a place not simply to its growth.

Some places might be willing to accommodate both development and growth. But the important point is that development should be accorded the higher priority – not growth.

Attentions

3. Don’t overlook the wider impacts of transportation plans
   - Transportation plans always have wide ranging impacts, affecting not just travel but also economic, social and environmental aspects of our lives.
   - These impacts may be short term or much longer term, and they may extend across geographic and political boundaries.
   - If we don’t consider these wider impacts, our plans will lead to unintended or undesirable consequences.

Attentions

4. Do not base plans simply on predicted past trends

   - Transportation planning is often using past trends to predict future vehicle traffic. This predicted traffic volume is then used to determine the size of new transportation facilities. One problem with this approach is that it assumes that the factors that led traffic volume to increase in the past will continue into the future.
   - We also have to consider the long term impact of widening roads, for example – as we discussed earlier - because they change the conditions, they can lead to induced traffic, which in turn makes the prediction useless.

Attentions

5. Do not focus just on issues that can be easily measured
   - Vehicle traffic is relatively easy to measure, so transportation system quality tends to be evaluated based largely on automobile travel conditions (e.g., average traffic speeds, roadway Level-of-Service, vehicle congestion delay, vehicle operating costs, parking supply).
   - Accessibility impacts, including impacts on transit service quality, non-motorized transport and land use accessibility, are often harder to measure and tend to be ignored.

Attentions

6. Focus on Accessibility not Mobility

In order to understand this issue we need distinguish between traffic, mobility and access as follows:

- Traffic: *Conventional transportation often reflects the assumption that transportation means motor vehicle traffic.*
- Mobility: *A more comprehensive approach reflects the assumption that transportation means personal mobility, measured in terms of person-trips and person-kilometers traveled.*
- Accessibility

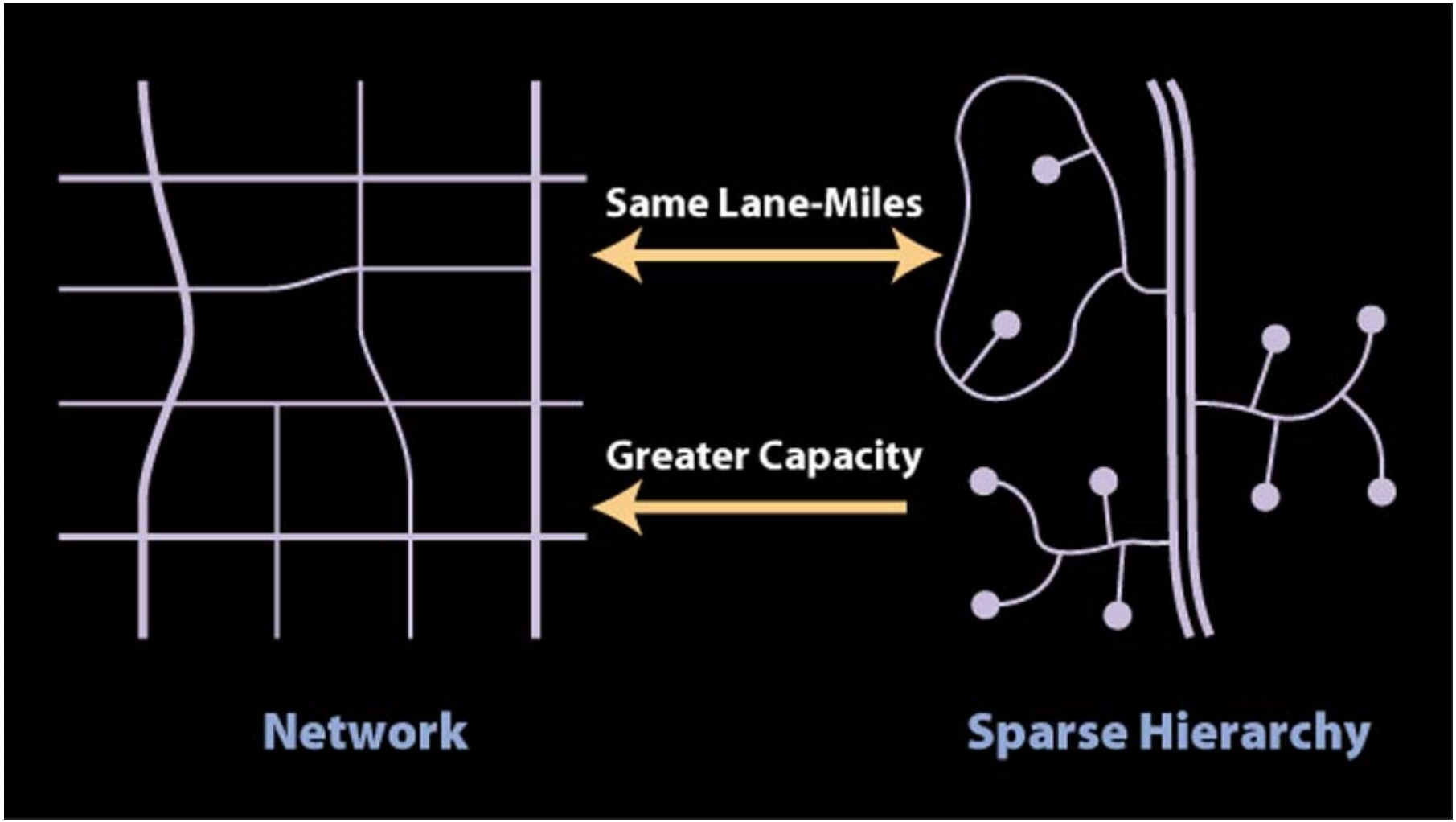
The most comprehensive definition of transportation is Accessibility, the ability to reach desired goods, services and activities. This is the ultimate goal of transportation, and so is the best definition to use in transportation planning.

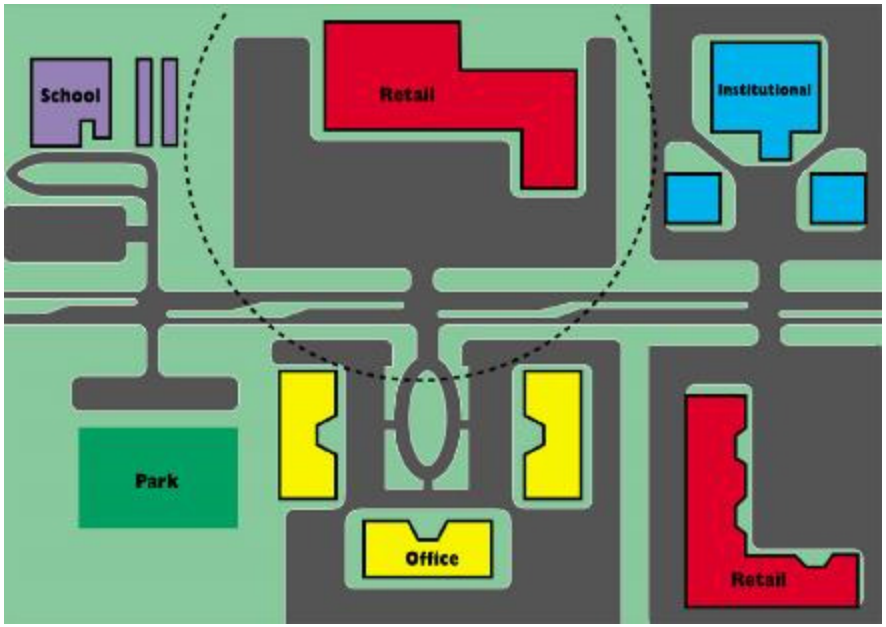
Attentions

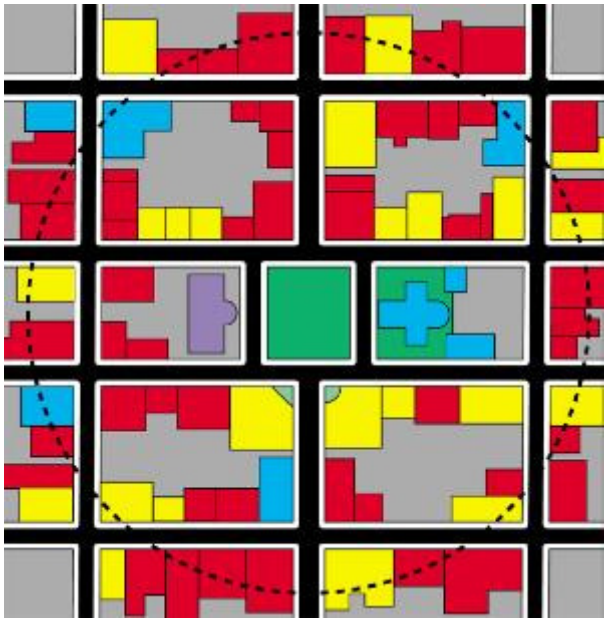
6. Accessibility vs. Mobility

- Mobility refers to the ability to move between different activity sites.
  - If a facility could move people and goods very fast then that facility provides very high mobility.
- Accessibility refers to the number of activity sites connected by the facility.
  - If a facility provides connection to large number of residences, commercial places and industrial places then it provides very high accessibility.

Do these two places provide the same level of Access? Mobility?

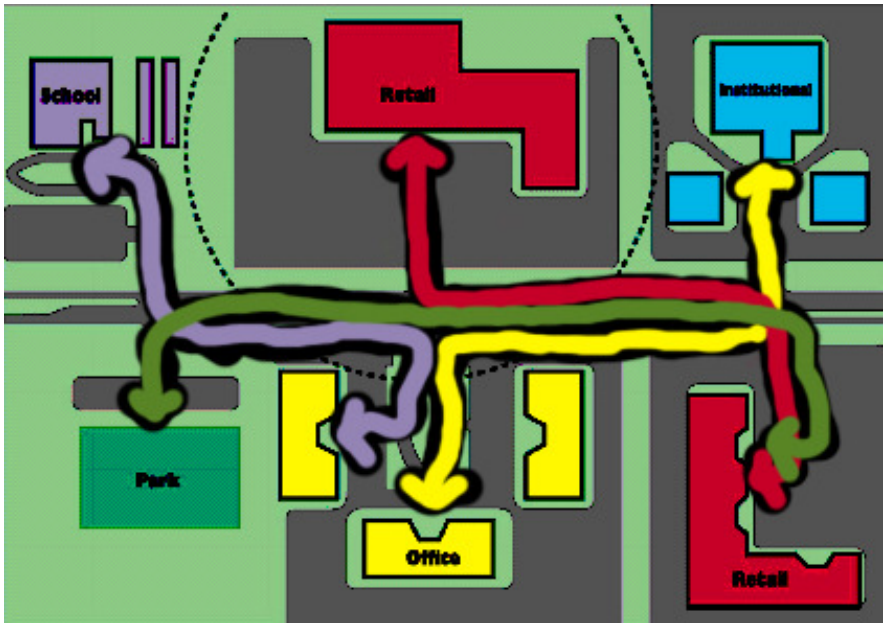


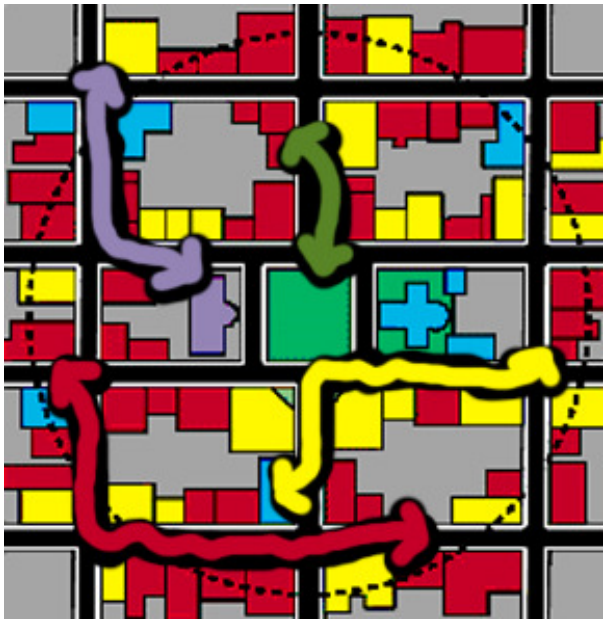




What are the physical differences between these two places?

Access versus Mobility





Which of these two places

•provide more access with less mobility?
•would you expect more congestion?
•would you expect more people walking?

Person Trips vs. Vehicle Trips

- Trip generation step calculate total person trips.
- Trip assignment deals with volume not person trips.
- Need to adjust person trips to reflect vehicle trips
- Understand units during trip generation phase
- Usually adjust by average auto occupancy

Example:

If:

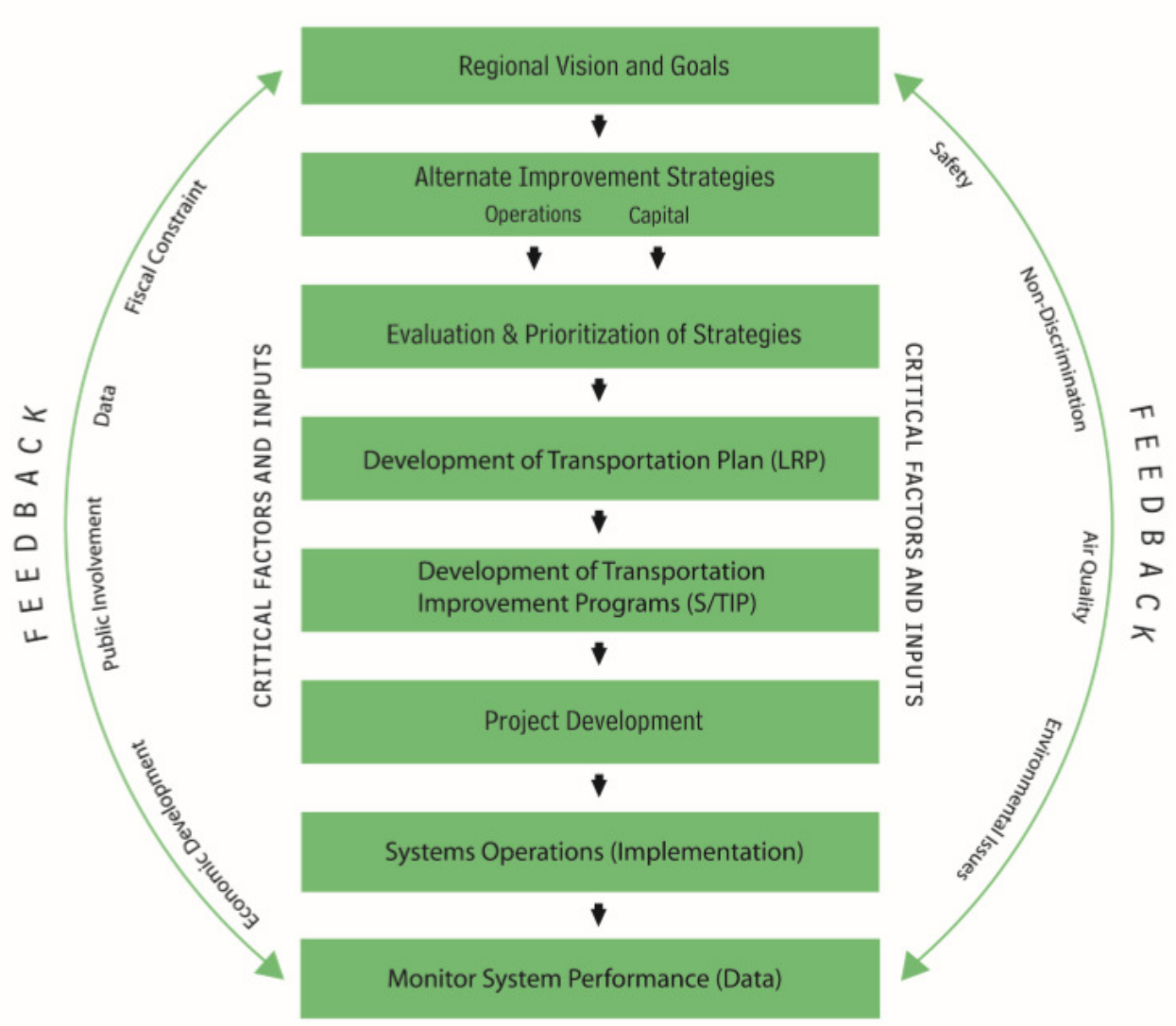
- average auto occupancy = 1.2
- number of person trips from zone 1 = 550

So:

Vehicle trips = 550 person trips/1.2 persons per vehicle =
458.33 vehicle trips

Process of transportation planning

- Transportation planning includes three stages:
  - Preparation stage: a comprehensive consideration of possible strategies;
  - Solution development stage: methodology;
  - Evaluation stage: encompasses diverse viewpoints;



Specific steps to do transportation planning

- Stage 1: Preparation stage
  - Situation Definition
    - Inventory of existing facilities
    - Current conditions and issues

      (e.g., congestion, very high travel time, very high road user costs)
  - Identification of other planning studies

    (e.g., earlier plans at National, regional and local level to arrive at a solution)
  - Problem Definition
    - Understand the present problems and define the research questions

    (e.g., to achieve reasonable journey speeds, vehicle operation costs, comfort and convenience for travel, ……)

Specific steps to do transportation planning

- Stage 2: Solution development stage
  - Develop alternative solutions to reasonably satisfy the future needs considering their impact on environment, safety, economy and social resources of the target area.
    - Forecast future population and employment growth
    - Assess projected land uses and major growth corridors in the region
    - Identify the differences between the current and the projected future transportation problems and requirements
    - Propose various transportation improvement strategies taking into account their impacts on environment, safety, economy and society.

Specific steps to do transportation planning

- Analysis of Performance
  - Demand forecasting
  - *Demand forecasting includes determination of daily volume of different classes of vehicles.*
  - *The forecast must also give the traffic volume during the peak hours of the day.*
  - *If there is toll-gate (or toll-free) measurement, then a relation between the volume levels and the toll levels should be established.*
  - Investigate the interaction between demand and capacity of the facility
- Use performance measures to shortlist the alternatives
  - Analyze the proposed solutions through detailed planning studies
  - Developing long-range plans and short-range programs of alternative improvement and operational strategies;

Specific steps to do transportation planning

- Stage 3: Evaluation stage – Economic Feasibility
  - Discuss the economic feasibility for all the alternative strategies.
    - Conduct economic evaluation for the short-listed alternatives
    - Compare each of the alternative with the do nothing situation
    - Work out the costs and benefits for all the alternatives

    (Costs include capital cost of construction, maintenance cost, environmental costs and so on; Benefits include savings in travel time, reduction in operating cost, improvement in traffic safety, etc.)

    - If necessary, compute the economic Internal Rate of Return (IRR) for all the alternatives and rank them based on IRR.

    (IRR is the interest rate at which the Net Present Value of the Project is zero.)

Specific steps to do transportation planning

- Stage 3: Evaluation stage – Financial Feasibility
  - Developing a financial plan for all the alternative strategies.
    - Financial feasibility analysis is conducted by sponsors
    - If the project is completely funded by the government, the sponsor is the Government.
    - If the project is being implemented under public private participation or purely by private agencies, then the sponsor is the concerned private agency.
    - A Financial Internal Rate of Return is worked out for each alternative by computing the cash flows by sponsors.
    - This financial analysis is also used to arrive at the best financial strategy for the project.

Specific steps to do transportation planning

- Stage 3: Evaluation stage – Environmental Impact Assessment
  - Assess the impact of recommended future improvements to the transportation system on environmental features;
    - The environmental impact of alternative concepts and recommended solutions must be considered and incorporated into the cost effectiveness analysis.
    - The following impacts should be studied and a proper environment management plan mitigating the impacts should be prepared.
      - *Traffic changes (e.g., congestion, volume growth, mode influence)*
      - *Air pollution*
      - *Noise pollution*
      - *Ecological effects*
      - *Social effects*

Specific steps to do transportation planning

- Adjust alternatives and re-evaluation according to the evaluation results.
- Select and perform the project
  - Prepare a Detailed Project Report for the selected alternative, including all the technical design details, schedules for implementation, funds support for the implementation of various phases of the selected project.
  - Construction, Maintenance and Operation
    - Establish feed back channel during the implementation stage, and make necessary adjustment possible.

Transportation Modelling

- Since transportation problems are multi-dimensional,

  (e.g., Traffic congestion, Emissions, Impact on economy, Traffic accidents)

- and the need for transportation infrastructure is high, due to:

  Globalization, Urbanization,

  Governments cannot afford transportation constraints to have a great negative impact on future competitiveness, foreign investments,…

- Moreover, changing the existing infrastructure is:

  Expensive and have significant long-term effects;

  No guarantee for success;

  Not trivial (existing spatial zones, restricted by local regulations, legislation, etc.)

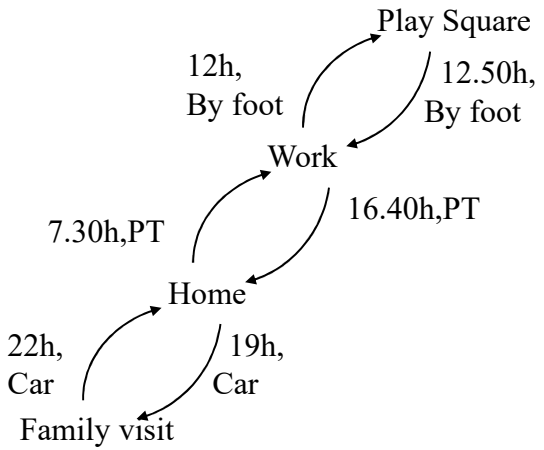
Transportation Modelling

- Therefore transportation models are often used. By using transportation models to represent human behavior, we can:
  - understand individual's travel behavior
  - support management decision making
  - make predictions in uncertain circumstances
  - forecast traffic trend for new or expanded transportation system
  - test scenarios (e.g., alternative land uses, policies)
  - influence future decision-making
- AIM: to portray reality as accurate as possible.
- Commonly used approaches in different countries :
  - Trip-based approach
  - Tour-based approach
  - Activity-based approach

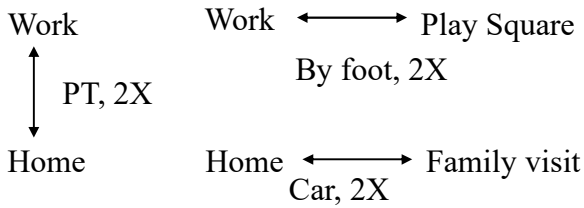
Approach: Trip-based approach

- Trip-based approach
  - In trip based approach, individual trips within a daily activity schedule are directly modeled;
  - Trip is defined as a travel from one location to another and without intermediate stops;
  - The entity of the model is the independent and isolated trips;
  - There is no connections between different trips.

Reality



Trip-based model



Typical trip-based model

- Four-step model: For the past 40 years, transportation professionals have used four-step approach in modeling transportation demand.
  - Step1: Trip Generation

    -- Estimate the number of trips generated in a zone or at a particular location, and attracted to another zone (particular location), based on the assumed relationship among socioeconomic factors, land use characteristics, and the past number of trips. Trip generation then leads to:
  - Step2: Trip Distribution

    -- Estimate the origin and destination for the production trips and attraction trips of each zone

Typical trip-based model

- Step3: Mode Choice

  -- Estimate the number of trips (or the share of the total number) made via each type of mode

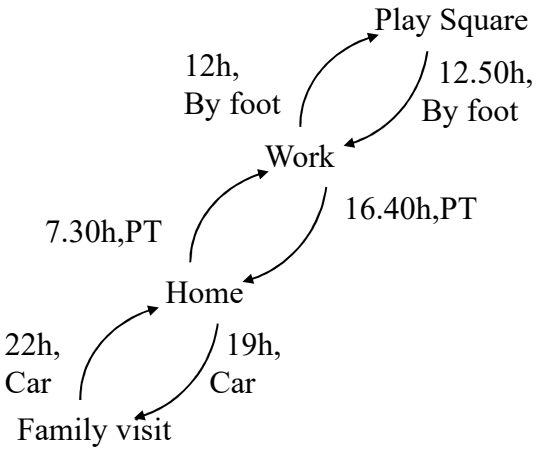
- Step4: Network Assignment

  -- Estimate the number of trips via a particular mode that will take specific paths through a road or transit network. The end result, when all trips are assigned to a network, is an estimate of the total number of trips that will use each link in the network. When compared to the capacity of this link, planners can forecast the level of congestion that will occur at that location. This becomes the basis for assessing the performance of the transportation system.

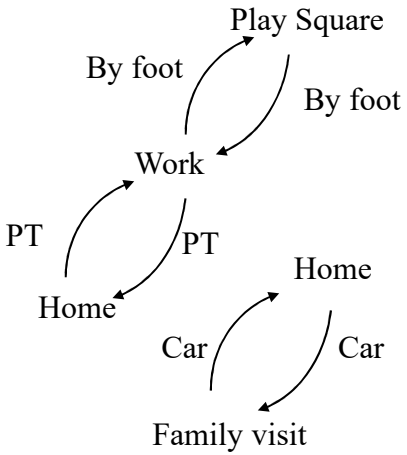
Approach: Tour-based approach

- Tour-based approach
  - In tour based approach, home-based (or work-based) tours are explicitly modeled.
  - Trips that start and end from home or from work location are modelled independent
  - Each tour is independent, model is not capable of making the integration
  - Frequently use nested logit techniques

Reality



Tour-based model



Typical tour-based model

- Several tour-based models have been developed, principally in Europe, including:
  - the Netherlands

    -- [Daley et al., 1983; Hague Consulting Group, 1992]
  - Sweden

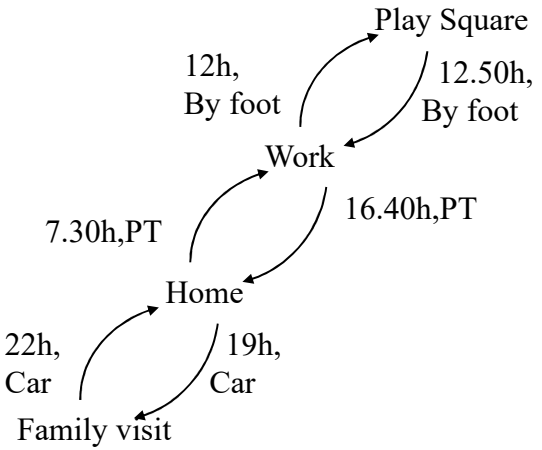
    -- [Algers et al., 1995]
  - Italy

    -- [Cascetta et al., 1993]

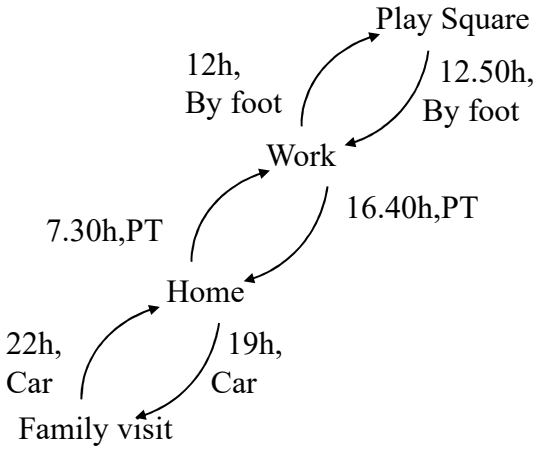
Approach: Activity-based approach

- Activity-based approach
  - In activity based approach, the research unit is the sequence of behavior.
  - Therefore, the full travel pattern of individual could be reflected in temporal and spatial dimensions.
  - which activities are conducted, where (location), when (start time), for how long (duration), and which transport mode (mode choice) is involved.

Reality



Activity-based model



Typical activity-based model

- Famous activity based models:
  - Constraint-based models

    -- (e.g. CARLA, MASTIC, PCATS)
  - Utility maximizing models

    -- (e.g. STARTCHILD, DAS, Tel Aviv)
  - Rule-based models (computational process models)

    -- (e.g. ALBATROSS, FEATHERS, TASHA, ADAPTS)
  - Micro-simulation models (mixed)

    -- (e.g. CEMDAP, HAPP, MATSim)

Lecture summary

- Transportation Planning:
  - (Motivation) why we need transportation planning?
  - (Definition) what is transportation planning?
  - (Function) what kind of problems could be solved?
  - (Process) How to do transportation planning?
  - (Approach) what approaches are commonly used?
  - (Evaluation) how much we can believe in the final results and what kind of methods can be applied for the assessment?
- Equilibrium of supply and demand
- Major policy and planning issues

Task

- Reference:
  - Sheffi, Y., 1985. Urban Transportation Networks, Prentice-Hall, Inc.
- After class reading:
  - Download and read 1 or 2 papers referring to transportation planning;
  - Know about some basic principles about transportation planning.

Thanks for your attention!

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