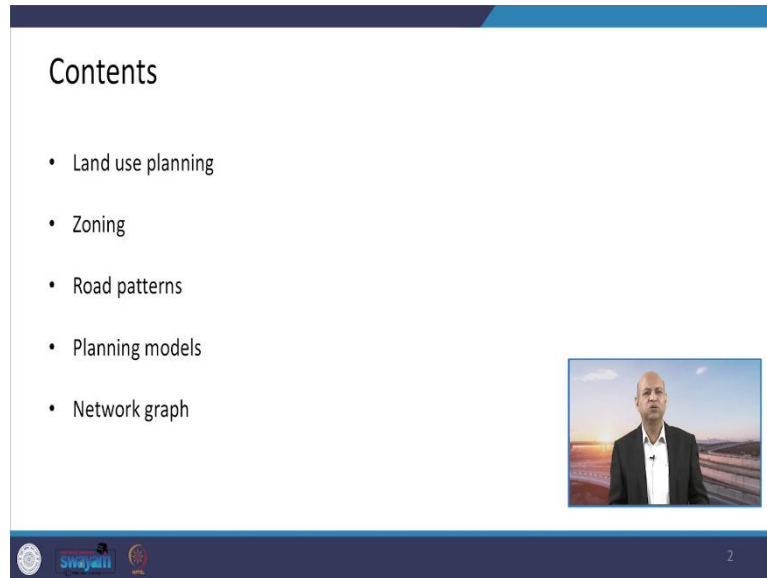


Sustainable Transportation Systems
Professor Bhola Ram Gurjar
Department of Civil Engineering
Indian Institute of Technology, Roorkee
Lecture 23
Land Use Planning and Zoning

(Refer Slide Time: 00:44)



Contents

- Land use planning
- Zoning
- Road patterns
- Planning models
- Network graph

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Hello, friends. So, soon after that lecture on introduction of land use planning, today we will go further to see its objectives, different kinds of zoning, those kinds of things today, we will look at. So, the contents of today's lecture include the land use planning, what is the purpose, how do we define the land use planning, what is the need of it.

And then the zoning how do we you know differentiate between different kinds of zones or how do we divide a city or town in different activities, which are represented by a particular zone like commercial or residential those kinds of things. Then what kind of road patterns can be part of the land use planning from the transportation point of view, so, that congestion or traffic jams can be avoided and smooth mobility can be achieved. And then those are the models which are used for planning purposes of the land from the transportation perspective that briefly we will touch, and the network graph related issues we will discuss and then we will conclude.

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Need for land use planning

- Land use planning is essential for any development project.
- Planning process can be used to prevent land-use conflicts and reduce exposure to pollutants.
- When it is performed thoroughly and accurately, the environmental, social, physical, and economic conditions will all benefit the local community



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So, the need for land use planning because we do not want to develop some particular city or town or habitat or any kind of human activity, which is without planning. Otherwise, what happens if adhoc is promoted then something will come up here then next time because of some emergence some other activity will be there and that way if that city grows like that in disjointed way, so, one activity is in the A and you will find that after two, three zones, you will find again the another activity similar to the A.

So, the those kind of conflict of uses of land use will be there and that should be avoided, otherwise what will happen that the traffic flow may be completely disturbed because you will find something here, something there and you do not meet your demands or needs of the whatever, whether it is related to your shopping or related to your automobile repair services, if it is not being met at a particular place, then you have to travel lot of distances and that is not good from the transportation point of view.

So, the planning process is very essential for preventing those kind of land use conflicts which are possible because of adhoc is more known planning related issues. And when we perform proper planning and keep considerations of environmental aspects or social, physical dimensions and the needs of the local community, all those things, then the city develops in a cohesive way in an integrated way and you do not find something which is kind of out of order. So, everything is in order proper.



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Example: Need for land use planning

Dharavi at Mumbai is the world largest slum.

Do you think this can be changed using land use planning?

Yes, more compact, high rise with economic housing development can accommodate the population and have a potential to turn around the aesthetics of locality.



swayamii

Now, if we see like, what is the need of land use planning as we were discussing, for example, if these kinds of slumps emerge out of those activities which are unplanned. So, those land uses which are of public nature, public properties, private properties, it is difficult to enclose otherwise, anybody who is owner of the private property, they will show you and they will take the legal action, but the abuses of the public property is rampant, you can see everywhere, in every city some kind of developments which are unauthorised.

And people did not have proper permission, but they develop their facilities, their huts or their other kind of activities, even of commercial nature. And because, our rules and regulations implementation agency is not so particular about these things. And then after some time, political issues emerge, and then all those vote based politics kind of things.

But the need of the planning in such kind of things is because if you do not plan properly, then the hygiene is not good, the living conditions are not good, many kinds of diseases people get from each other and the life, those conditions or the quality of life is not the right one which we really aspire for, as the dignified human being.

So, the planning is necessity there to remove those kinds of things and give them better conditions. For example, if you give them lot of spaces and high-rise buildings, so, the same population can reside in proper accommodation with better amenities and better space, right now, they are just it is spread horizontally and completely congested kind of residential areas are there.

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Definition of land use planning

- Landowners, developers, municipalities, and other professionals collectively work to approve a land-based usage
- Promotes an appropriate social and environmental effect, while also employing resources efficiently
- Promote the orderly development of the landscape, preserve some open spaces, and provide consistency among developments

The slide features a blue header and footer. The footer contains the Swayam logo, the text 'Swayam', and a small number '5'. A small video inset in the bottom right corner shows a man in a suit speaking.

Well, if we talk about theoretical aspects of defining the land use planning, then you can say that there are several stakeholders which are involved in these kinds of activities, whether it is the landowner or the developers who develop the land or like builders or the municipalities who give some kind of regulations to regulate the development activities.

And then there are professionals like architects, engineers, who give you the maps and designs and then the building activities go as per the plans. So, the promoting appropriate social and environmental effects in a proper way so, that things happen efficiently and productively, that is the aim.

And then it can also as I said, orderly development, not the haphazard way, orderly development always help you to move from point A to point B efficiently and without wasting much time, without wasting much resources, resources like fossil fuel etcetera. When you travel from one point to another, you need to have some sort of transportation mode, whether your own automobile or public transportation, but it consumes energy resources. So, the resource utilisation efficiency has to be achieved plus time related efficiency is also to be achieved.

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The slide is titled "Objectives of land use planning" and features a list of four bullet points. The text is as follows:

- Efficient utilization, acquisition and disposition of land
- Highest and best use of land
- Desirable patterns of land uses to prevent wasteful development and minimize the cost of public infrastructure and utilities and other social services
- Conserving the areas of ecological, aesthetic, historical and cultural significance

On the right side of the slide, there is a small video inset showing a man in a suit speaking. At the bottom of the slide, there are logos for "Swayam" and "6".

Well, the objectives when we talk about then as I said, that efficient utilisation of the resources and meeting the demands and the needs of our daily life in a better way and the land usage should be in an optimum way, in a proper way, so, that means the all resources in an integrated way, so that there is nothing wasteful kind of space utilisation, every space is properly planned and used, that should be the objective.

And also, the aspects of aesthetics or ecological responsibilities or commitments, those should be fulfilled, and the historical and cultural significance is there in a particular location, so, the developments should not demean those kind of heritage or cultural significance related areas, rather it should be properly protected. So, that is why planning is very much needed and the objectives are to protect those kinds of things, which are historical in nature or cultural from centuries and they have very important part in our social life or cultural life you can say.

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Example of efficient land use planning

The diagram illustrates two models of land use planning. On the left, 'Urban sprawl' is shown as a circular area with a central core and a red line representing a single public transportation route. Green spaces are scattered and limited. On the right, 'Green space expansion' is shown as a star-shaped area with a central core and multiple red lines representing public transportation routes. Green spaces are significantly increased and more integrated. Labels include 'Green space', 'Public transportation', 'Urban sprawl', and 'Green space expansion'. A blue arrow points from the sprawl model to the expansion model.

Through land planning, we may utilize space efficiently and may use extra space for making locality greener and aesthetically pleasant.

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Well, the efficient land use planning examples can be seen, for example, you can see urban sprawl and green space expansion. So, means the population which were living in in this particular kind of areas, so, the public participation happens in these kind of developments more, here it is less. So, the public transportation is here and you can have more kind of ways for public transportation.

And then the attractive inner cities means some thing must be there, where people go and visit those kinds of places, otherwise in this not so, good planning only one lane is there for this kind of public transportation system and green spaces also not so much, but in this better planning, we can achieve more green space, because more greenery and more eco centric developments you can call that, so more nearer to the nature. And we have all these components of the nature whether air, water, soil means we are not disconnected to that, rather we are connected in a healthy way, not the polluted air, not the polluted soil or not the polluted water, but the clean one healthy one.

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The slide is titled "Advantage of land use planning" and features a list of seven bullet points. The text is in a blue font. At the bottom right of the slide, there is a small video inset showing a man in a suit speaking. The slide also includes a footer with logos and the number 8.

- Beneficial framework for the development
- Helps to anticipate the future of a particular area, implement an infrastructure that acts as risk mitigation
- Positively impacts the urban economy
- Put measures in place to combat climate change
- Protects lands from negative impacts of transportation
- Minimizes the public health and safety risks
- Prevents land use conflicts

So, the advantages are many fold like in time framework or development framework, we have several benefits, it also helps in anticipate seeing the future demands of the particular area, how it will develop after 10 years or so. So, we can plan in that way, futuristic planning can be achieved.

Then the positive impact on the urban economy because when you are doing much more work in a given time frame, rather than wasting time in travelling. For example, if you want to go to your job destination and if you are wasting 2 hours, your productive 2 hours are wasted every day to reach to your office it is not the good planning. You can reach, let us say within 30 minutes or 20 minutes, then it is better.

So, the urban economy also grows because we have more productive hours not only for our professional purpose, for our family purpose also, because we have family commitments, if we are giving more hours to the reaching to the office then coming back, so, 4 hours are gone, where from, from the family time, that family time you could spend with your kids, with your family members, you could have healthy environment. So, that we also we should think.

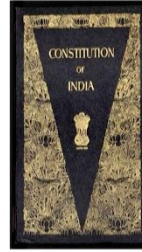
Plus, you know, it also protects the land from negative impacts of the transportation like more congestion, more emissions, more pollution, those kinds of things can be avoided. Also, it minimises the public health related issues or safety related issues, because when planning is better, movement is better and there are no chances of like accidents also. So, it prevents lot of conflicts, lot of negative externalities that way so, that is the advantage of proper planning.

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Legal aspect of land use planning: Indian Constitution

Indian constitution refer land use planning at following sections:

- **74th constitutional amendment act:**
Setting up and devolution of powers to Urban local bodies (ULBs) or city governments as the lowest unit of governance in cities and towns & planning rights.
- **243-ZE article:** Metropolitan planning & rules for it.
- **243-ZD article:** Committee for district planning & related rules.



Also, the legal aspect of planning is there, means constitutional, that is very, very important aspect, we should focus on because in our constitution also in constitution of India, it is properly mentioned that, we should go for land use planning in that way, this is the 74th constitutional amendment, which focuses on that aspect like setting up or devolution of powers to urban local bodies, ULBs or city governments as the lowest unit of governments in cities and towns and planning rights. So, they have rights.

And then, metropolitan planning and rules are there, committees for district planning and related rules. So, everything is there properly, in a proper framework. So, there is no kind of confusion or gap that how to proceed. So, agencies are defined, organisations are defined, their powers and rights are defined, so it is better, it happens better to function or govern. So, that way we can achieve more governance, better governance, healthy governance.

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Urban sprawling/organic growth of cities

- Rapid urbanization and migration towards cities is leading to expansion of urban areas.
- Expansion in cities boundaries are observed.
- This organic/unplanned expansion is called urban sprawling
- This leads to poor land use, poor lifestyle for residents and growth of slums near cities.




Image: Slum in sector 57, Gurugram (India)




Image source: cityspidey.com

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When we talk about the growth of the cities like urban sprawling or organic growth means those kind of concepts are there. So, the rapid urbanisation happens then, migration from countryside to the cities and those planning related issues jeopardise, and they are really harmed very much, because you do not have much utilities or infrastructure to support that influx of the people who are coming without much warning.

Because you have planned certain facilities, according to a number of people in the city, but if those people are coming and they are putting the stress or pressure on those facilities, those common infrastructures, then the quality of life will go down and that that kind of slumps start to spring there like in Gurugram, this slum is there in the sector 57.

So, those are kind of things which are without warning you can say or without the planning means people did not plan for this slum, it happened because of certain reasons, those things should be really catered properly, and these kinds of developments which happen and which contribute in a kind of negative thing, although people may argue that lot of labour, lot of you know those household activities or domestic helps come from these areas, so that way informally, they are also contributing economically, that is a fact.


But what is the quality of life? Do we provide better quality of life to them in these kind of localities? No, that means planning is needed, planning is needed for those kind of people also. So, the unplanned expansion is called like, urban sprawling and the better planning is needed to avoid these kinds of situations.

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Zoning

- Zoning divides a city into multiple small parts.
- Zoning is the way the governments control the physical development of land and the kinds of uses to which each individual property may be put.
- Zoning is done for better governance and planning.
- Zoning is done based on socio-economic features.

Example: Noida, Greater Noida, Chandigarh, Gurugram are examples of zoned cities. Cities are divided into sectors.




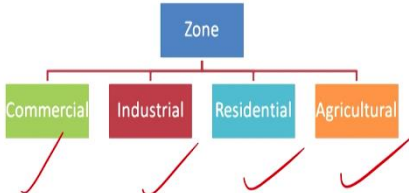
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Zoning, zoning is very good example of better planning in urban areas, like you can see Noida, Greater Noida, Chandigarh, Gurugram, where zones are defined and various colonies various pockets are divided into different sectors. And there are like shopping centre in a particular sector, or automobile related services in a particular sector, industry area in a particular sector, then there are greenbelt those kinds of things.

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Zone classification

Based on socio-economic conditions, zones are classified mainly in these 4 categories (shown in figure)



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And then small pockets are also for each sector, there are shopping complexes, so, that kind of zoning related planning can be much better and, it gives us better governance as well as better execution of several activities and it is better socio-economic feature rather like commercial,

industrial, residential, agriculture. So, those kind of zones we can divide the complete city into and those zones can help in a better execution of different activities.

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Need of zoning: Example

- Frequency of metro/bus/shuttle services can be kept higher in morning time from residential to CBD (Central Business District) zone and vice-versa in evening.
- On off days (weekends), frequency towards markets zones can be kept high.
- In case of absence of clarified zone division, management of demand (frequency of public transport service) is difficult.



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Why do we need, because as why do we need zoning? The example is very simple, because, when we have a particular city centre or business activity in a particular location, then we can plan from residential area to the commercial centres, some metro, some bus, some shuttle service, those kind of things and we can decide the frequency because we know this is the commercial sector, here people will come every day from Monday to Friday.

Then on Saturday and Sunday, where they will go, they will go to some other places where shopping or some other kinds of activities are there markets. So, for them in weekends, those kind of support system can be provided. So, the frequencies of the public transport sector as per the zoning activity, it helps to decide when we know the proper zoning and activities related to those particular zones.

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Road patterns based on land use

- Block pattern
- Star & block pattern
- Star & circular pattern
- Star & grid pattern
- Hexagon pattern




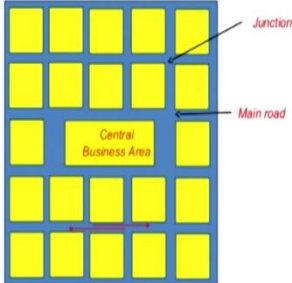
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When we talk about the road patterns based on land use planning then we can talk in different way like block pattern, star and block pattern, then star and circular pattern or star and grid pattern or hexagon pattern these kinds of developments maybe there for roads in the city, and we will see the example.

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Block Pattern

- Whole area is divided into rectangular blocks
- Streets or branch roads intersect with each other at the right angle.
- The main roads always pass through the center, and it should be wide enough.
- Branch roads may be narrow as compared to main roads.
- The main roads should be provided with a direct approach to outside the city.



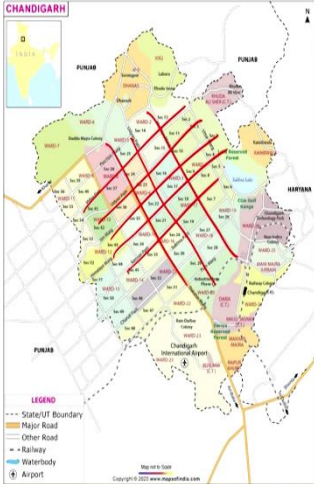
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For example, this is the block pattern. So, whether you see the Noida or Chandigarh those kind of cities, they have these kind of block patterns where sectors are divided into squares or rectangles, and the roads are intersecting with each other at 90 degree. So, this is very simple way of planning and elegant also. So, main roads are wider but then other roads maybe there like service roads etcetera which are narrower and those, those kinds of plans and city this

centre can be there, where lot of activities and for that wider roads can be there to connect the other areas to the city centre.

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Example of block pattern:
Chandigarh



Road pattern is in rectangular form which is called blocked pattern in city of Chandigarh.




Image source: mapofindia.com


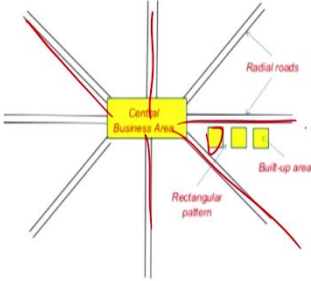
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Well, this is the block pattern of Chandigarh you can see all these roads are straight and they are intersecting each other at 90 degree, and there are different zones like secretariat, then industrial area particular and commercial zones etc.

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Star & block pattern

- Entire area is divided into a radial network of roads radiating from the center outwardly with block pattern network of roads in between the radial main streets.
- Reduces the level of congestion at the primary bottleneck location



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There are other patterns of the roads like star and block pattern where the radial kind of roads go from the city centre and then within those radial roads, there are blocks again in parallel to the roads etcetera so those kind of patterns can be achieved.

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Example of star & block pattern




Image: Arc de Triomphe (Paris, France)




Image source: lonelyplanet.com



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This is one example of Paris in the France. So, from this particular this city centre, these roads are going in a radial way and the developments are there in between, but there are in parallel to the roads, the main roads, the block pattern, you can say.

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Star & circular pattern

- Main roads(radial roads) radiates from the central point and relate to concentric roads(ring roads) that are also radiating outwardly
- Reduces the possibility of rear-end crashes

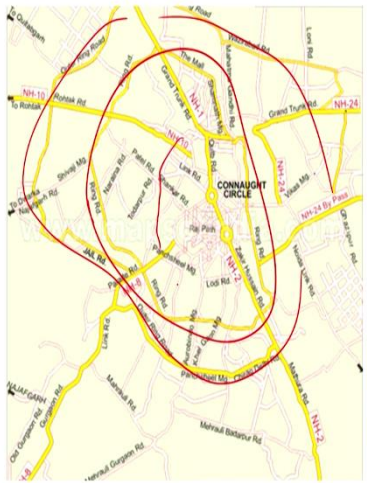


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There may be star and circulation pattern. So, again radial roads are there, but again the another roads may be in a circular fashion, ring road kind of thing, inner ring road, outer ring road those kind of things maybe they are as in Delhi we know inner ring road or outer ring road those kinds of things.

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Road network pattern in Delhi



Can you recognize pattern in central Delhi's road network (image)?

It is close to star & circular pattern




Image source: indiaonlinepages.com


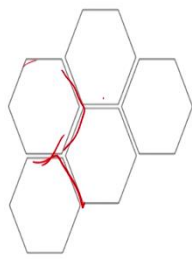
20

This is the example of Delhi. So, you can think whether it is star related planning or the ring related planning. So, the New Delhi especially, you can see the Connaught place or those. So, these kind of almost round circles are there and these are in a circular fashion and the traffic moves. So, this is the outer ring road and the inner ring road there. So, not perfectly circle, but still a circular motion, they fulfil the demands of the travelling from one point to another.

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Hexagon Pattern

- Entire area is divided into hexagonal patterns.
- Three roads meet the built-up area boundary by the sides of the hexagons at every corner of the hexagon which can be further divided in suitable sizes.



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Example of Hexagon Pattern



Image: Gramscichele, Italy is a city with hexagon pattern land use and street network



Image source: wonderfulengineering.com



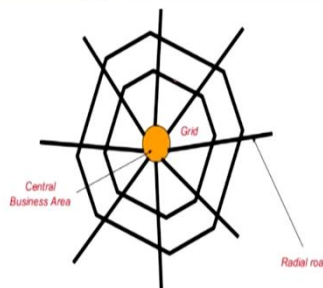
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Then there are hexagon patterns where different hexagons kind of blocks are touched each other on three sides or two sides and then there are roads in that pattern. So, this is one example of one city, Gramscichele in Italy and that gives this planning kind of hexagon, you can see the pattern in a particular hexagon way all these developments of the city sector have been achieved.

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Star & grid pattern

- combination of Star and Grid Pattern.
- Radial network of road radiates from the center outwardly. Then, the main radial streets are interconnected by providing a grid pattern.



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Then there may be star and grid pattern where star is there, but rather than circular there may be some grids and at some particular, perpendiculars may also be there. So, the grids may be there as well as these radial roads may be there. So, kind of star as well as the grid pattern both can be combined.

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Planning models

- Rational planning model
- Advocacy planning concept
- Collaborative planning theory
- Political economic model in urban planning
- Critical minimum efforts theory

Rational planning model is most successful and commonly used method for planning



Source: planningtank.com

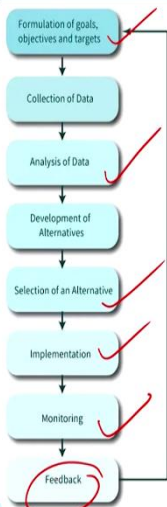
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Then we talk about different planning models which are used for achieving the urban planning and urban land usage patterns. So, these are like rational planning model and advocacy planning conceptual related models are also there, then collaborative planning related theories which are also used for achieving the planning of the land uses in the urban areas, then political economic model in a simple simplistic way where lot of political pressures, economic needs combine with each other and then some, some sort of planning is achieved. Then critical minimum efforts theory all these are based on different kinds of experiences of urban planners, regional planners.

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Rational Planning Model (RPM)

Considered as technocratic approach due to tedious data collection and dependency on technical expertise.



Do you think, this model is like EIA process/model?

Yes, it is
Conceptually both EIA process & RPM are decision making model for development



Source: planningtank.com

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But out of those rational planning model is most popular, because it is based on a systematic data collection analysis and then implementation of certain planning. So, it is like EIA we have seen in EIA, if you remember in environmental impact assessment, we collect data, we analyse them, then we get some feedback from the people, we again go for, whether it is meeting the necessity or not.

And then again, we see the analysis related data. So, the formulation of goals and objectives of the targets is the first thing, then collection of data according to the goals, analysis of the data, development of different alternatives, which can fulfil the objectives which we have set. Then selection of the alternatives out of those available alternatives in fashion that it is more resource efficient, it is more or less costly all those kinds of things. Then we implement it, we monitor it, and get the feedback. And then according to the feedback, some changes can be incorporated during the development of the particular urban space or city.

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Advocacy/plural planning concept

Planning is done based on consultation with following:

- Representatives (mainly political)
- Interest groups (commerce of chamber, social groups, NGOs, think tanks etc.)
- Ad-hoc organization (temporary collaboration of people for any protest etc.)

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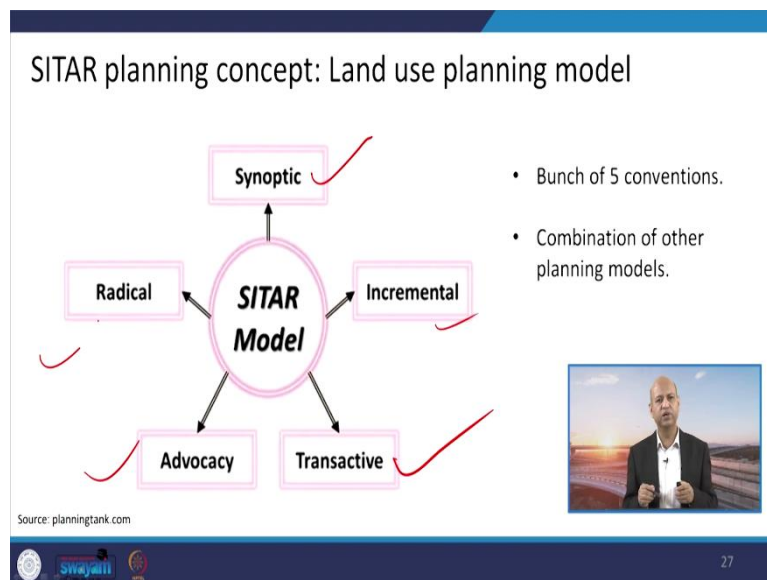
What is advocacy and plural planning where it is a kind of very informal feedback or formal feedback, where representatives of let us say some political example, we can give like, if some big state is divided into two states, now, the other part wants to have a capital city. So, this is a political need, now, you have to have new capital city.

So, there will be representatives of political parties to decide which part of the new state will be better for the having capital city. So, those kinds of things can be there. Then, there may be some other interest groups, other stakeholders like commerce of chambers, business organisations or groups, social groups, NGOs or think tanks who work in this particular area,

and there may be when let us say, a particular site has been decided, this will be the capital city.

Now, there will be some people who may feel that we will be harmed because of location of certain lands to a particular facility or our interest may not be met as they might have seen or their agriculture land is going for the city area, and their livelihood will be affected. So, there may be several reasons and there may be some protest or some people who want to give you some feedback that how to address their concerns. So, that way those kinds of advocacy or plural planning concepts are joined together where all these groups consult with each other and then they reach to some consensus and the city is planned properly.

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There is one another concept which is known as SITAR planning concept and this is the short form or abbreviation of Synoptic Incremental Transactive Advocacy and Radial, all these five aspects are clubbed together to give this particular model.

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SITAR planning concept: Terms

- Synoptic: Comprehensive in nature
- Incremental: Accommodating as per need
- Transactive: Replace the existing one with improved
- Advocacy: Views are taken up of different stakeholders
- Radical: Implementing new ideas



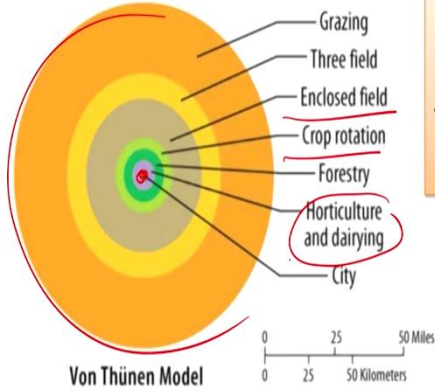
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Where synoptic means the comprehensive in nature, means all needs must be fulfilled by that particular planning related issues. And then incremental means it accommodates then as per the need means some need is figured out and let us say after 10 months and some groups come, this is more important one need which we did not give due importance, then it can be incorporated. So incremental, maybe there.

Also, the transactive like it can replace the existing one with the improved one, some facility in terms of a particular industrial township or whatever. So, it can do in that way. Then advocacy because it takes views of different stakeholders so, that means, you can incorporate their likings, disliking or their futuristic thoughts or concerns or issues. And radical implementing new ideas because when you are planning a new township then it is also an opportunity to give space to very, very new ideas which have never been implemented. So, the radical concepts can also be incorporated.

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Von Thunen model for land use



- This model was proposed for agricultural land use by Von Thunen in 1826.
- Land value or viability decreases with increase in distance from city.

Von Thünen Model

0 25 50 Miles
0 25 50 Kilometers

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One example, very interesting is that of Von Thunen in 1826, he developed this idea for example, there is a city or township. So, he says that in nearer location there should be like horticulture or dairy related activities, after that forest related land use can be located and after that the crop rotation related, then enclosed fields or the grazing related area at the outer space. So, those kind of, small town which are based on animal husbandry or agriculture activities, these kind of models can also be used or developed.

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Gentrification

- Gentrification is the **rebuild of an area/locality into a more affluent and well-developed neighborhood.**
- It is generally **beneficial in terms of aesthetics & economy** but may cause **hardship for middle/low-income people.**

Lisbon, Portugal –
It has become one of the most multicultural places & attracts more wealthy residents

Lot of construction happening in the city. This makes it a gentrified city

Causing hardship among the middle-class population as it favors the upper middle class and affluent citizens

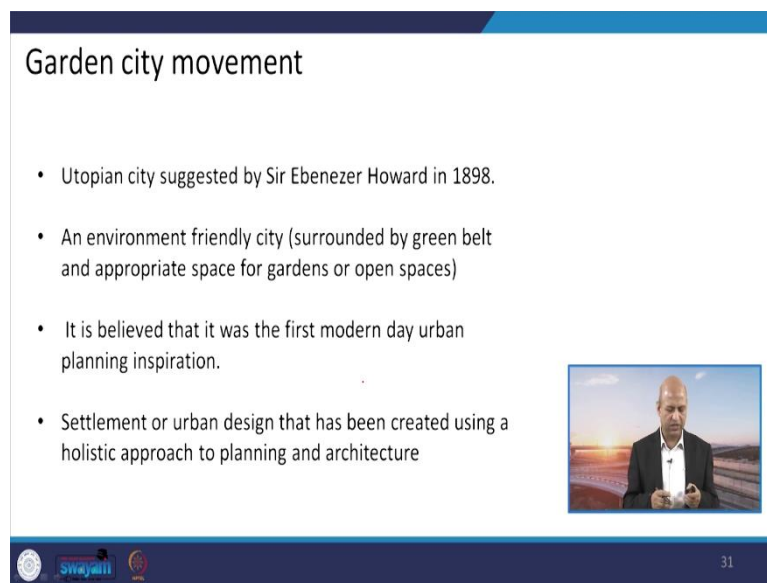
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There are other aspects like gentrification because certain cities can promote a particular kind of class. So, as you say, this is good gentry, this is so called not so good gentry, according to

the location, you sometimes call that this is posh colony, those kind of, we talk with each other when, so, gentrification may also occur.

One example is like Lisbon, in Portugal, that it favours a particular class and that the reason they say that the middle or lower middle-class people, they do not find those kinds of facilities, which are as per the needs of those class, which the city has been developed to support. So, those kinds of issues may emerge in a particular city, if it is supporting a particular class and not giving due attention to other classes.

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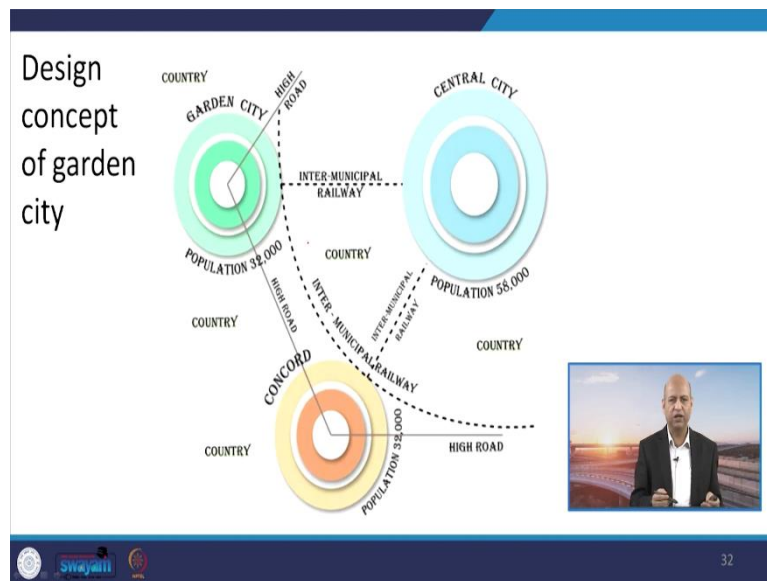
The slide is titled "Garden city movement" and contains the following bullet points:

- Utopian city suggested by Sir Ebenezer Howard in 1898.
- An environment friendly city (surrounded by green belt and appropriate space for gardens or open spaces)
- It is believed that it was the first modern day urban planning inspiration.
- Settlement or urban design that has been created using a holistic approach to planning and architecture

There is a small video inset on the right side of the slide showing a man in a suit speaking. The slide footer includes the Swajati logo and the number 31.

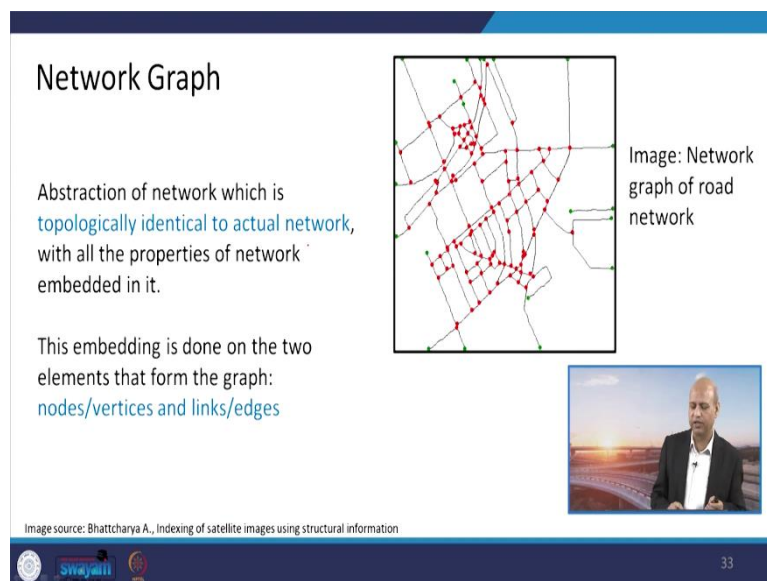
Then there may be like Garden city movement, it was also part of these theories and philosophies of land use planning, when it was growing. So, in 1898 means nearer to 1900, this Utopian city suggested by Sir Ebenezer Howard, and he said that we should have lot of green space and parks and a lot of open space, so that we can have a better living conditions. And though means, so, many cities are there which are fully packed, skyscrapers, highly dense population. So, he was in favour that the cities must be surrounded by green belts and it should have proper space for gardens and other amenities which are helpful for better quality of life.

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So, accordingly, they gave these concept that the Garden city must be kind of near an old city one can develop a another city or township kind of thing and that way you can help to have better city planning, if you cannot change much in the old city kind of patterns.

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There may be some network graphs because when you are having development of the city and the road networks etc. So, you have to have connection between different zones between different points and that with the this network develops and those network must help in a kind of like certain pockets or certain points must be hubs, which can meet the demands of like transit from one mode of the transport to another those kinds of things.


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Node and link in network

A Node or vertex is a terminal point, or an intersection point on a graph.

It is the abstraction of a location such as a city, an administrative division, a road intersection, a dead end or a transport hub which connect to another network (stations, terminals, harbors and airports)

Link is the abstraction of a transport infrastructure supporting movements between nodes.

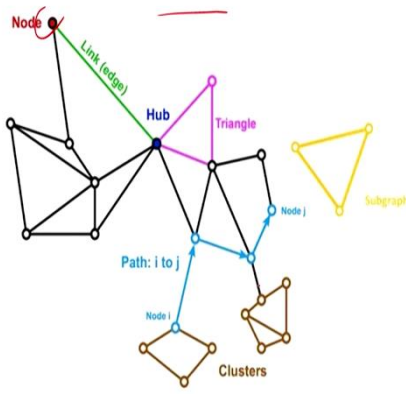


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So, the nodes may be there or vertex where all roads will meet and there will be a kind of joint or terminal point where you can change from one mode of the transport to another one, those kinds of things maybe there.

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Network graph: Key words




Hub: Meeting points of 3 or more links.

Cluster: Closed loop of network

Sub graph: Independent part of network

Triangle: Closed loop with 3 nodes




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So, this node and link related network is also important, which is shown in this particular graph, like this is node and it can link different hubs and that way different kinds of triangles or other points you can link from node 1 to node 2. So, hubs are basically meeting points of three or more links we call and clusters are like closed loop in a network and the sub graphs like independent part of network and triangles, the closed loop of three nodes. So, these kind of nomenclature is there to explain these parts of the network.

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Network Density

- Network density measures the territorial occupation of a transport.
- It is the length of the network per unit area.
- The higher the network Density, the more the network is developed.

$$\text{NetworkDensity}(ND) = \frac{\text{Total link length } (L)}{\text{TotalArea}(S)}$$


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And the network density is important means, as you are an engineer if you want to think then you have to think in a quantitative manner also. So, when you want to, want to know what is the network density, then the total link length which is in the network and the total area divided by the total area.

$$\text{Network Density } (ND) = \frac{\text{Total link length } (L)}{\text{Total Area } (S)}$$

So, that is the basically the length per unit area, length of the network means in network there will be several links. So, add up the length total length of the links and divide it by the total area of the network. So, you will get certain value which is basically the length per unit of area and that is called the network density.


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Eta Index (η)

- Eta index gives the average link length.
- Complex networks will tend to have a lower eta value.
- One can as well imagine it as how frequently a node will appear on average.

$$Eta\ Index(\eta) = \frac{Total\ link\ length\ (L)}{Total\ No.\ of\ Links\ (e)}$$

Walkable neighborhood, it's important for eta index to be lower allowing pedestrians more options for movement, but significantly reducing traffic speeds too




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And there is another concept which is Eta index, which is basically the total link length divided by total number of links.

$$Eta\ Index\ (\eta) = \frac{Total\ link\ length\ (L)}{Total\ No.\ of\ Links\ (e)}$$


So, there was area here link by link means number of links and the length basically, there was length, the total length and divided by total area here total length divided by total number of link's.

So, these are two different things, which are used for planning purposes, it gives us insight like, which are the neighbourhoods which can be promoted for non-motorised transport modes, walkable or cycling purposes. So, these kind of indices gives us insight that which particular locality is favourable for pedestrians, where you will need some other kind of, traffic or what kind of speed of the traffic should be there, those kinds of things are needed for and these calculations really help in planning those aspects.

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Conclusion

- Land planning & transportation system are closely interlinked.
- Better integration of these benefits the users/residents.
- A proper planning model should be adopted for land use planning.



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Well, when we conclude then we can see that the land planning and the transportation system are very much interrelated to each other, because they influence each other. And according to the you land use planning, you have to have certain transport modes, if there are very near distances, you have zoning related planning, then if shopping centres are at the walkable distance, then you do not need to bring your car or something, you can walk and buy something and go at home, those daily routine related demands.

If you go for big shopping, then you can go to the city centre then you can have a public transport system or your own automobile or car. Then better integration is needed, because we want to achieve benefits in terms of users demands as well as from environmental and socio-economic aspects point of view, plus proper planning model to choose and implement that model also help us to adapt and adopt the land use planning related issues and give us the optimum utilisation of the resources in terms of time, in terms of energy, in terms of the land space utilisation.

So, this is all for today, when we talk about why, what is the land use planning and how do we do that in a planner manner or in a, in an engineering perspective, those kind of issues we have talked.

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References

- Silberstein J., Mase C., 2013 "Land use planning for sustainable development"
- Brody S., 2013 "The Characteristics, Causes, and Consequences of Sprawling Development Patterns in the United States"; *Nature Education Knowledge* 4(5):2

And these are the references where you can have more information about these aspects. Thank you for your attention. And we will continue on land use planning again in next lecture. Thanks a lot.