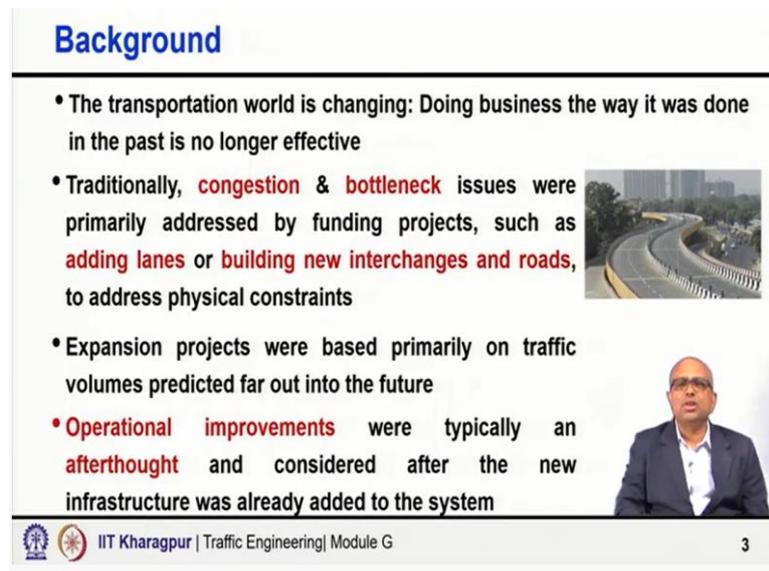
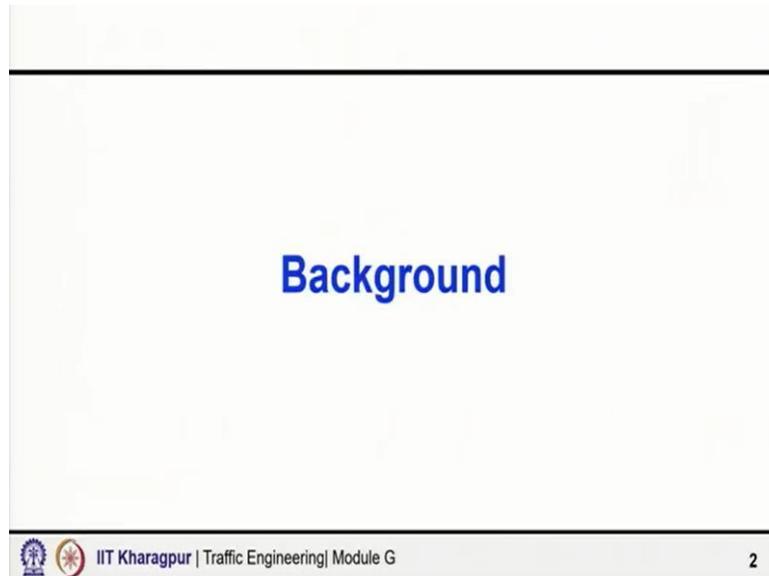


**Traffic Engineering**  
**Professor Bhargab Maitra**  
**Department of Civil Engineering**  
**Indian Institute of Technology, Kharagpur**  
**Lecture 51**

**Introduction to Traffic Control and Management**

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- The transportation world is changing: Doing business the way it was done in the past is no longer effective
- Traditionally, **congestion & bottleneck** issues were primarily addressed by funding projects, such as **adding lanes** or **building new interchanges and roads**, to address physical constraints 
- Expansion projects were based primarily on traffic volumes predicted far out into the future
- **Operational improvements** were typically an **afterthought** and considered after the new infrastructure was already added to the system 

Welcome to Module G, lecture 1. In this lecture, I will give you an introduction to Traffic Control and Management. The transportation world is changing, doing business the way it was done in the past is no longer effective. Earlier times in earlier time, or, traditionally, congestion and bottleneck issues were primarily addressed by funding projects. Say for example, these are mostly infrastructural augmentation projects, capital intensive as well.

Say for example, adding lanes or building new interchanges or roads. And, through those projects, attempts were made to address the physical constraints. Expansion projects were primarily on traffic volumes predicted far out in the future. Horizon year, we used to have the traffic volume forecast and based on that assessing the infrastructure need and accordingly build new road, add lanes or develop new interchanges and so, on.

Operational improvement on the other hand, were typically an afterthought and considered after the new infrastructure was already added to the system. You have the road in place, you have augmentation already has happened, has been implemented. And then, you are thinking about operational improvement, once the infrastructure was already added to the system.

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**Background**

**New Trends & Considerations**

- Due to **increased urbanization**, transportation agencies are now facing trends that create a growing demand for travel with less space to work with; we can no longer build our way out of congestion

**Limited Funds**

- The **financial constraints** for public agencies have increased
- The **cost** to build roads and bridges has **increased**

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Now, the world is again changing or has changed as well. Due to increased urbanization, transportation agencies are now facing trends that create a growing demand for travel. Huge urbanization is happening especially, emerging nations or developing worlds, a lot of urbanization is happening, we have population growth happening in urban area, probably at the fastest rate under the current scenario.

And therefore, the altogether even the transport demand is growing, the vehicle ownership is also growing, but with less space to work with. So, we can no longer build our way out of congestion. To explain this, why, what are the real reasons? Let us discuss a few salient points.

First, limited funds, the financial constraints for public agencies have increased, fund is no longer easily available. You have limited resource, limited fund. So, very judiciously one has to invest that money. Of course, infrastructural augmentation will happen, road infrastructure

augmentation also will happen. It is the need, naturally it is required actually to invest and augment infrastructure, but understand that the finance, availability of finance is not so easy anymore.

Also, the cost to build roads and bridges has increased, even 10 years back, what used to be the cost for a building road per kilometer, under the present scenario, these days if you consider the cost is significantly increased. So, one way resource available is limited, the other way the cost has increased.

Along with the limited funds which I have not mentioned, I will also like to say that there are physical constraints, a very, very important context, especially considering countries like India. You do not have land for augmentation of infrastructure. Urban areas, hardly anything you can do because there is no land. So simple, it is not only the limited fund, but there are tremendous physical constraints in terms of augmentation of road capacity, or road infrastructure.

Rural areas also several highway projects are suffering simply because the land is not available. So, even though the money is there, it is difficult to build it because you do not have land, ROW is so restricted, and land acquisition is becoming increasingly challenging and difficult task.

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**Background**

**Advances in Technology**

- Due to advancement in **technologies** (smart phones, GPS, etc.), **mobility services** (Uber, Ola, etc.) and **information availability**, traveler expects products & technologies they encounter will be **smart** and **improve** their travel experience

**Changing Customer Needs and Expectations**

- Travelers are **less tolerant towards unexpected delays** in their trips that can result from crashes, bad weather, work zones, and special events
- Such **delays** can be **frustrating** for drivers and can **impact businesses** as well

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Second, due to advances in technologies, say for availability of smartphone, GPS, everybody has got a smartphone, GPS is there, they can track, they can see, they can estimate the time, availability of mobility services like Ola, Uber, you give a call, people book a taxi and the vehicle is there, right at the place where you want.

And also, the information availability. And due to all these things, traveler expects products and technologies they encounter also will be smart and will eventually improve their travel experience. People are not happy, their expectation has changed. It is not just I am able to travel from point A to point B, but how I will be able to travel, how comfortably, how conveniently I am able to travel, that matters.

So, expectation also has increased, people expect the smart encounter for whatever they encounter will also be smart. And therefore, through those their travel experience will be improved. They want to be informed, they want to know everything, how is the traffic state, what route I should take, what is the traffic condition and the current scenario, whether there are incidents, whether there are other kinds of blockage due to some other reasons.

Changing customer needs and expectation, travelers are these days all together because of maybe there are impact of the technology availability also, less tolerant towards unexpected delay in their trips that can result from crashes from bad weather, work zones or even special events. As I say the overall expectation has changed. It is not that we are reaching late, but anyhow I am able to reach but people are not happy with that, no more happy with that.

So, they are less tolerant towards unexpected delay due to various reasons. Such delays can be frustrating to drivers and the road users I will say or the vehicle users and also impact their may impact their business. So, they are worried, they want to reach on time, they want to know how much time it will take to reach. So, overall, less tolerant towards unexpected delay.

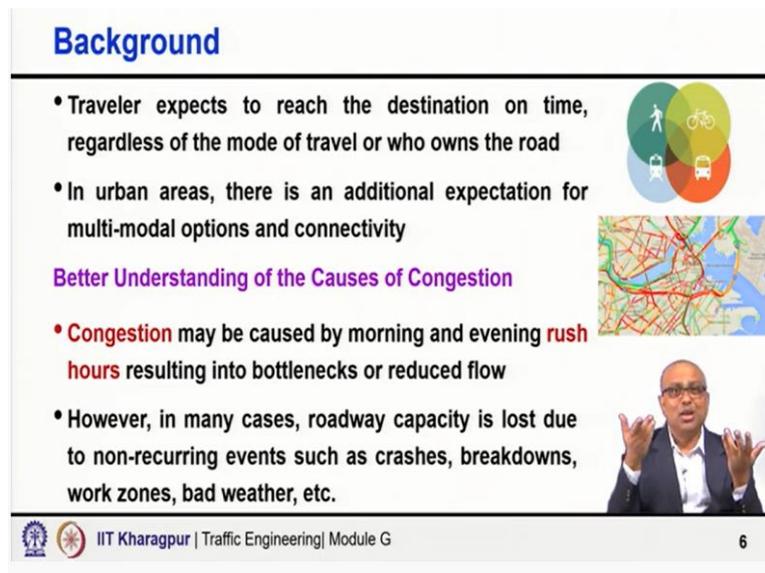
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**Background**

- Traveler expects to reach the destination on time, regardless of the mode of travel or who owns the road
- In urban areas, there is an additional expectation for multi-modal options and connectivity

**Better Understanding of the Causes of Congestion**

- Congestion may be caused by morning and evening rush hours resulting into bottlenecks or reduced flow
- However, in many cases, roadway capacity is lost due to non-recurring events such as crashes, breakdowns, work zones, bad weather, etc.



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Traveler expects to reach the destination on time regardless of the mode of travel or who owns the road. In urban areas, there is an additional expectation for multimodal options and connectivities. They expect that okay not like in rural transportation scenario, but in urban case, they also expect the multimodal options to be available, they want people to get good walkway, good connectivity, one mode to another mode, one same mode, maybe one mode of transport, one bus route to another bus route or one mode to another mode.

The facility, the transfer facility, the infrastructure, the overall multimodal options and connectivity. Also, better understanding of the causes of congestion. Congestion, as you know may be caused typically due to recurring or congestion could be recurring in nature. For example, every morning and evening, during the peak hour or rush hour the demand is very high as compared to the capacity.

So, every time, every day, every week day or work day, during the peak hour, the congestion will occur. But at the same time, road capacity is lost or congestion do occur due to non-recurring events. For example, somewhere there is a crash or a breakdown of vehicle or work is happening or due to bad weather and somewhere the water accumulation has happened and such kind of factors.

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## Background

### New Trends & Considerations

- Due to **increased urbanization**, transportation agencies are now facing trends that create a growing demand for travel with less space to work with; we can no longer build our way out of congestion



### Limited Funds

- The **financial constraints** for public agencies have increased
- The **cost** to build roads and bridges has **increased**



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## Background

### Advances in Technology

- Due to advancement in **technologies** (smart phones, GPS, etc.), **mobility services** (Uber, Ola, etc.) and **information availability**, traveler expects products & technologies they encounter will be **smart** and **improve** their travel experience



### Changing Customer Needs and Expectations

- Travelers are **less tolerant towards unexpected delays** in their trips that can result from crashes, bad weather, work zones, and special events
- Such **delays** can be **frustrating** for drivers and can impact businesses as well



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## Background

- Traveler expects to reach the destination on time, regardless of the mode of travel or who owns the road
- In urban areas, there is an additional expectation for multi-modal options and connectivity



### Better Understanding of the Causes of Congestion

- **Congestion** may be caused by morning and evening **rush hours** resulting into bottlenecks or reduced flow
- However, in many cases, roadway capacity is lost due to non-recurring events such as crashes, breakdowns, work zones, bad weather, etc.



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## Background

- Given these trends, a different philosophy and approach is needed than what has been done before
- Addressing congestion requires transportation professionals to seek out solutions that involve optimizing the performance of our existing facilities
- Transportation Systems Management and Operations (TSMO) provides agencies with the **tools to manage** and **operate** what they already own more **efficiently** and **effectively** before making additional infrastructure investments
- TSMO can also be expressed as traffic management measures



So, considering all these reasons, for example, what I said limitation of funds, physical constraints of augmenting infrastructure, which I have not mentioned, but I am repeatedly mentioning it, advances in technology, changing customer needs and expectation, better understanding of the cause of congestion and with all these a different philosophy and approach is needed today, to address congestion issues and to enhance operational efficiency.

So, addressing congestion requires transportation professionals to seek out solutions that involve optimizing the performance of our existing facilities. This was traditionally not the need, not the requirement also. So, now the efficiency, how we optimize, how we offer a better performance within the available infrastructure and facilities to cope up with the growing demand.

So, the Transportation System Management and Operations provide agencies with the tools to manage and operate what they already own. Only with those, not only just, not just by building more and more roads or additional infrastructure. What they already own, with those, how they can manage and operate, what they already own, to bring more efficiency, and therefore, effectively addressing the transport related issues.

So, how to bring efficiency, even with additional, even without additional infrastructure or rather with what already we have, what already we have, how using those things in a better way, in an optimal manner, how we can improve the performance, how we satisfy the expectation, how we fulfil the objectives, starting from environment to energy, to user expectation to everything. TSMO can also be expressed as traffic management measures.

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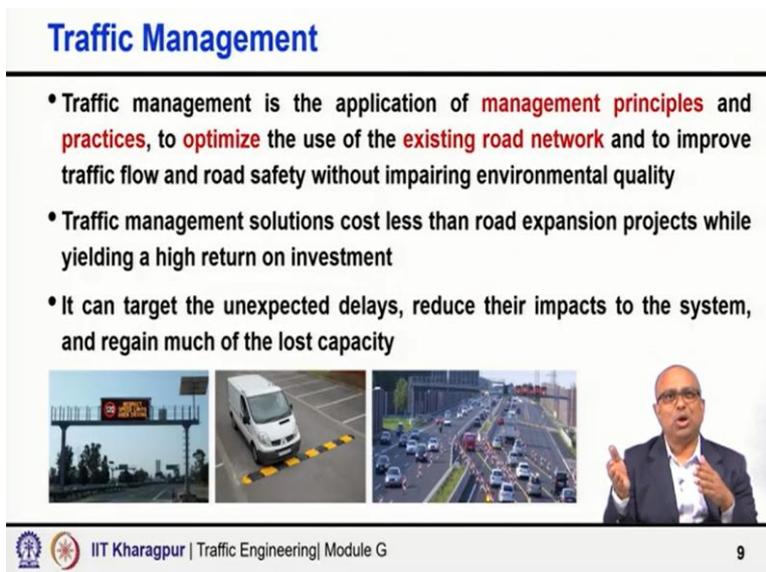


**Traffic Management**

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A slide with a white background and a black border. The title "Traffic Management" is centered in blue. In the bottom right corner, there is a small video inset of a man in a suit speaking. At the bottom, there are logos for IIT Kharagpur and the text "IIT Kharagpur | Traffic Engineering | Module G" on the left, and the number "8" on the right.



**Traffic Management**

- Traffic management is the application of **management principles and practices**, to **optimize** the use of the **existing road network** and to improve traffic flow and road safety without impairing environmental quality
- Traffic management solutions cost less than road expansion projects while yielding a high return on investment
- It can target the unexpected delays, reduce their impacts to the system, and regain much of the lost capacity



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A slide with a white background and a black border. The title "Traffic Management" is centered in blue. Below the title are three bullet points. At the bottom, there are three small images: a traffic light, a white van, and a busy highway. In the bottom right corner, there is a small video inset of a man in a suit speaking. At the bottom, there are logos for IIT Kharagpur and the text "IIT Kharagpur | Traffic Engineering | Module G" on the left, and the number "9" on the right.

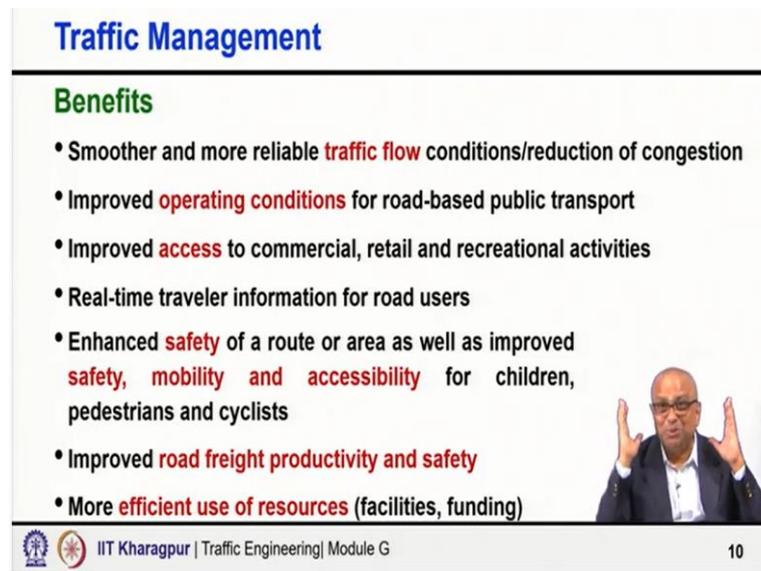
With this, let us go to what is traffic management then, it is the application of management principles and practices. For what? To optimize, very carefully, to optimize the use of existing road network or facilities in general, to improve traffic flow and road safety without impairing environmental quality. That means, we want to apply through traffic management, we want to apply actually management principles and practices to optimize the use of existing facilities and infrastructure, to offer better traffic flow, higher safety and protecting the environmental aspect.

Traffic management solutions because these are not capital-intensive projects we are talking about but we are talking about principles and practices to optimize the use of the existing

facilities. So, they are not capital intensive. And therefore, these solutions cost less than the road expansion project or typical infrastructure projects.

But they are still able to bring high return on investment, because the investment is not so high as these are not capital-intensive projects. But the return is high so, you can actually get high return on investment, if you are applying traffic management techniques. It can target the unexpected delays, it can reduce the impact of such kind of delays on the overall transportation system and regain much of the lost capacity. So, it is quite effective.

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**Traffic Management**

**Benefits**

- Smoother and more reliable **traffic flow** conditions/reduction of congestion
- Improved **operating conditions** for road-based public transport
- Improved **access** to commercial, retail and recreational activities
- Real-time traveler information for road users
- Enhanced **safety** of a route or area as well as improved **safety, mobility and accessibility** for children, pedestrians and cyclists
- Improved **road freight productivity and safety**
- More **efficient use of resources** (facilities, funding)

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There are multiple benefits of traffic management. For example, smoother and more reliable traffic flow condition, reduction of congestion in general, improved operating condition for road-based public transport, improved access to commercial, retail and recreational activities. Real time traveler information for road user, people expect yes, there may be even if there is an accident, I want to know or I want to know how much time still it will take for me to travel, I want to get informed, I want to even know that there is an incident, this kind of expectation can be fulfilled.

Enhanced safety of a route or area as well as improved safety, mobility and accessibility for children, pedestrians, cyclists. Improved road freight productivity and safety. More efficient use of resources, that is what is basically the whole objective. How without building or without taking up capital intensive infrastructure project what, how applying policies and measures or actions which do not require infrastructural augmentation, but how we can make better use of the existing resources to bring operational efficiencies in terms of reducing congestion,

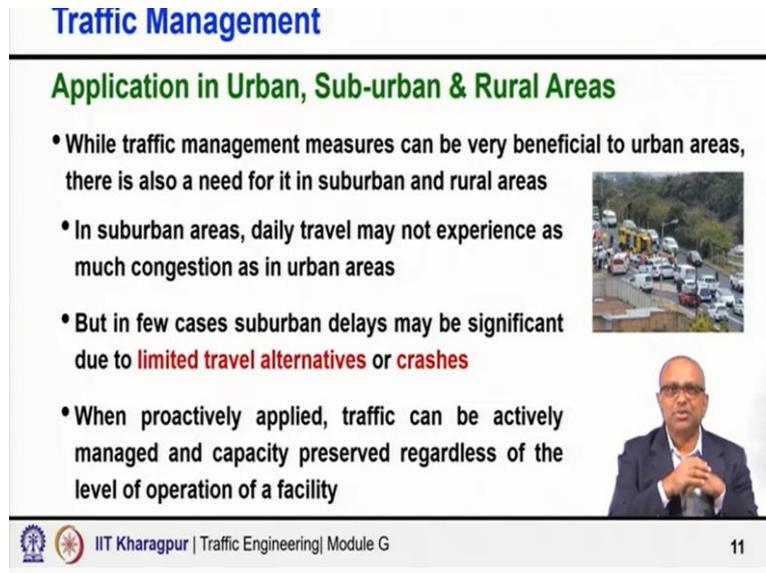
enhancing safety, fulfilling users expectations, but protecting environment. So, all these objectives, how we can satisfy.

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**Traffic Management**

**Application in Urban, Sub-urban & Rural Areas**

- While traffic management measures can be very beneficial to urban areas, there is also a need for it in suburban and rural areas
- In suburban areas, daily travel may not experience as much congestion as in urban areas
- But in few cases suburban delays may be significant due to **limited travel alternatives** or **crashes**
- When proactively applied, traffic can be actively managed and capacity preserved regardless of the level of operation of a facility



Traffic management actions may be applicable or should be applied for urban, suburban and even rural areas. While traffic management measures can be very beneficial to urban areas, because the complexity there is more. I said, the growth, urban growth, urban scenario in developing countries or emerging nations is really very complex. Demand supply imbalance is high, constraints are much more, requirements are also higher. So, the complexity is much more simply.

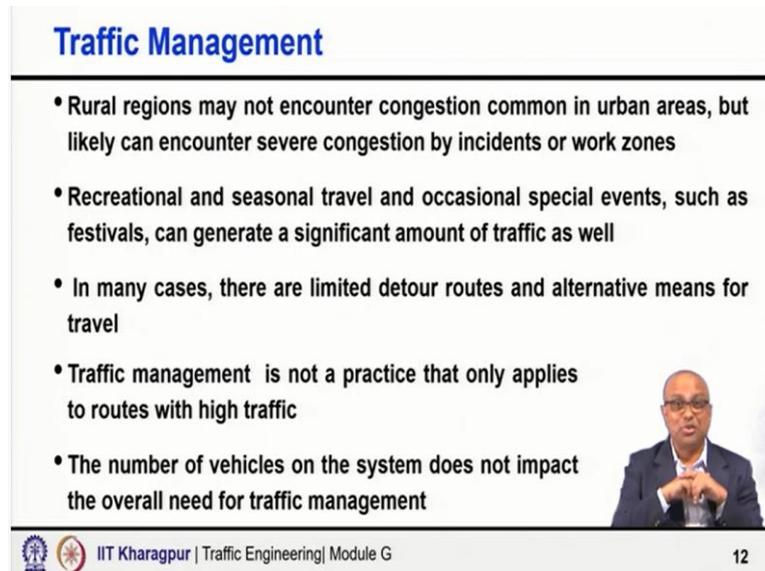
So, obviously, traffic management methods can be very beneficial to urban areas. And therefore, it is required there, but it is equally needed for the suburban area. And in countries like India, the peri-urban what we can call peri-urban, suburban or peri-urban, they are the more problematic areas because expansion has happened in terms of population growth, housing, but the other infrastructure and facilities have not been developed.

Road is still narrow, drainage system is still not the modern one, maintenance is not good, but people have started building houses, multistories are there, people want to use car, no road, but they want to use car and to then there is no facilities for the pedestrians to walk or by cyclists to use by cycle safely. Also, it is kind of contradiction are there.

So, while in some cases in suburban areas, travelers may not experience congestion or other problem, but in other areas, they experience such kind of issues. They have limited travel alternatives, there are road safety issues, there are operational issues. So, there also we need to

apply traffic management. So, when proactively applied, traffic can be actively managed and capacity preserved regardless of the level of operation of a facility.

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**Traffic Management**

- Rural regions may not encounter congestion common in urban areas, but likely can encounter severe congestion by incidents or work zones
- Recreational and seasonal travel and occasional special events, such as festivals, can generate a significant amount of traffic as well
- In many cases, there are limited detour routes and alternative means for travel
- Traffic management is not a practice that only applies to routes with high traffic
- The number of vehicles on the system does not impact the overall need for traffic management

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Rural regions in general, do not experience recurring congestion fairly the demand will be more than the capacity as normally it happens in urban area or suburban area or peri-urban areas, but rural areas also people may encounter severe congestion by incidents or because of the work zone. We do not see the congestion, but if the highway or the motorway is blocked for even 10, 15 minutes or so, you can see the amount of vehicle which will get accumulated, the length of the queue which will be formed, then you can understand the how severe the impact could be.

Recreational and seasonal travel and occasional special events, such as festivals can also generate a significant amount of traffic and thereby, may cause imbalance between the demand and supply to create externalities such as congestion, regular emissions, safety issues. So, in those cases, also the traffic management measures might be very helpful.

So, traffic management is not a practice that only applies to route with high traffic, this is very, very important. Everywhere we may take advantage or we may bring benefit out of the application of traffic management techniques in all areas, as I said, our urban, suburban, rural, low traffic volume scenario, high traffic volume scenario.

So, do not think that traffic management needs to be applied only when there are, there is high traffic volumes, that is not true. The number of vehicle on the system does not impact the overall need for traffic management. Because traffic management maybe the, our highways

may not have that much traffic, not like urban case, but still there are significant operational issues, there are significant safety issues, which all can be addressed to a large extent, I should say using suitable traffic management measures. So there lies the role, that is where the strength of the traffic management.

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**Traffic Management**

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**Limitations**

**Traffic Generation**

- Improved traffic management may induce more or longer trips to be made so that congestion is little relieved and total emissions may even increase



**Technical Capabilities**

- Good traffic management requires effective planning, implementation and enforcement skills which tend to be in short supply in developing countries



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Of course, as I said, there are several benefits and it can really help to improve or to address the concerns related to traffic in urban, suburban, in our cases, I added the peri-urban as well and also rural areas. There are limitations as well that also we need to understand. For example, one important issue is the traffic generation. As you improve the facility, increase the operational efficiency you may find that more and more vehicles will get attracted. And because of the larger volume again the congestion may aggravate and total emissions may even increase.

Second, the technical capabilities. Good traffic management requires effective planning, implementation and enforcement skill which tend to be in short supply specially in developing and emerging nations. And there is an example also because you need the complete holistic approach, effective planning, implementation, enforcement.

So, if you do everything it is not like you do something and leave it everything will work, no. You have to enforce it. If you have to implement it, then also the understanding is required. So, everything has to be synchronized, your planning, your implementation, your enforcement, it is like a team game, all together you can get or make a big difference. So, their technical capabilities or the capacity building issue, maybe there.

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## Traffic Management

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**Continued Commitment**

- Traffic management is not a guaranteed, one-shot cure for traffic congestion
- It needs constant adjustment and enforcement to be effective



**Conflicts of Interest**

- Conflicts of interest may occur between jurisdictions competing for business, because restraining parking freedom can discourage trade in their area



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You need continued commitment. Traffic management is not a guarantee one short cure for traffic congestion, not that you do something today and leave it, forever the problem will be solved. No, it cannot happen. Whatever you are doing today, it will improve the scenario today definitely, of course, it will also have a long-term impact, do something to solve current problem but also think about the future.

So, for example, I will say that kind of mistake should not be done. So, the interpretation should be taken in right spirit. For example, people have traditionally over the years, the traffic motorized vehicle volume is high, so they started the footpath, to ease congestion, that is only gives you a temporary benefit for some days or some months or maybe one or two years that may help.

But eventually, we will find that again it will become congested, the intersection area or the particular location, will again become a problem. And over years, you start cutting the footpath, you only take away the facility for pedestrian and you have city roads, no facility for pedestrians to walk, but you have not been able to solve the congestion problem as well for the motorized vehicle.

Such kind of actions, no. So, if you are thinking today also you should understand the implication, long term implication, that is, that has to be there. But what I am trying to say here, that it is a continuous process, you do something today, tomorrow the land use may change, tomorrow further improvement, demand may grow up, technology implication may even change the expectation.

So, you have to continuously upgrade, infrastructure augmentation also has to happen, traffic management also has to evolve, more and more advanced things you have to implement as required. So, what I am saying it is, do not think it is one-time thing, I have done something and then I will go and sleep, that you cannot do.

So, even if when you are taking actions, thinking the long-term implications, then also you have to accept that you have to be vigilant, after some interval on a regular basis, you have to check whether anything new has come up, any change in the road environment, any change in the local perspective, global perspective, anything has happened, which require further action and then appropriate actions are to be taken in a time bound manner. That is, I am saying, therefore, you need some kind of continued commitment.

So, it needs constant adjustment and enforcement to be effective. Conflicts of interest, how to make the things happen in reality, because you want to do something, it may benefit the larger society, but sometimes it may also have some negative impact on some stakeholders or some groups. So, that conflict of interest how we are able to handle. So, conflict of interest may occur between jurisdictions, competing for business.

Say for example, if you are restraining the parking that may add actually benefit to the moving traffic streams. The congestion may reduce, the overall traffic scenario may increase, but that may adversely affect the discourage or adversely affect the trade in that area. Maybe because of that reason people cannot stop or people cannot park in that area, people will be less and less attracted to those shops and establishments.

They will start thinking of going to another place where they can park the vehicle comfortably and go to the shop or establishment. Such kind of things may happen. You may actually convert it to a road to one-way streets, to gain in terms of capacity and operational efficiency, but that may be for people who are residing in this areas to some of them that may be extremely inconvenient, because they want to go in the other direction even a short distance probably a big derouting, they have to do.

So, in overall sense still maybe it will be good for the society, but there could be conflicts of interest, because not to everybody it will be equally beneficial, to some people it will be detrimental also or may affect their business and therefore, be conflicts of interest. So, you have to understand that.

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**Traffic Management**

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**Traffic Management Strategies**

- Some specific traffic management strategies are given below:
  - ✓ Access management
  - ✓ Demand management
  - ✓ Transit priority measures
  - ✓ Emerging traffic management measures

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Now, coming to then what are the different strategies? Some specific strategies are mentioned below. I have mentioned here, there are so many things actually, traffic management is really a vast area, very simple thing to the modern day most advanced traffic control where everything you are getting on a real time basis, you are getting the data from sensors, from heterogeneous data sources to applying AI Artificial Intelligence, machine learnings and all other kinds of advanced algorithms and techniques to solve or to control traffic on a real time basis.

So, it is a big range, but some of the strategies particularly four very important things, that I am going to discuss in this module, and they will be the four subsequent lectures actually. Access management, demand management, transit priority measures, and emerging traffic management measures. So, basically the last one I have put together, what are the advanced things that are happening and the kind of future direction, in a compare, not in very lot of elaboration I will not be able to do but within one lecture, I will try to cover whatever maximum I can do.

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**Traffic Management**

**Access Management**

- Access management refers to the design, application, and control of entry and exit points along a roadway which includes intersections with other roads and driveways that serve adjacent properties
- Thoughtful access management can simultaneously enhance safety for all modes, facilitate walking and biking, and reduce trip delay and congestion



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Now, a little bit introduction about these all four strategies. Access Management refers to design, application and control of entry, exit points along the roadway, which may include intersections with other roads, and also simply the driveways that serve, the adjacent properties. In a building you have establishments, they need access or it could be some another road meeting creating a proper intersection or junction.

Thoughtful access management is necessary, very important, because they can simultaneously enhance the safety for all modes, facilities, maybe walking, biking also may reduce trip delay and congestion. And this is one very, very important aspect. If you see in whole country in India, we are building roads, but this is one major issue we have not been able to solve. The way it was required to be solved, we have built our highways, but we have not been able to control the access.

So, the accessibility mobility conflict is happening everywhere. And you will find that is bringing down the operational efficiency and so many accidents, so many road fatalities, I should not call it accident or whether I should call crashes, so many crashes and resulting fatalities. So, the access management is a big area and very much part of the traffic management.

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## Traffic Management

### Demand Management

- Strategies that increase overall system efficiency by encouraging a shift from single-occupant vehicle (SOV) trips to non-SOV modes, or shifting auto trips out of peak periods
- ✓ Improved transportation options
  - Cycling and walking
  - Transit and ridesharing
- ✓ Incentives to use alternative modes and reduce driving
  - Telework and flexible work schedules
  - Road and parking pricing
- ✓ Parking management



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Second, demand management. How to make best use of the existing facilities also include how I can do better management of the demand. Not only the control part of it, not only the control part, control part of course, is included under traffic management, signalization to access management to where, which one to connect, where the connection should not be given directly all this, but also our basic objective is how to make best use of the available resources.

So, the demand management is also part of the traffic management. This may include strategies that increase the overall system efficiency by encouraging the shift from the single-occupant vehicle to non-SOV mode, that means, which are not single-occupant modes or shifting auto trips, auto in this case is privately vehicles out of peak periods.

So, if we can do some strategies, some methods, if I can promote the vehicles which are not SOV, not Single-Occupancy Vehicle, then number of vehicles may get reduced, people may be encouraged to use non-SOV modes, may use bus, other kinds of public transport or if I can discourage people to use car during the peak period then with a better demand management I am also able to increase the operational efficiency.

So, examples mainly include improved transportation options, so better infrastructure and safe facilities for cycling and walking, transit and ride sharing, how to promote incentives to use alternative modes and reduce driving for example, telework and flexible work schemes, road and parking pricing. Pricing is very, very interesting because it is an instrument for demand management. Overall parking management all this spectrum. So, several things are related to

demand management are very important. And all these are very much again part of traffic management.

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**Traffic Management**

**Transit Priority Measures**

- A range of techniques designed to increase the speed of transit vehicles (e.g. buses) along roads with more consistent travel times and improved reliability
  - ✓ Include physical improvements, operating changes, and regulatory changes
- Numerous benefits include reduction in delay, decrease in emission, etc.



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Third, transit priority measures. Again, linked with the demand management. We have to promote transit because then higher transit uses with lesser vehicle and lesser problem. If less number of vehicles, we are able to carry the same number of people using less number of vehicle, then my congestion problem is solved, my emission problem is reduced. So, so many energy aspect also I am able to address effectively.

So, a range of techniques designed to increase the speed of transit vehicles. For example, buses, along roads with more consistent travel time and improved quality. Such kind of priority measures may include physical improvement, operating changes and or regulatory changes. There are numerous benefits include reduction in delay, decrease in emission and all such kinds of benefit as I just mentioned. This is again part of traffic management.

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## Traffic Management

### Emerging Traffic Management Measures

- Use of automatic and intelligent systems to manage traffic flow, reduce accidents, and reduce congestion
- Sensor loops are placed in roadways to monitor roadway activity and observe real-time traffic
- While computer systems, linked with variable message signs, are used to re-set speed limits on the system in advance of accidents and bottleneck locations



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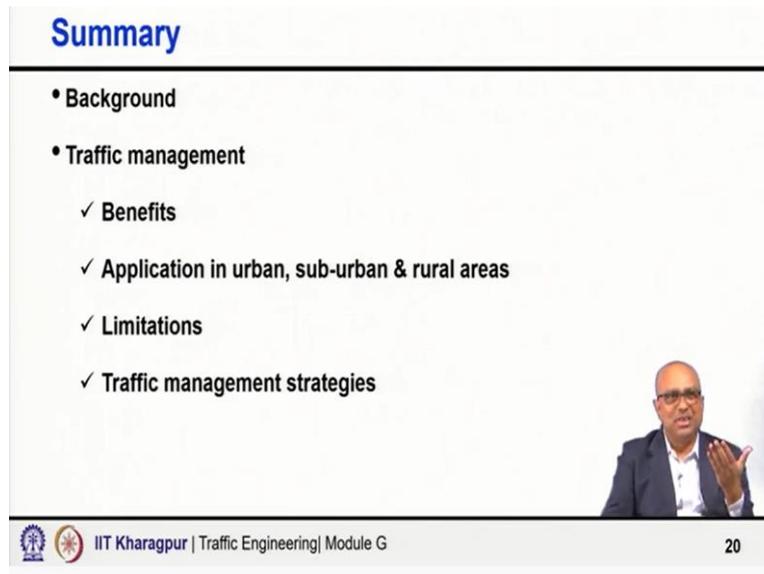
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Last but not the least, everything together, the way we are now moving towards the future, emerging traffic management measures. Most of these include use of automatic and intelligent systems, to manage traffic flow, reduce accident, reduce congestion and bring overall benefit to the larger society.

Sensor loops are placed in roadways to monitor roadway activity and absorb real time traffic. Of course, when they use heterogenous data sources also some were video camera, some were other kinds of embedded sensor, some were maybe people sharing information about the congestion, all this could be there.

And trying to assess the real state, at this time, what is the most likely state of the network and accordingly trying to formulate actions. While computer system links with variable message sign that used to reset speed limits on the system in advance of accidents and locations. So, multiple types of things, we can set the speed limit accordingly, we can change the traffic lights accordingly, make the whole management responsive to the actual scenario. So, these are again very much part of the traffic management or traffic control, real time traffic control.

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**Summary**

- Background
- Traffic management
  - ✓ Benefits
  - ✓ Application in urban, sub-urban & rural areas
  - ✓ Limitations
  - ✓ Traffic management strategies

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So, altogether what we discussed today is what is, why we need to focus on traffic management. And then, what are the benefits, where we apply to remind you, it said that we need to apply urban area, definitely, that is where it is definitely, definitely required. But it is also required and beneficial for suburban and rural areas.

We did not get guided that always the where the demand of the traffic flow is high, there are only we need traffic management, that is not true, we need it in every scenario, what are the potential limitations that we must bear in mind and the broad four traffic management strategies, what we are going to discuss in the next four lectures. So, with this, I close this lecture. Thank you so much.