Urban Transportation Systems Planning
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Lecture - 60
Big Data, GIS and SDI

Welcome to module I lecture 2. This module is on emerging trends in transportation planning. In lecture 1 of this module we discussed about the advanced modelling topics.

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Say basically gave an introduction to the activity based model that how the travel behaviour is going to be important, more and more important in the future and then how the activity based models are emerging in the field. In this lecture we shall discuss about three different aspects. One is the big data then about the geographical information system GIS and then SDI spatial data infrastructure.

As the purpose is to give you an orientation towards the emerging techniques, emerging approaches tools so these sections will be really brief. We shall not be able to explain you everything in detail but give you a brief orientation and understanding that these are going to be the future progress in the area of urban transportation systems planning.

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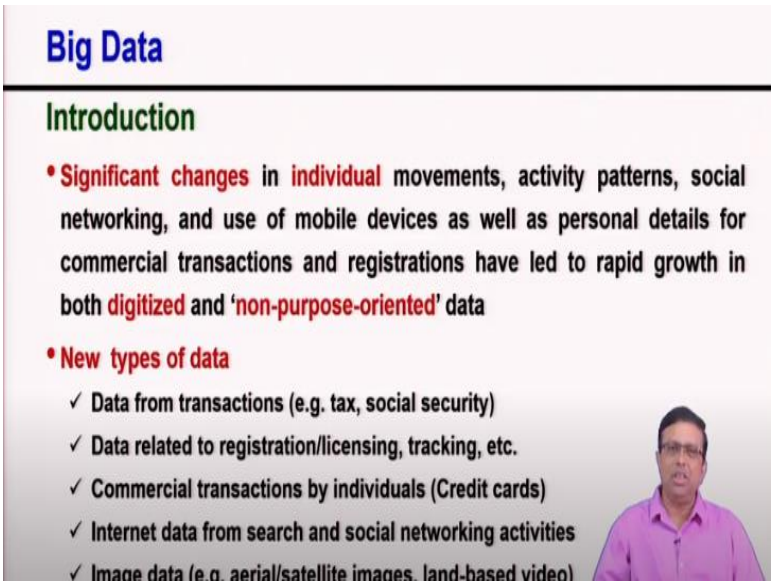

First coming to part A that is the big data. Now as over the last one or two decade's things have changed very significantly. In fact, use of computers, mobile communication, the lifestyle, the way we are using technology in our day to day life. So; significant changes in individual movements, activity patterns, social networking and use of mobile devices as well as personal details for commercial transaction and registration.

Practically say use of credit card, debit card, online transactions and all these have led to rapid growth in both digitized and non-purpose oriented data. Non-purpose-oriented data includes those kinds of data which are collected for a different purpose but may have a context, say for me, I am interested in transportation. So, I may still find something interesting in that data. So, an example of such new types of data may include the data from the transaction.

Maybe you are paying the tax, starting from income tax to every transaction then the data related to registration, licensing, tracking. See everything starting from vehicle registration data to getting the driving license, everything is digitized and the database is available these days. Similarly commercial transactions by individuals specially using credit cards, debit cards, then internet data from search every now and then mobile and internet it is part and parcel of our life.

And you are visiting different websites, what you are searching and even in social networking sites. Everything is such information are available. I mean, whether you like it or you do not like

it, such kind of information we are providing every now and then and such kind of data is available. Some is true for the image data, huge volume of image data, say for aerial and satellite images, land based videos.

So, all these are new type of data and interestingly all this data are getting generated in huge volume and getting generated continuously. So, every time period the new and new databases are getting generated. So, the data is actually getting accumulated over time and a huge database is available.

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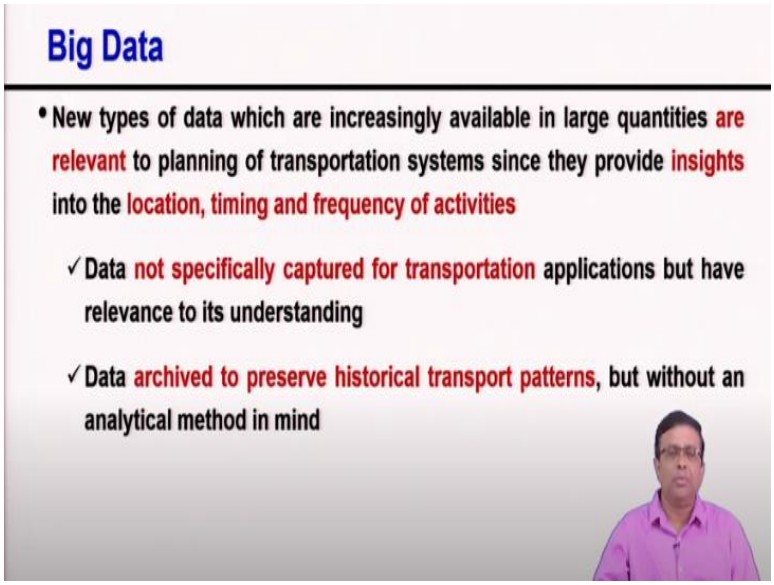

Now this new type of data which is increasingly available in large quantities is also relevant to planning of transportation systems as they might be relevant for so many other purposes. Not only in transportation but our interest as transportation planner or traffic engineer is also to see what we can do with this kind of available information which is available in large quantities and huge data over a period of time continuously such kinds of data are coming.

So, we find that there is also something to do with transportation planning because this kind of data provides insights into the location, timing and frequency of activities. Now if you are using a simple mobile device for tracking a route I want to travel from A to B I just put it there in the Google search and Google suggests me the routes and I am moving. So, my movement data is available. So, to someone it is available.

So, it gives me about the location, it gives about the timing of travel and also the frequency of activities. Now all these are extremely important in the context of transport planning. So, we need such kind of data. So, these are of course of interest to us and such kind of data may not be specifically captured for transportation applications but also have relevance to its understanding. May be the service provider who is getting this information is not getting it for doing transportation planning.

He might be getting it because he wants to show where I am along my route and which route I should take and whether I am taking the correct path, and he wants to tell me also that how much time is left for me to reach my destination. But eventually this data is not collected for transportation purposes, but of course, still it has something or some relevance to me or in the context of understanding of the transportation or the travel behaviour or the pattern of the movement of people.

So, locations, timings and frequencies are activated. Then secondly this kind of data may be archived just to preserve historical transport patterns. You are getting the data you are accumulating it somewhere but without an analytical method in mind. Maybe they do not have very much idea or not collected with that kind of idea in mind that I want to do such kind of analysis to derive some insight from this.

But they are simply connecting it. Many examples are there for such kind of data, maybe the vehicle registration data. It is every time the vehicle is registered the data is accumulated or the driving license, even the accident information, every time the accident, occurs the accident data is recorded somewhere. So, police will record the accident data and that digital data in some format or other is available somewhere.

It is getting archived probably not with an idea. Police probably want to mention records because they need to maintain the record of accidents and cases and so on so forth. But that information can also be used by transportation planners because I want to do something, some analysis with that accident data and to derive some meaningful insight from it.

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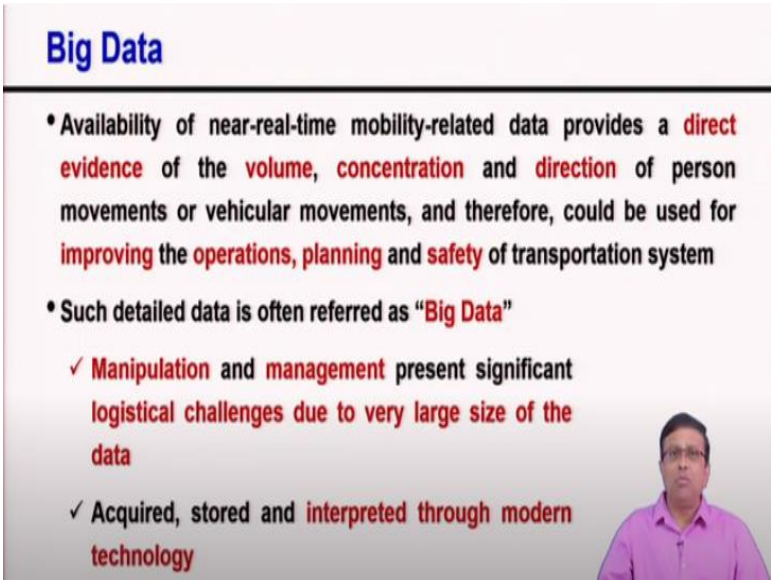

Availability of the near-real-time mobility related data, as I said that we are using maybe mobile, we are using the GPS and all such kind of things, number of things are there. And which provides me with near-real-time mobility related data and which is just excellent. Because they provide direct evidence of the volume, the concentration and direction of movement of vehicle or persons and therefore could be used for improving the operations, planning and safety of the transportation system.

All individual level data is available and it gives me an excellent pattern of movement, where, in which direction, at what time people are moving, where the concentration is more the civil area, where people are actually moving and all such kind of data can be used advantageously for operations, planning and safety of the transportation system. So; such kind of data which is huge in volume and getting available over a period of time.

Digital data may also include as I said, the non purpose oriented data, but they still might be useful for us for transportation planning and all such kind of data may be referred to as big data. The manipulation and management present significant logistical challenges due to very large size of this data because it is getting accumulated large amounts of data. So, obviously the manipulation and management is a problem.

So, all such kinds of data are normally acquired, stored and interpreted through modern technology. And we have such kind of support system available because with the advent of technology many things as we are able to do it. We are also developing the technology for acquiring, storing and interpreting these data.

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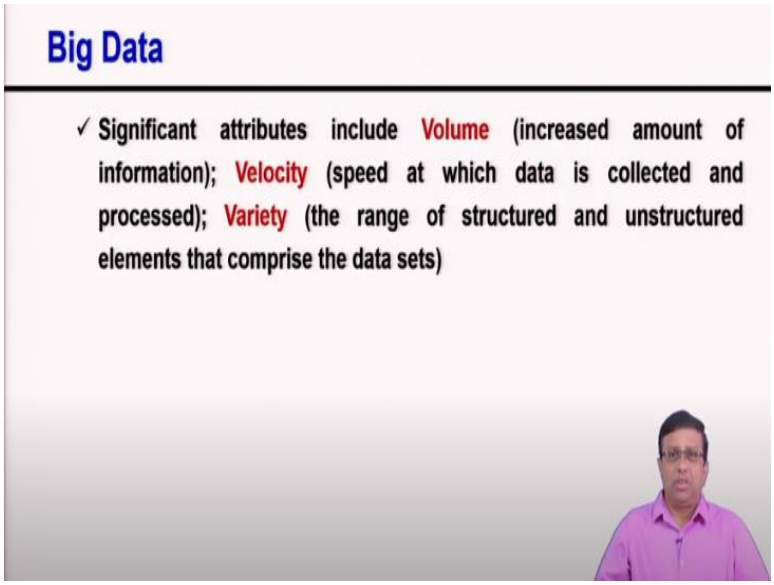

So, significant attributes of such kind of data is at the very basic as I said, we would not be able to teach you everything. It is literally impossible. Just in orientation, a very brief orientation rather. So, there are 3 very significant attributes of such data. There are even more. But I would mention here only 3. One is volume that is an increased amount of information that is the huge volume of information you can say.

The other is the velocity, in a way we can say the speed at which this data is collected and the processing is happening. That is another important characteristic. And the last one which is also very, very important is the variety, the range of structured and unstructured elements that comprises the data set. So, much variety of information, so, these are the three basic characteristics.

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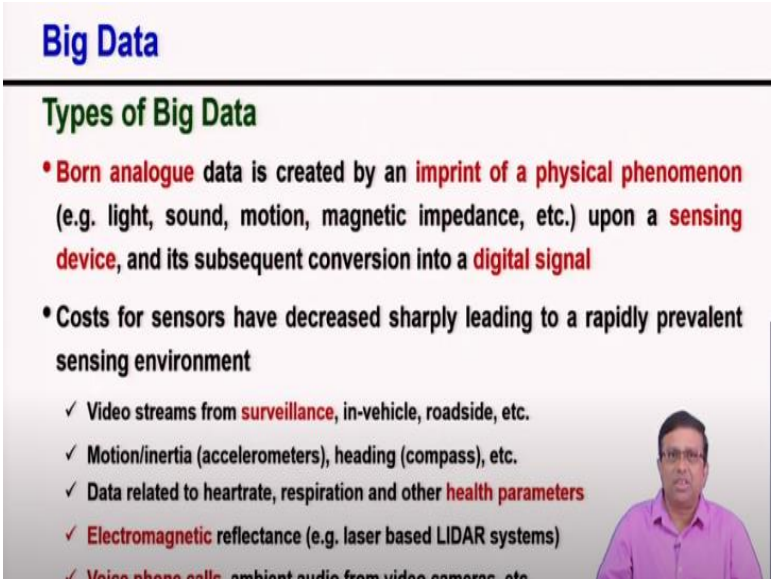

Now the type of big data basically there are mainly two types of data.

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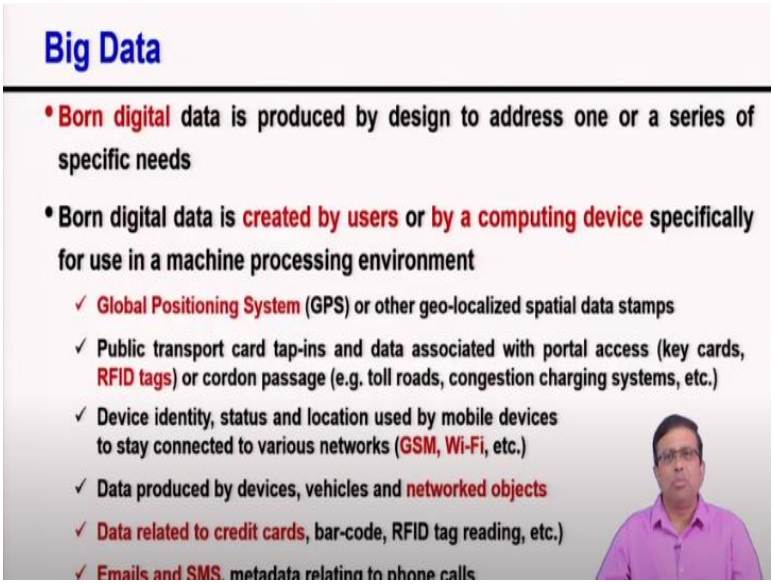

One is the born analogue data, the other is the born digital data. The born analogue data is created by an imprint of a physical phenomenon. Remember that for example, through light, sound, motion, magnetic impedance etcetera, upon a sensing device and its subsequent conversion to a digital signal. Say the cost of sensors has come down drastically and that has resulted in a widespread use of the sensors for collecting all such kinds of data.

So, it may include video streams for surveillance, you can see frequently we are using it in vehicles, roads, all situations. The motion data, the data related to even the medical or health

parameter, the electromagnetic reflection, may be the lighter system, which is again these days used very frequently even for the transportation engineering purpose, highway engineering for route alignment and getting the basic data, topographic data and all features as even the voice phone calls.

So, plenty of examples are there. The other is basically the born digital data which is produced by design to address one or a series of specific needs and generally these are created by users or by a computing device specifically for use in a magnetic processing environment. The GPS data or any kind of geo-localized spatial data stamps that is why you are using RFID tags very commonly used then GSM or Wi-Fi.

The device identity, status and location used by mobile devices to stay connected to various networks. Then the data produced by devices, vehicles and networked objects. Similarly as they say even the emails and the SMS's so, all such kinds of data which also include big data.

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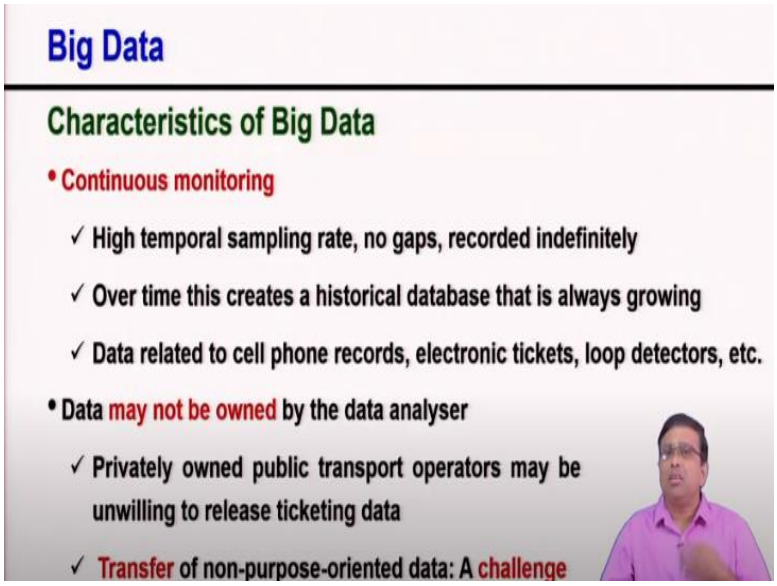

Now there are certain important characteristics of big data which are important for us to get a little bit of understanding, better understanding of such kind of data. One is I can say the continuous monitoring, high temporal sampling rate, no gap and all recorded indefinitely. So, over a period of time this creates a historical database that is always growing. So, it keeps growing always such kinds of data.

Data related to cell phone records, electronic tickets, loop detectors, continuously they are getting the data. Now data may not be owned by the data analyzer. I mean I may be interested in transportation and I may still have something to do. That is what is interesting with the big data. But I may not be the owner of the data. The data will be collected by someone else for an entirely different purpose.

But still the data tells me something. So, in most cases privately owned public transport operators may be unwilling to release such kind of ticketing data. Because some of the data when they think confidential for them. Although I may not be doing it, I have no interest in their business probably. But still they would like to maintain confidentiality. So, transfer of non-purpose-oriented data is often a challenge.

Because here the; person or the group who have the data, their confidentiality or the business might get influenced although I may not have interest in their business. I am looking for it because I am interested in a simple transportation perspective and I may use it for better planning, better operation or better management. But still they may be hesitant to share it.

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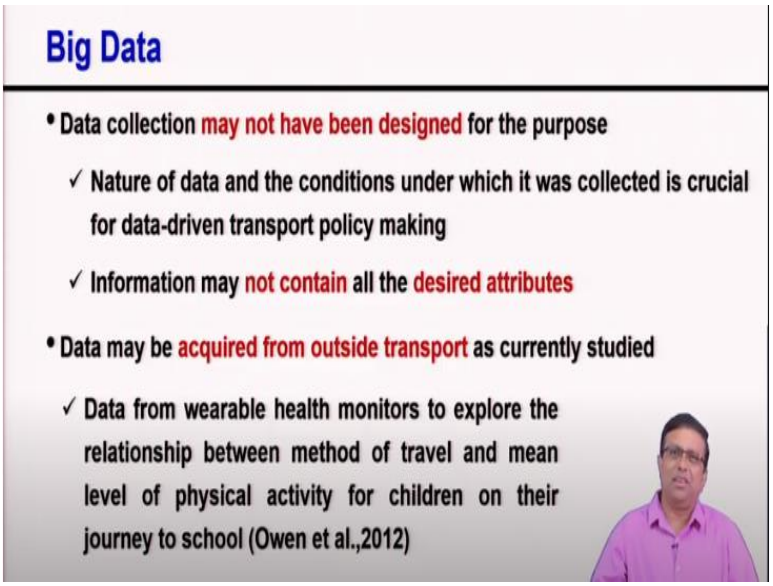

Now data collection may not have been designed for this purpose. It is linked with the previous reason or characteristics that because they are not collecting it keeping transportation planning in

mind. So, obviously they want to collect the way it is necessary for them. So, I may not get every attribute that I want. So, in many cases data from one source might be incomplete. I may not get all the attributes that I want.

But still it gives me some ideas, some patterns. So, maybe the data which are available from multiple such sources if I put them together somewhere they make some sense, some meaning, some pattern. So, data may also be acquired, sometimes outside transport as currently studied. This is an example of work where data from variable monitors could be used to explore the relationship between the methods of travel.

How school children are traveling and the mean level of physical activity for children on their journey to school, so, trying to relate this perspective. Now this data is not collected by transportation people. They are collected for health monitoring purposes. So, they may be completely outside transport, somebody is collecting data because he is interested that variable health monitor is telling them giving them the data to explore the relationship between method of travel and mean level of physical activity for children on their journey to school.

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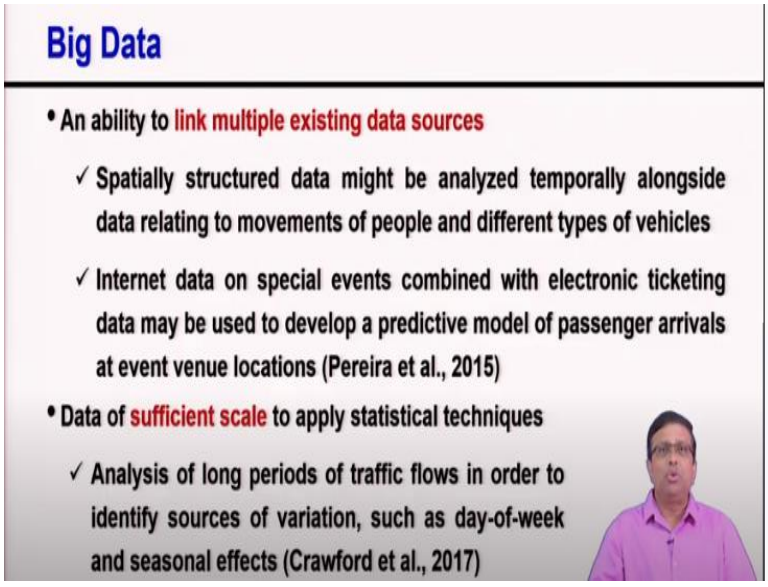

Similarly an ability to link; multiple existing data resources. So, that is what I hinted also earlier that multiple sources may give different types of data. So, spatially structured data might be analyzed temporarily alongside the data relating to movement of people and children by different

types of vehicles. So, internet data on special events that is one source maybe combined with electronic ticketing data.

And altogether all this database may be used to develop a predictive model of passenger arrival at event venue locations. That is again a research I have given the reference. When I give you the material all the detailed references will be there. So, this kind of application is possible. Then data is of sufficient scale to apply statistical technique. Analysis of long periods of traffic flow, any pattern you want to do such that a day of a week or seasonal effects or the climate condition because you are continuously getting huge data.

So, when the festival is there how the people are moving and when there is no festival on a regular thing how the different patterns you get it. On a weekend or weekdays you get it. When it is too humid or the temperature is very high if you also get the meteorological data you can relate it. So, many patterns we can explore which otherwise just with the conventional data we will not be able to get. Because we; will not get so much exhaustive data to explore all such patterns.

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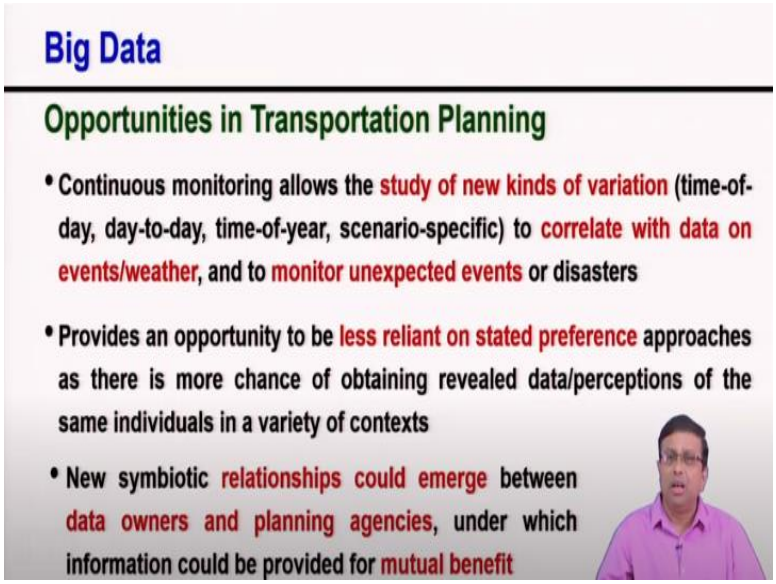

There are excellent opportunities of using this kind of data in transportation planning. Continuous monitoring allows the study of new kinds of variation. As I said that so much data is available the pattern can be explored in n dimensions. You can explore the pattern to correlate with the data on events on whether as I said that when there is a festival what happens, when

there is no festival how it happens, when it is raining, when the temperature is very high.

Different patterns because you have huge data which otherwise when we design a survey instrument and collect the data always we will have some limitations. We will carry out or collect the data only for a few days and try to do the analysis may be across income, across household size and all that kind of variation we can see. But so much huge variation in the data across so many dimensions that we would not be able to get otherwise which we can get from this big data.

Now it also provides an opportunity to be less reliant on the stated preference data. Because many things which we cannot observe we actually go and try to get the data for stated preference form, SP form. The data may be stated preference data or revealed preference data. So, stated preference data often we use for hypothetical alternative, new alternative. That is a different context altogether.

But in many cases we still try to get stated preference data because we do not have scope to observe such kinds of things. So, many of those things which not all; I would like to remind you, not all. But many of the things like if the metro is not existing I want to see how people would react to the metro I have to still go for SP data. But suppose the climatic condition how it changes the travel behaviour now I cannot really do the survey throughout the year with so many people.

But the big data is available in some form or other and that can give me such kind of pattern. So, a new symbiotic relationship could emerge between the data owners and the planning agencies were different people they normally do not talk to each other. But still there is a huge potential and huge opportunity that they can be brought together and do something meaningful for their mutual benefit.

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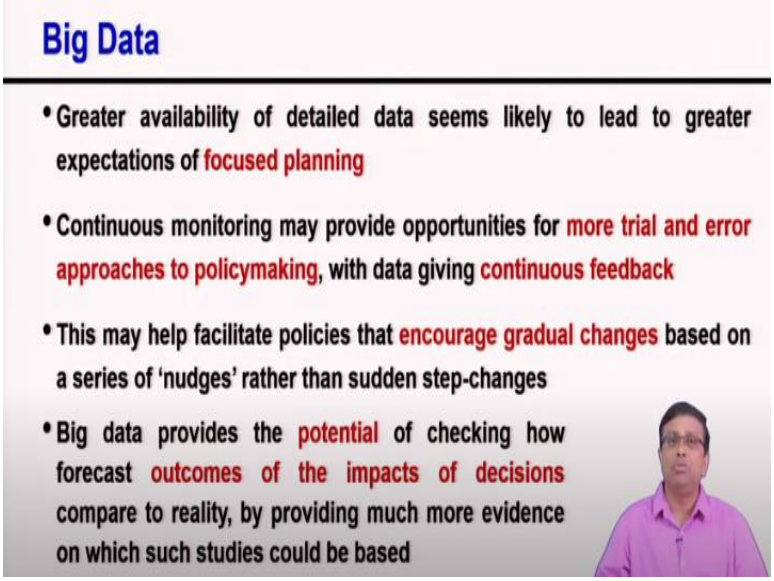

So, these kinds of opportunities are very much also greater availability of detailed data seems likely to lead to greater expectation of focused planning special purpose, special events, special scenario. Now we are doing continuously we are getting the data so more trial and error approaches to policy making. That can happen. And this may also facilitate policies that encourage gradual changes rather than drastically or sudden step-changes.

We can do that. Because where we do not know what is going to be the outcome or how it is going to be received or what is going to be the impact. It allows us to go for gradual changes. Now big data provides the potential of checking how forecast outcomes of the impact of decisions compared to reality. Your real-time data is available, real behaviour is available. So, you are readily able to use them for kind of validation.

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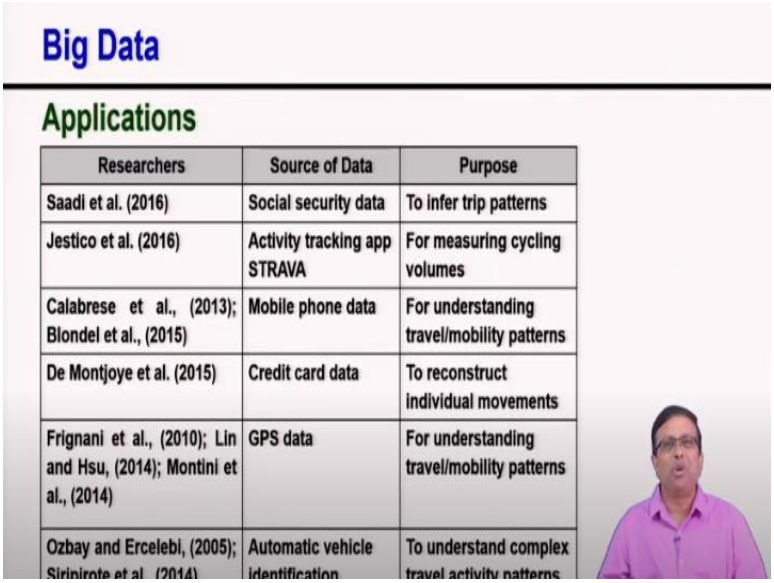

There have been many applications of such data. I have mentioned here some of the very recent works and say to infer trip pattern, for measuring cycling volumes, for understanding travel or the mobility pattern. Mobility related so many things can be done with this data. To also construct individual movements, for understanding again this other example is also for understanding the travel or mobility pattern, to understand complex travel activity patterns.

So, it is really relieving and fascinating. So, I will say that there is a lot of potential to use the available big data and try to extract findings and observations from those to benefit the transport planning and traffic management operations and overall the benefit people in the transportation context.

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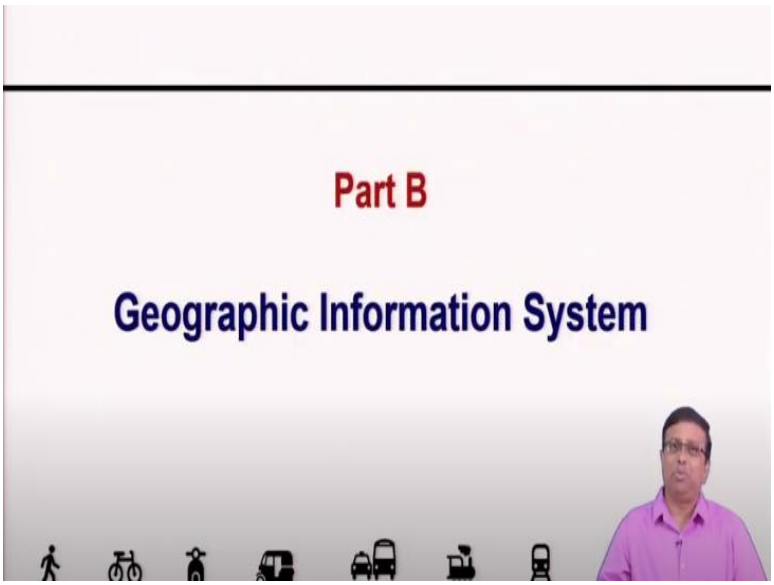

Now going to the next part is basically the geographic information system.

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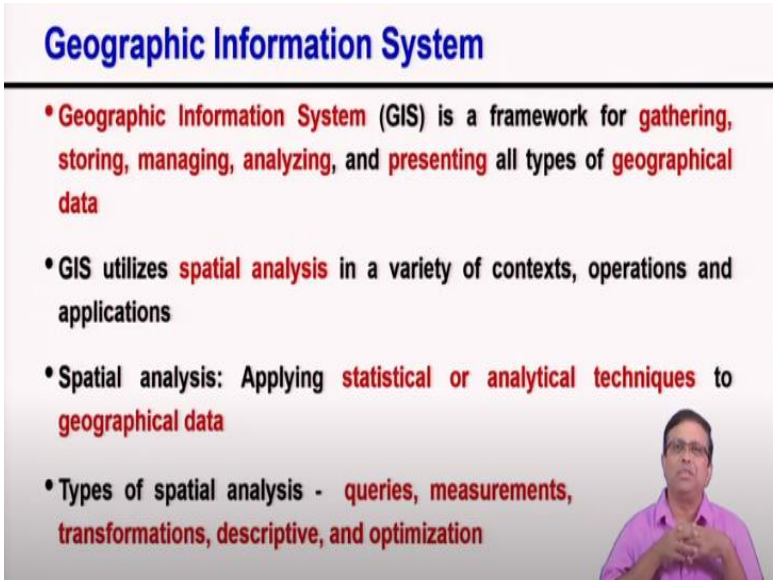

Now in transportation always I have been telling you right from the beginning the demand is temporal and special. If we say that it is congested or demand is more we are referring to a specific geographical location and at a given time. So, any demand or any transport related problem it has got a special dimension, it has got a temporal dimension. And the whole concept of transport planning is built on that.

Now this geographics information system is a framework for gathering, for storing, managing and analyzing and presenting all types of geographical data. So, GIS utilizes special data in a

variety of contexts, operations and applications. So, you can use statistical or analytical techniques to this geographical data, generate queries, do all sorts of measurements, transformations, description, carry out optimization with that available data.

So, again GIS has opened a new world to the transport planning professionals. So, whatever we are doing we still do the same thing. But we do it in a GIS platform.

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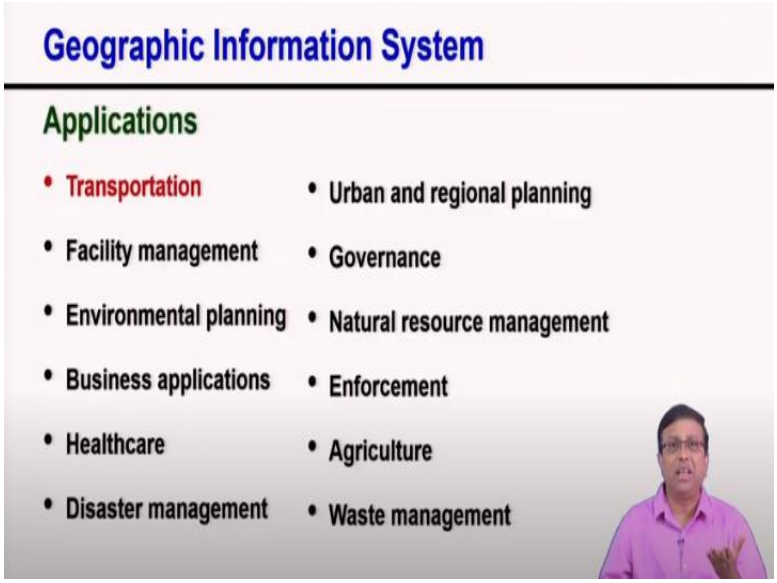

So, there are various applications as I said. The GIS spatial data is not only used by transportation people. So, if I say it is only transportation it is wrong. But we also have a stake. So, the transport planner, transportation community can also benefit from the use of this GIS for doing that analysis. So, like many other fields as I have indicated.

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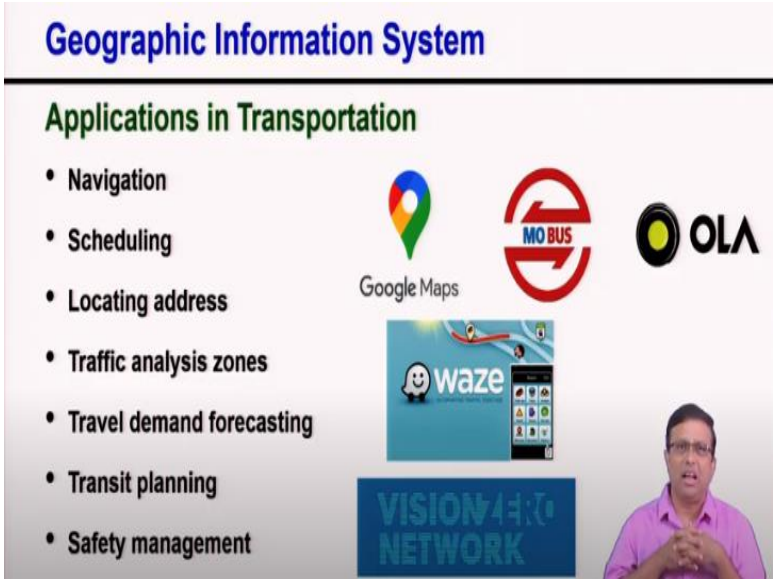

In transportation a number of applications where we can do actually using this GIS base or GIS platform starting from navigation to scheduling to locating addresses then identifying traffic analysis zones based on the land use. Even the complete travel demand forecasting. What I have told you the fourth stage transportation planning, the whole thing you can do in a GIS platform and that will be much more realistic and there will be many advantages when you do it.

For transit planning, for safety management so a host of transport applications can be built on this GIS data or this GIS platform.

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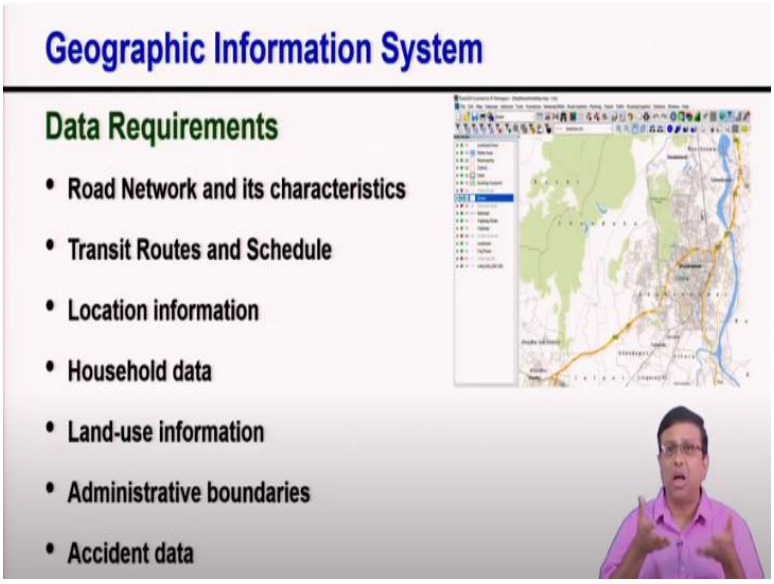

There are different requirements as you have any kind of you want to do a transportation

planning you need data like road network and its characteristics. You need the transit route schedule, location information you need household data, land use data, accident data. All such kind of data you can build a database but in a geographic information system. So, it will be a GIS base, GIS database, so, all such kind of spatial data.

Every data has a special nature and if you see you will hardly find data in transportation, which is not spatial. Almost all the data is spatial.

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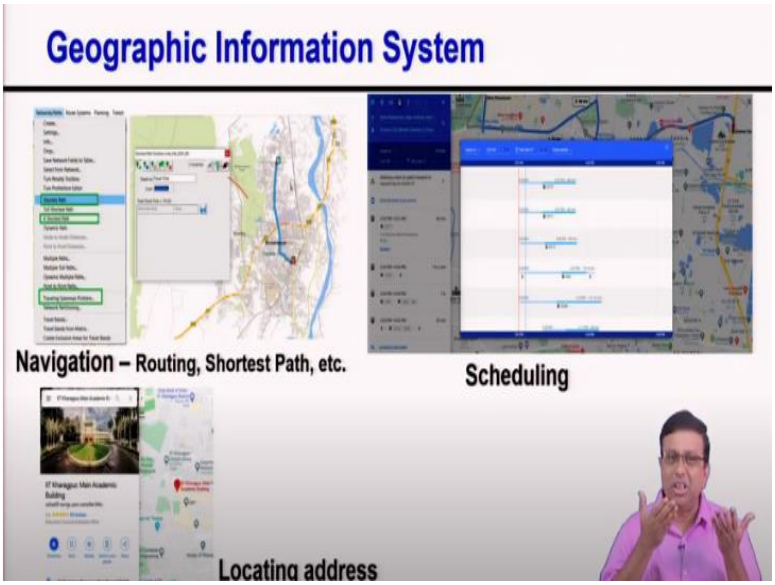

So, you can build such and then whatever I said multiple applications you can do starting from navigation, training out the routing, getting the shortest path, scheduling locating addresses and then doing traffic analysis zones.

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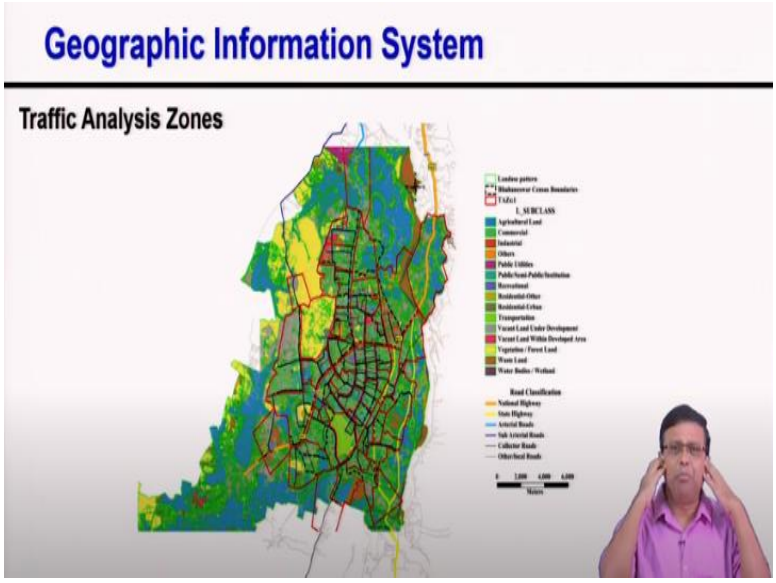

So, you can based on the land use you can produce, you can get much better visualization apart from doing all the analysis which are much more realistic. But wonderful representation you can give visual representation also you can give.

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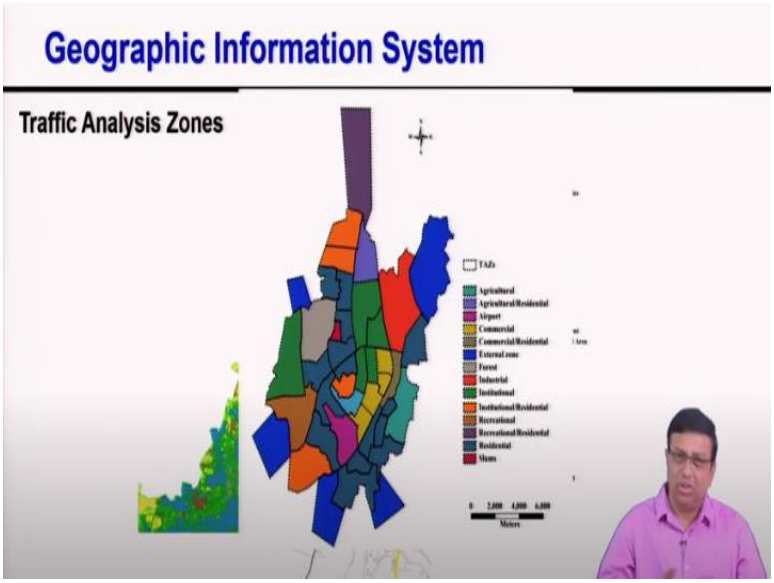

Then you identify the traffic analysis zone based on the land use.

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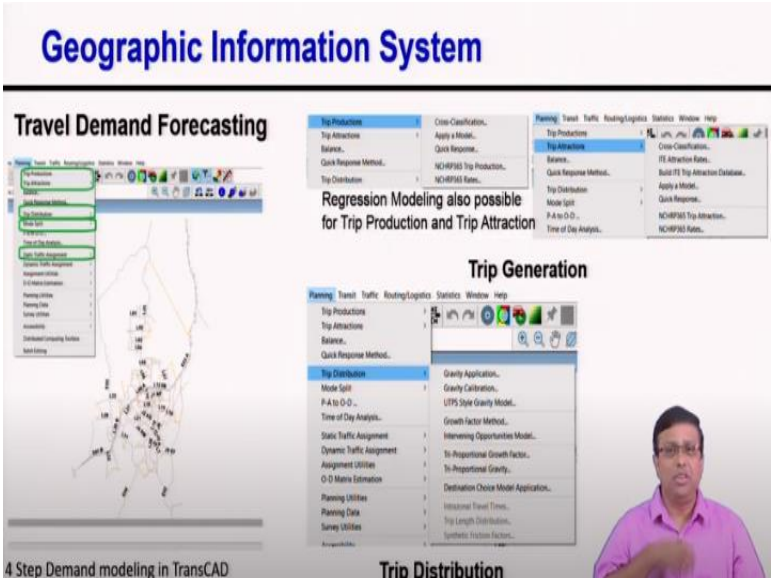

Then the; whole travel demand forecasting as you do starting from the trip generation, trip distribution, more choice traffic assignment, the complete fourth stage planning.

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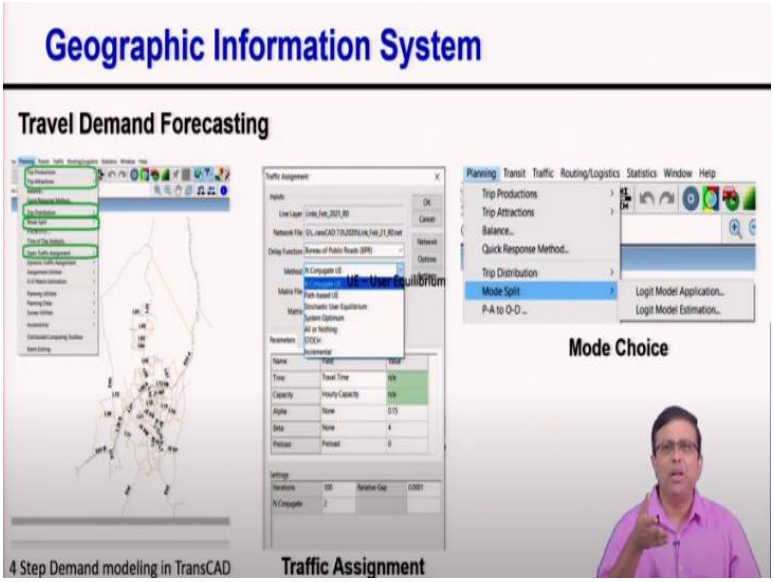

But I am referring to fourth stage planning not that you can do only fourth stage planning but I am referring to this because I have taught you fourth stage planning in this one. And I am telling that in a GIS platform you can do this whole thing very nicely. And there are specialized softwares which are available if you are able to acquire those platforms or can get access to those platforms then you can take advantage of those things.

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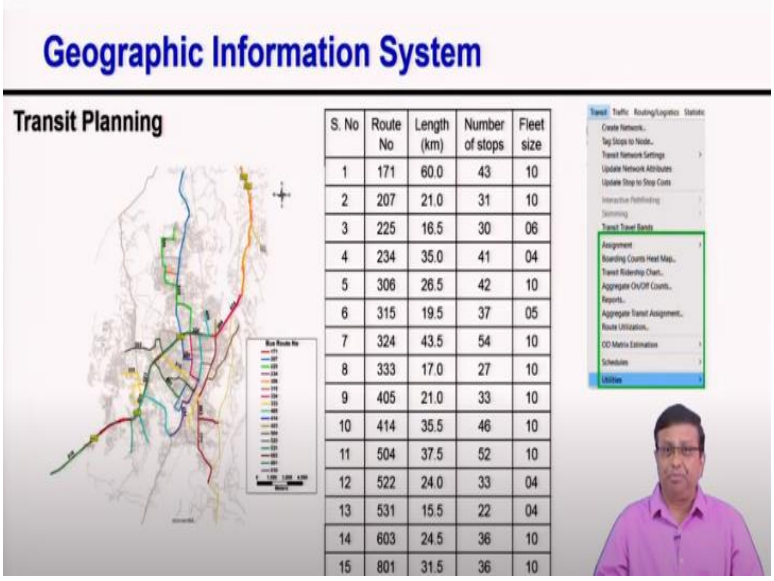

Also for transit planning there are specialized modules which allow you to do everything you actually need if you are using a GIS platform.

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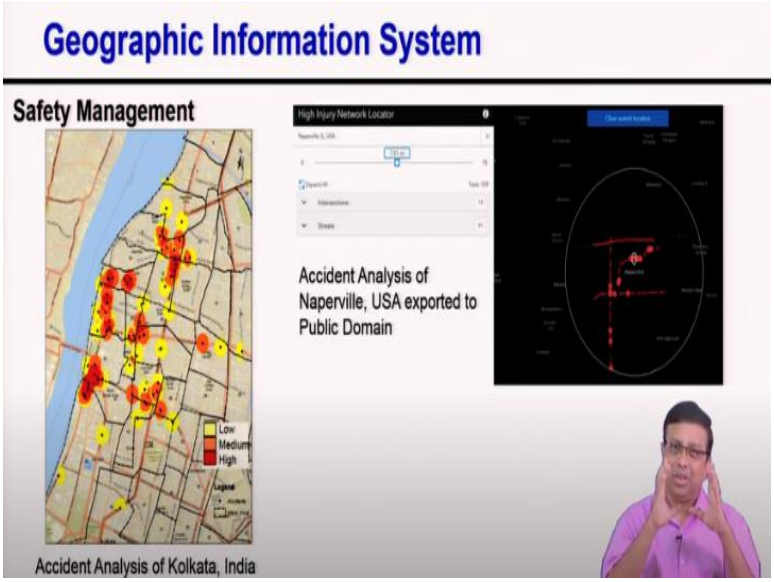

Also the safety management because safety if an accident happens at certain locations, maybe certain intersections are a lot of accidents are happening or a particular mid block location due to certain deficiencies lot of accidents are happening. So, you do an accident mapping and some analysis and then try to find out the counter measures or the interventions which are necessary.

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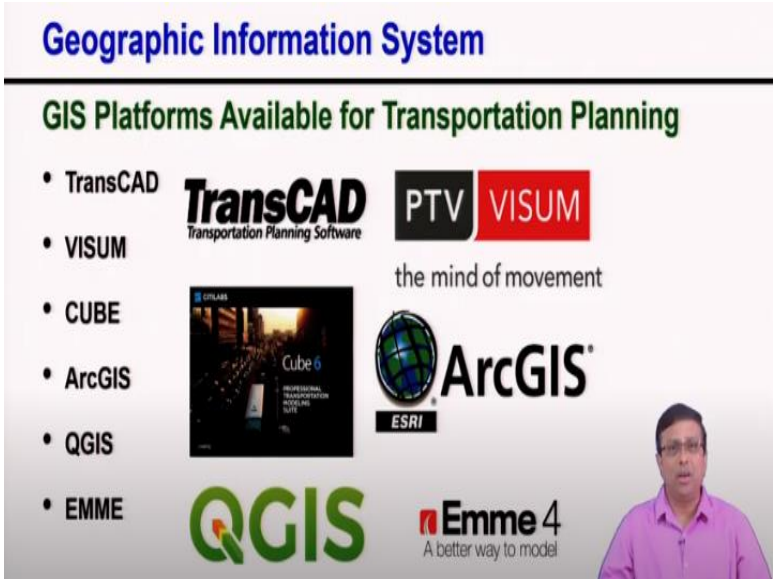

So, there are multiple platforms, GIS platforms which are available. Many of them have got maybe some basic things you can do in any of these available platforms while some other platform may have a little specialized modules to help you to do certain specific things. So, maybe some are just generally purpose GIS software and these platforms can also do many of the things while some may be little bit specialized, developed based on this specific support for the transport planning.

But you can use them and a number of things are there spatial data and the GIS being used by so many platforms.

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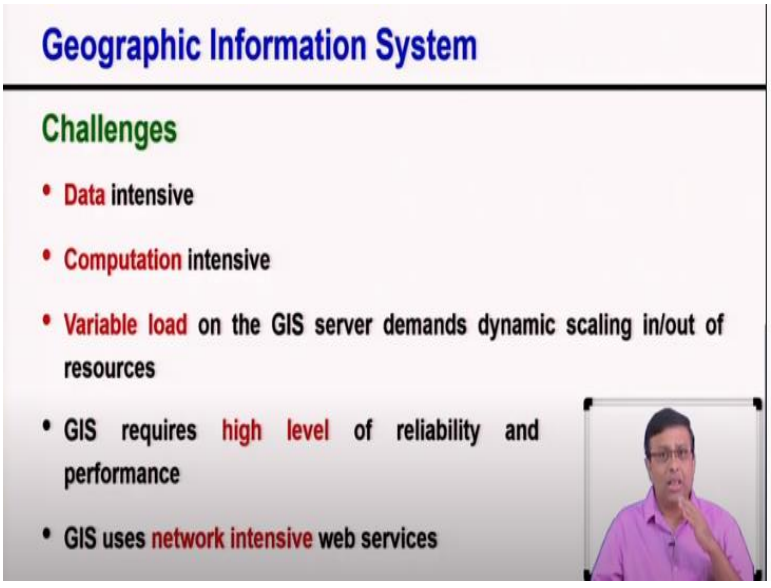

Now there are of course unique challenges also related to the GIS data or if you want to think that you want to do something in GIS platform, it is data intensive, a lot of data is actually required because you are developing a special database basically. So, it is computation intensive, you need good machines and powerful machines to do that. There is the other consideration, of course, we may not be interested or transportation people may not be interested.

But that is also a practical thing that variable load on the GIS server demands dynamic scaling in out of resources. Then GIS requires a high level of reliability and performance. Also GIS uses network intensive web service. So, all such kinds of things will be there. Something good comes along with certain requirements, so you have to fulfill those requirements.

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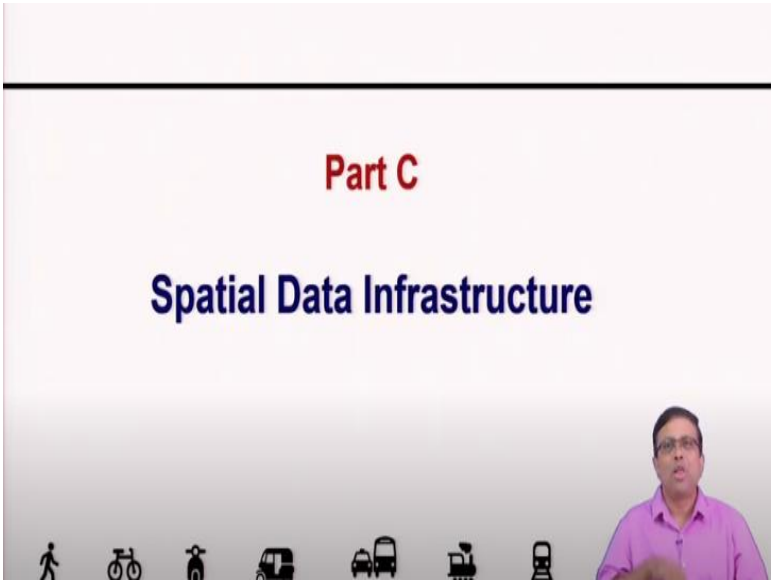

Now with this brief introduction you can see also as I said that big data is a big opportunity for transportation planners and in the future you can really expect a lot of work to happen and that is the direction where the transport planner will work. Similarly transport planners will also use the geographic information system GIS and more and more GIS based works are expected. So, we want to do the things we are doing, but we want to use the GIS to further gain from our work.

The next is basically a related and continuation beyond GIS I should say it is spatial data infrastructure. So, far we talked about the GIS we are talking about spatial data only but here we are talking about spatial data infrastructure.

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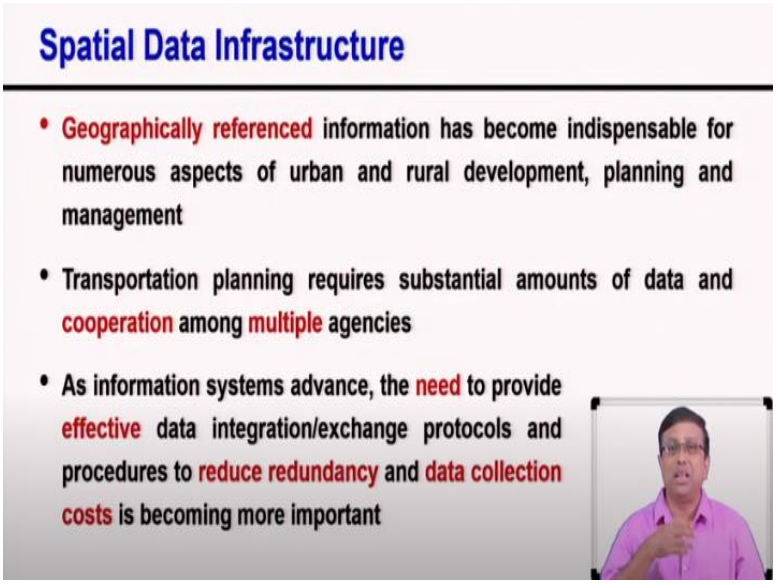

Now if you see geographically referenced information has become indispensable for numerous aspects of urban and rural development, planning and management. With time more and more GIS or special data people will use. That is bound to happen. Now transportation planning requires a substantial amount of data and these are spatial data in one way. But there is one more thing which we have not discussed so far that getting such kind of data requires cooperation among multiple agencies.

Not all what you want for the transport planning you get everything just from one organization. The land department will have some data, the transport department may have vehicle data. Similarly the emission department may have the emission data, the police may have the accident data and if you want to really develop a GIS base then you need cooperation from all. From everybody you want to need to get the data and develop your GIS. But then who will update it because you do not have the data.

Data will still remain with the police, still remain with the environment department still remain with the transport department. So, not with one organization, so, we need cooperation among multiple agencies. So, as information systems advance the need to provide effective data integration and exchange protocol and procedures to reduce redundancy and data collection cost is becoming more important.

So, we are now trying to think in a little bit of a holistic manner. Not just using this spatial data. Yes, that is possible. But what if there are other related issues. How we can promote better use of this GIS data by multiple agencies? How we can bring them together, how we can avoid redundancy? I collect the data, I develop a database then somebody, multiple departments everybody is taking data from others and developing their own database.

So, it is a redundancy and we are increasing the cost of data collection. How to reduce the cost of data collection? How to avoid redundancy? How to make this cooperation among multiple agencies better?

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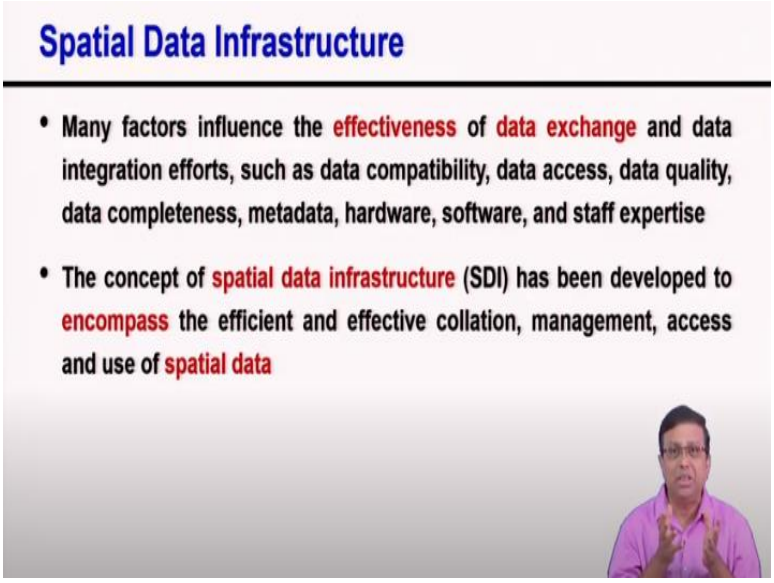

So, there are many factors which influence the effectiveness and of data exchange and data integration effort. For example, data compatibility is a very big issue. So, people collect data in different formats. So, if everybody collects in different formats, obviously, there will be no comparability of the data. Then the data access, the quality of the data, data completeness, metadata, hardware, software, staff expertise all these things because it is not only just using GIS or the special data for analysis to benefit the society.

But overall think in a bigger way that in a government framework or the government of India is working so how they can benefit how the largest society can be benefited for all such kinds of

multiple departments or agencies are involved. So, the concept of spatial data infrastructure has been developed to encompass the efficient and effective collation, management, access and use of spatial data.

So, all around spatial data everything is all around. All the discussions are happening because we want to understand, we are convinced and we want to promote the use of the spatial data. But then effective collation, management, access and use how to make all such things better?

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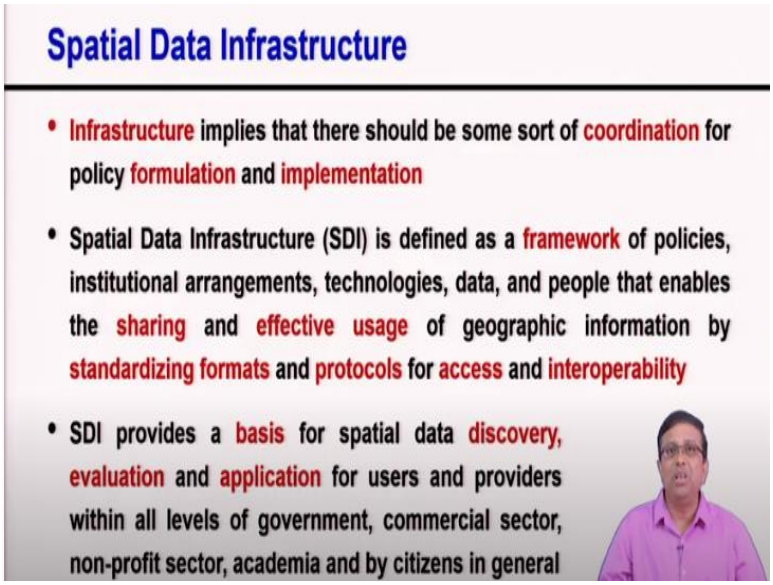

So, infrastructure implies that there should be some sort of coordination for policy formulation and implementation. Without proper policy you cannot do anything. Because when you have multiple departments multiple ministries are involved you need policy formulation. Without that nothing is going to work. So, if I have to define I will say that special infrastructure is defined as a framework of policies, number 1, 2 institutional arrangements, third technologies, fourth data, fifth people.

So, framework of policies, institutional arrangements, technologies, data and people enables the sharing and effective usage of geographic information. So, we are also talking about sharing and effective use of geographical information by standardizing formats and protocols for access and interoperability. So, carefully read this definition not just for remembering the definition but for understanding every element.

This definition itself in code every word is important. I am saying a framework of policies, institutional arrangement, technologies, data and people that enables what, sharing and effective use of geographic information. Not only transport so many things. Transport is not in isolation. You cannot deal transport in isolation. If there is interdependency by standardizing formats and protocols for access and interoperability.

So, SDI provides a basis for spatial data discovery, evaluation and application for users and providers within all levels of government, commercial sector, non-profit sector, academia and by citizens in general. There will be whichever you think is confidential you keep it, limit it and you do not give access to everybody. But there are certain things which you can give access to everybody. So, all these protocols, all these policies, how we implement, all these become important.

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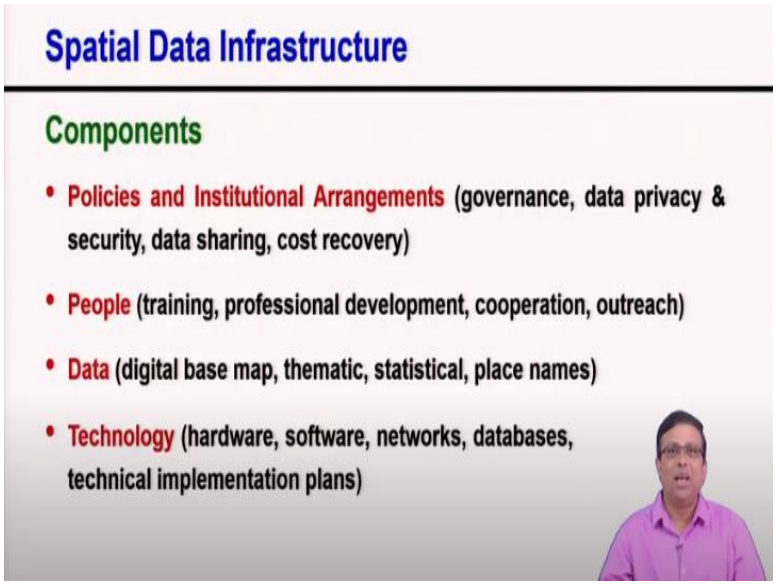

So, three are four major components in SDI. I have told it indirectly but let me be very specific. One is the policies and institutional arrangements. Governance, data privacy, security, data sharing, cost recovery all these aspects are to be dealt very nicely through the policies and institutional arrangements that is one aspect. Then ultimately people will use it. So, we need training, we need professional development, we need cooperation, we need outreach.

Third is actual data. So, digital base map, thematic, statistics place names etcetera and then the technology hardware, software, networks, database, technical implementation plan. So, with policies and institutional arrangement, people, data and technology these are the four basic pillars I should say. They are the four basic components.

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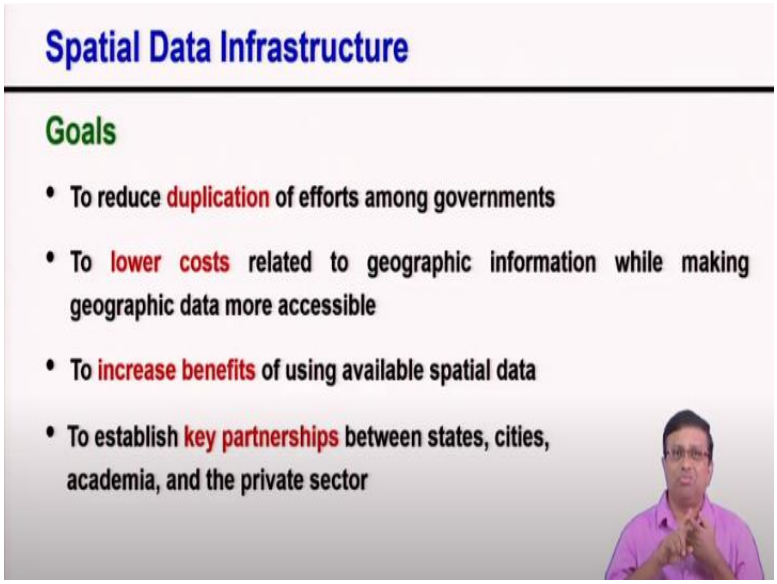

Why we are doing it? Again to summarize we want to reduce duplication of efforts among various government departments. Not that multiple organization, multiple departments are collecting the same data. Taking data from each other, nobody is then able to update the whole database because the ownership remains with someone else. To lower the cost related to geographic information while making the GIS data more accessible.

If you can bring down the cost then more people can access this kind of data which is valuable and which is important for the larger society. To increase the benefit of using the spatial data available spatial data more and more people will use it for various applications, in various contexts. Ultimately the society will get benefited and to establish key partnerships between states, cities, academia and the private sector. So, all these are the basic goals.

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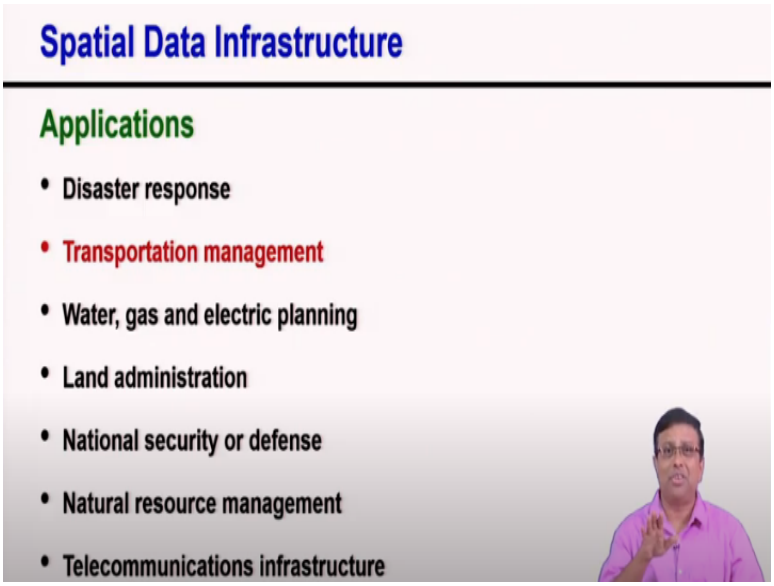

There are applications. Applications, as I said, not only in transportation management because the spatial data is not used only for transport but for a large number of applications starting from disaster response to land administration to telecommunication infrastructure, large number of domains, practically every domain which links with the service of announcing the quality of life of urban citizens, they can get benefited.

So, they are multiple applications including transport and as I said that no discipline you can think in isolation. There are interdependencies.

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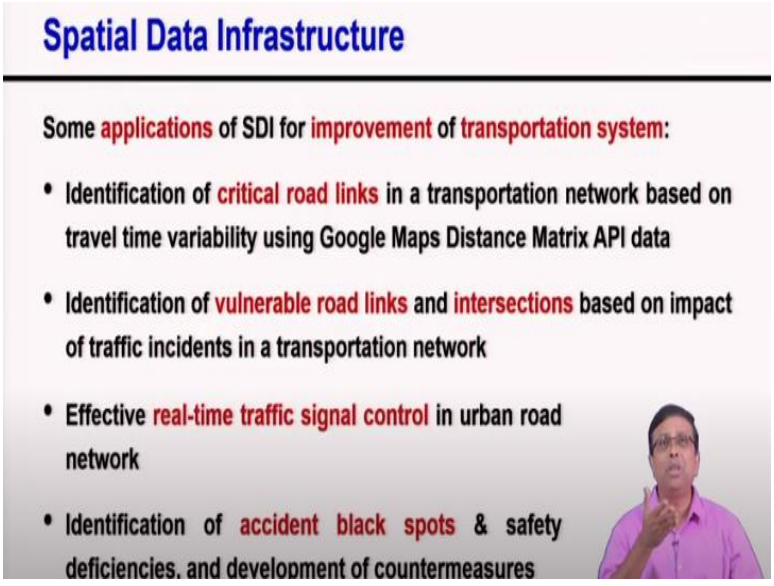

So, some of the applications may include I would say that anything I have taught to you the

whole transport planning you can do using spatial data. And wherever you are using spatial data, the special data infrastructure is a stage beyond that. So, anything that you are actually able to do with the spatial data SDI is going to benefit that sector. So, we also have national level NSDI national spatial data infrastructure.

At state level SSDI state spatial data infrastructure. So, it is a vertical developing coordination at different levels with a kind of one way of looking it is a type of pyramid structure. There are of course other ways of looking at it. So, anything that I have taught every transportation data is basically spatial in nature. So, this spatial data analysis will be beneficial and SDI is the future. SDI can help boost it.

Other than those few applications where we are working now to show that how SDI can be used effectively for improvement of transportation systems. They may include identification of critical links in the transportation network. So, the travel time varies during peak hour but will not every link response of increasing traffic load is the same. Somewhere the peak hour travel time may vary too much.

Some may be it will be more but the variability will be less. So, considering peak to off-peak or off-peak to peak and then within peak hour itself, what is the level of variation? Considering all those things we can identify which are the critical links, which are actually upsetting the scheduling of bus movement. And once you can identify then you can take appropriate methods. Similarly once an incident happens in a network.

Maybe a traffic accident or a roadside building, there is a fire breakout or some other kinds of incident, traffic gets disturbed. So, the impact of an incident will depend on where it is happening. Again geospatial data is important that if it is right at the busy intersection or the particular road during a peak hour the impact may be driven by dash. But not every point, every link, every intersection, every main block is equally vulnerable.

So, how to identify vulnerable road links and intersections? Then how we can have better real-time traffic control? A quick method which can take as the real-time traffic state and benefit the;

signal control in an urban network and also identify accident black spot and safety deficiencies and development of counter methods.

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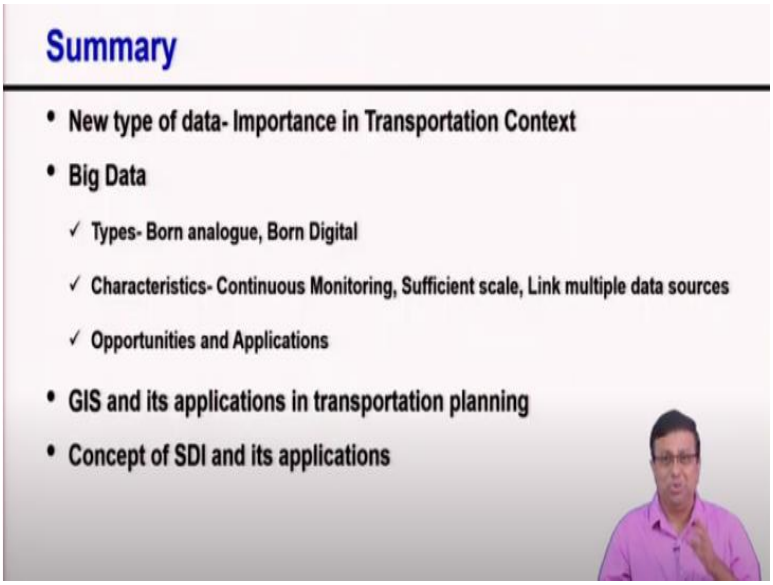

So, altogether I would say that we discussed not in detail if there was no scope discussion in detail. But we told you that one is the new type of data which has emerged in huge volume and getting stuck over time. How that big data is important in the transportation context. We quickly mentioned to you about the type of data, born analogue and born digital. Then the basic characteristics and also what are the kind of opportunities and applications that can happen.

Then we mentioned about the GIS, what is GIS and how its application in transportation planning could benefit us. And also shared with you briefly the; concept of SDI and its potential application. So; altogether as I said that as one way the travel behaviour analysis the future is activity based modelling. Similarly, we expect with the advent of this new emerging thing like the big data is going to play in a big way and is going to influence the work.

GIS application is going to increase further over time and SDI will really boost up the kind of application of big data, GIS in the transport planning context. So, in the future all these applications are likely to increase and are likely to give you a new dimension to urban transport planning. So, with this, I thank you so much and this is the last lecture. So, with this we also close this subject urban transportation system planning. Thank you so much.