Sustainable Transport Systems
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Lecture 60
Measuring Sustainability

Hello friends, today is the last lecture in the series of 60 lectures on the course of Sustainable Transportation Systems. And in this lecture, we will discuss about how do we measure sustainability? Because we have already seen the sustainability indicators. So, how to apply those indicators for the measurement of sustainability and at last we will see the complete overview of the lectures which we have conducted or recorded for you for this entire course. So, this is the last lecture for today for this course and the contents in this particular lecture is like why and how do we measure sustainability?

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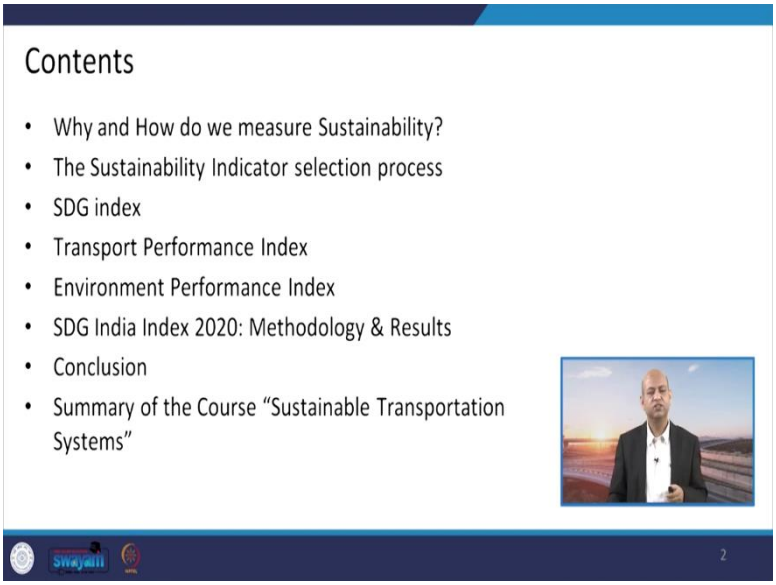

Because, as you know if something is not measured then scientists and engineers cannot figure out how to proceed further because for any planning execution for scientists and engineers or technocrats, we need to measure something. Without measures and in fact, there is a saying that if something is not measurable, it is untrue. This is just saying for scientists and engineers. Anyway, the next the sustainability indicator selection process, how do we select the indicators which are compatible for a particular project or particular exercise?

Then we will see the Sustainable Development Goals their indices, based on the Sustainable Development Goals and then the Transport Performance Index, which is used for the evaluation of performance of transport sector and then environmental performance index and we will see in the Indian context the SDG India index 2020 which was proposed by NITI Aayog and this methodology and results based on the SDG India index 2020 and then we will conclude and see the summary of the course of sustainable transportation systems.

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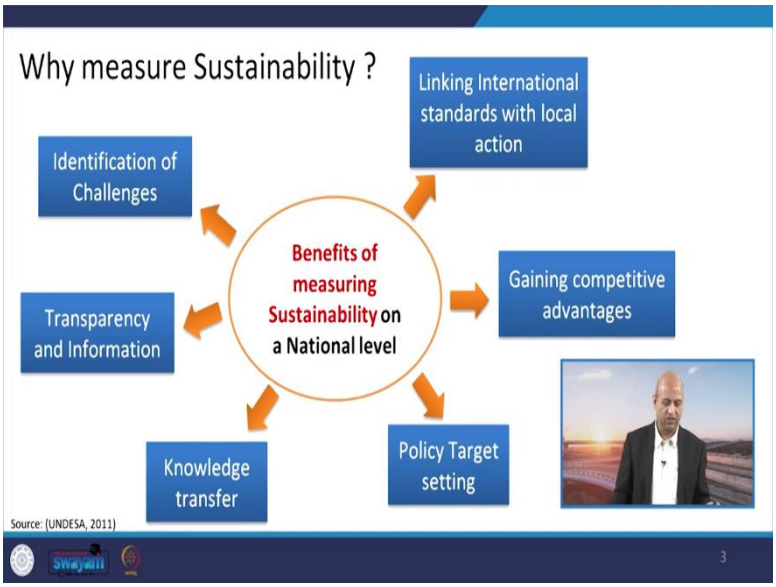

So, as you know, why do we want to measure sustainability as you know, because the benefits of measuring sustainability are several at the national level as local levels or even at global level. Because at global level, you can compare different countries based on the sustainability indices. And at the national level there are so, many parameters or aspects like linking internationally standards with the local actions whether we are performing in that direction or not then gaining competitive advantages.

Because whenever we are having a particular thing in a sustainable way then market value of that thing increases because people are becoming more and more aware of the products and services aspects of the sustainability. And then policy target setting for setting the policy targets again, the measurement of sustainability is must. Otherwise, how can you set the target for you designing or achieving certain policy programs?

Then knowledge transfer also it is easy when we have some measured indices, then transparency and information because, even if you are trying to highlight that my product or service is very good or we are doing very good in a particular sector, but unless you have certain data to show the transparency cannot be really authenticated in that way. So, the information the objective data is necessary for maintaining transparency on sustainability.

Then identification of challenges. Because, whenever, some products or services you want to improve upon, unless you have the data of the sustainability, you will not be able to see which aspect of that product or service is for improvement, so, that you can further have meeting the challenges. So, now, when we talk about how do we measure sustainability.

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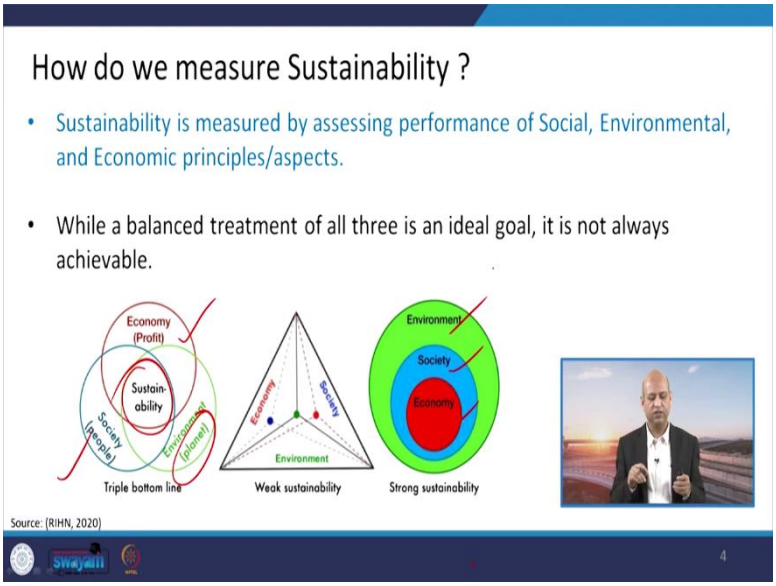

So, we see, three major aspects of the sustainability like social that is related to people then economy that means, it should be profitable also, it should not make losses. Then environmental that means, the complete ecosystem is harmless with this activity or means cities being damaged. So, all these things when we see the triple bottom line, the sustainability is basically achieved by these marries of these three aspects.

Then weak sustainability when we see that certain aspects are not being properly interwoven and they are separated. A strong, sustainability means they are completely integrated in a right way like their organic part or organic like our body our hand everything is organically integrated in one system. So, that way these three systems are integrated like an organ or organic entity then you can say this is very strong view of achieving the sustainability. So, the balancing of these three aspects, these three ideal goal is very much necessary.

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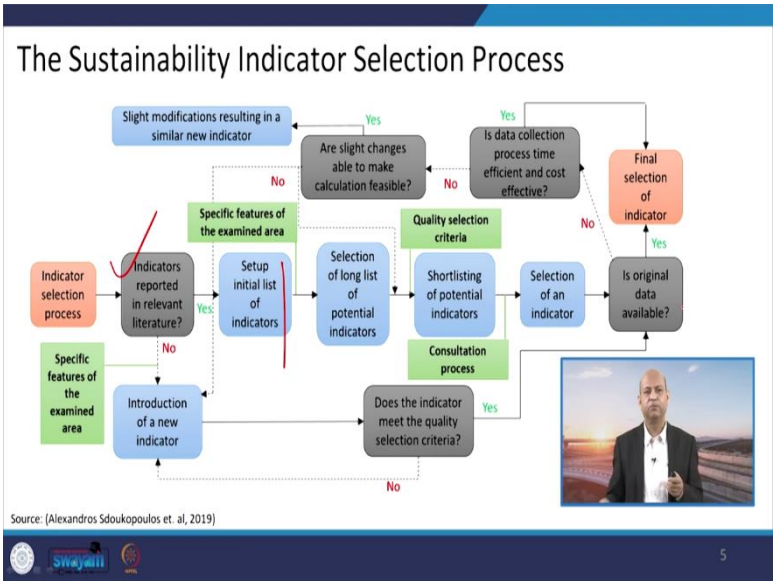

Well, then, we come to this process of selection for the sustainability indicators. So, how do we select the indicators which will be compatible or which will be proper or appropriate or not. So, we first of all we see in the literature published literature as well as the case studies what kind of indicators people are using. Then as per the context, as per the project or as per the program, we set up the complete the list of indicators probable list of the indicators.

Then within that long list we try to shortlist based on certain criteria and then when we see that these indicators which we are selecting whether the related data are readily available or not if we have selected some particular indicator, but different features which need some data set and those data set or input parameters are not available easily then those indicators will not really help us.

So, we need to ensure that the original data is available for that particular indicator and ultimately quality selection criteria and then the need of the new indicators if it is there all these things are evaluated and ultimately, we select the particular indicator which will be useful for measuring the sustainability.

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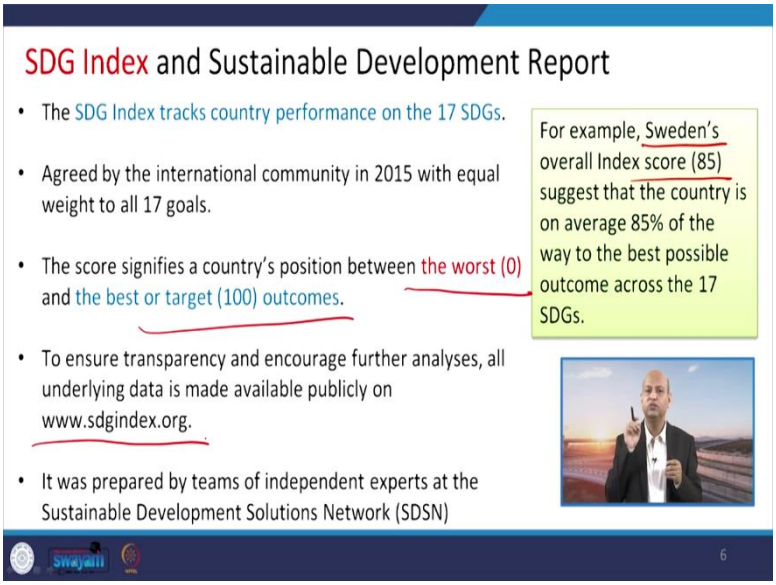

Now, if we come to the Sustainable Development Goals indices, which are part of United Nations programs and every country signatory countries following those 17 Sustainable Development Goals and they are trying to integrate in their policies that whether it is poverty reduction or environmental protection or so, many means, access to education, everything all these 17 development goals are the part of national policies and programs of every government.

So, if we see in that light, if we categorize every country, if we rank all the countries based on the equal weight is given to all these 17 parameters, then we find that, Sweden; it scores overall as around 85. So, that is the top most score in that sense and it is at the top-ranking country, but the worst performing country will have the 0 and the best performing country will have the 100 score.

But, as you can see, even Sweden is not scoring 100 So, that means is still there are certain gaps there and those criteria those parameters are quite stringent and they need lot of extensive efforts to meet them and to ensure the transparency and increase further analysis, all these underlying data which are used for the SDG indices, calculations, they are publicly available. So, at this particular website, www dot SDG index dot org you can find out means complete data set which are used for calculation of these indices or scores.

And then these independent experts have been invited for getting sustainable development solutions network and proposing this particular index. So, that means, the whole exercise was very extensive based on expertise opinion and knowledge experts of the particular domains. So, that way means, this is very objective exercise it is not just perception based or subjective, it is very much objective exercise and that is the beauty of this.

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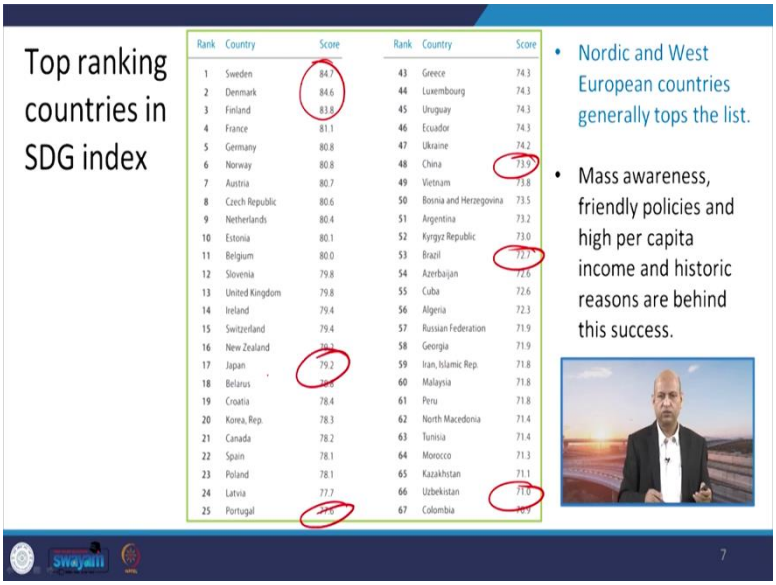

So, the top-ranking countries you can see here the first is the Sweden, next is Denmark, Finland. So, they are like three these countries are almost similar from 84 to 85, 83.8, 84.6, 84.7 those kind of values they are scoring and then there are all countries are having like China is having 73.9, Brazil having 72.7 and then you can see even this Uzbekistan 71, Portugal 77.6, Japan 79.2, New Zealand is also having 79.2.

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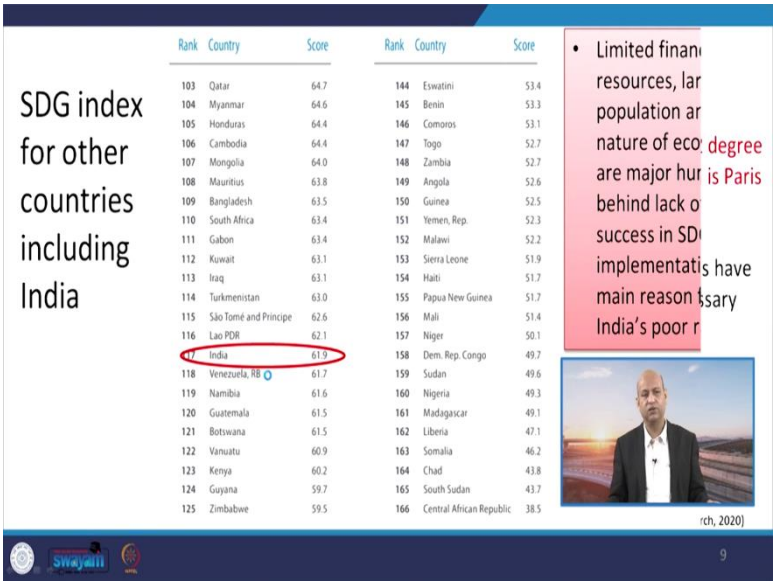

So, that way India is at 61.9. So, this is not so good, though we are making continuous efforts, but there are certain gaps which we have to fill. So, limited financial resources or large population and nature of economy are major hurdles behind this lack of success in SDG this ranking system and the implementation is going on the main reason is for poor ranking is as I said that there are so many things because so much population is there and whatever program you are launching, it takes time to go up to the last person who is going to be benefited.

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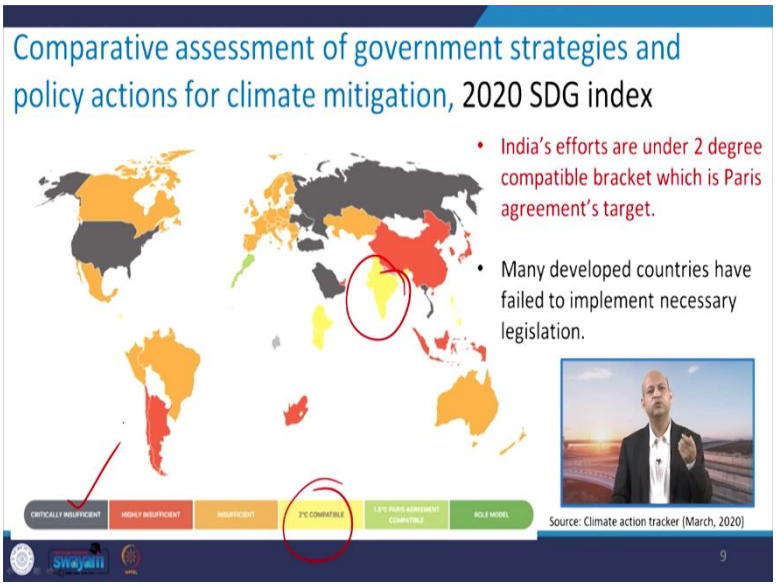

Well, then when we go for comparative assessment of government strategies and the policy actions for climate mitigation, particularly which is one part of this 2020 Sustainable Development Goals index. So, you can see in that sense India is playing good and it is making good efforts, it is basically in this particular you know, 2 %, 2 degree 2 degree compatible bracket which is as per the Paris Agreement.

So, in that sense, India is falling in that particular group. So, that is a very good group because even developed countries, several developed countries are not falling in that category, they are basically critically insufficient their performance is there in that sense. So, in particular climate related mitigation strategies like government is doing a lot for solar energy and wind energy, renewable resources, and many other policies are there which are really helping us to going towards mitigation of the climate change related issues.

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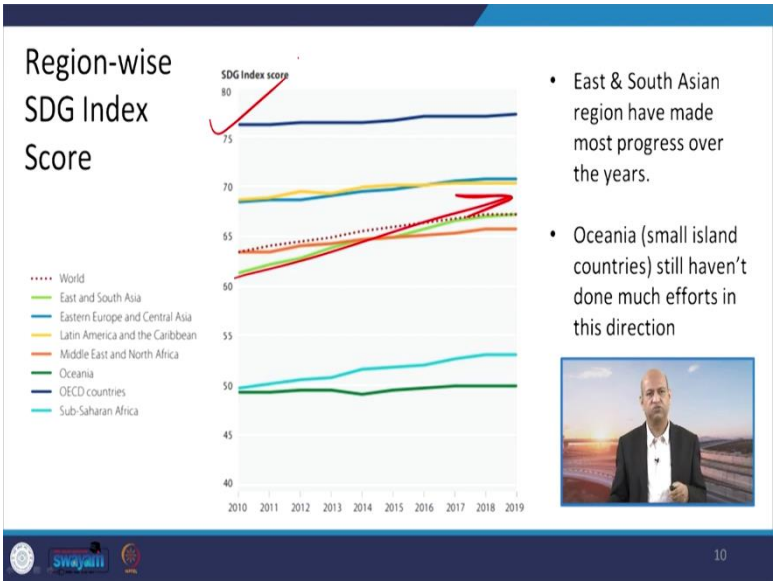

Well, when we compare region wise SDG index score, then you can see the world data is on the dotted and you can see the green one East and South Asia. So, if you see this particular the direction or the slope that way the East and South Asia countries, the South Asian countries, they are making good progress although the score is lower in comparison to other countries like Latin American or those countries and these OECD countries are doing very well. But in that sense, although ranking is lower, but progress is very high. So, that means, it has a good future we will be scoring good in near future.

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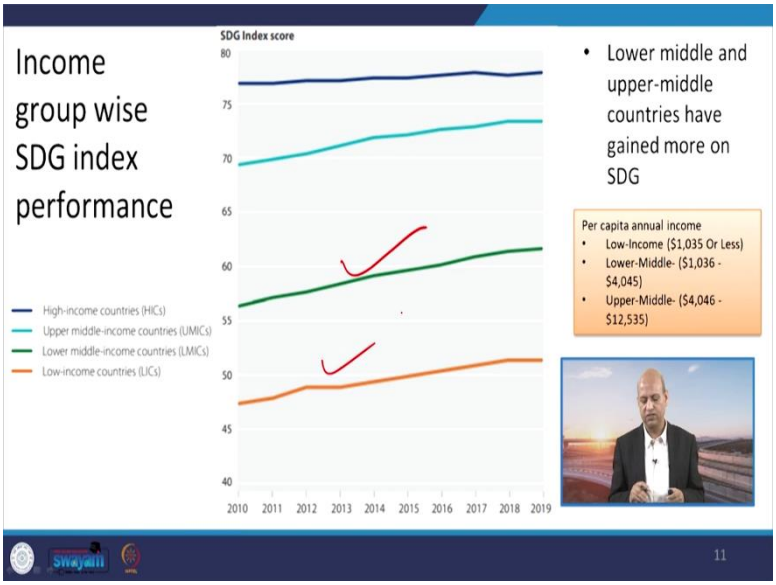

When we talk about different income group wise this SDG index performance then again we can see that high income countries are having very good index score, but again you can see that this lower middle income countries like this and the low income countries they are having a good slope means they are rising or increasing their performance in a very good way.

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Then from pictorial and form sign-based kind of comparison of region wise then you can see from different kind of SDG goals 17 goals are there like first is no poverty, zero hunger, then good health and well-being all those things. And then clean water and sanitation, 6 number and 11 number is sustainable cities and communities. So, which is very much related to our sustainable transportation system then climate action again, transportation sector influences it.

So, so, many are they are 17 is particularly this partnerships for the goals of different sectors, different programs. So, you can see in all these areas or regions and different kinds of progress is there. So, like, if a green circle is there, so, that means that SDG that goal has been achieved and if this arrow is there a green arrow or the vertical one, then that means, the efforts are on that track. Otherwise, the red circle which is major challenges remain. So, that way it has been pictorial representation of different kinds of stages you can go through.

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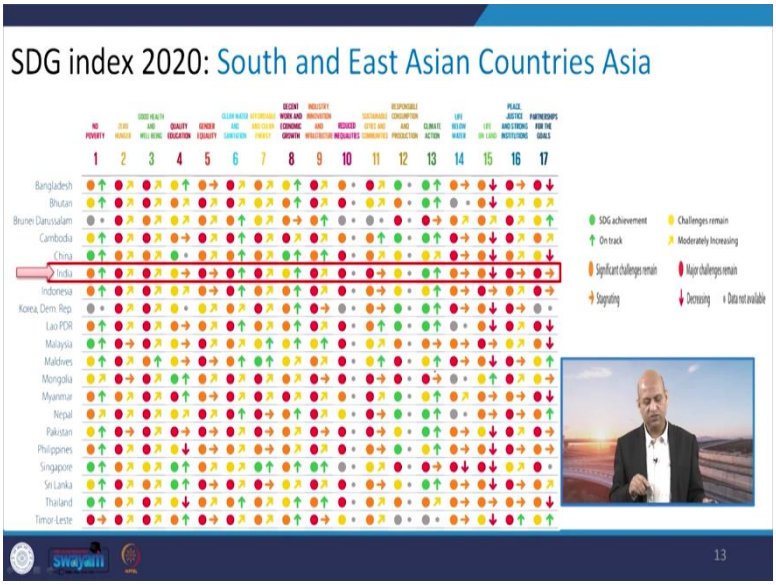

Similarly, South and East Asian countries have been compared and the India is figuring out in several goals, it is on that track the green arrow is there. So, that way it is a good sign for that.

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Similarly, when we talk about the absolute values of sustainable development goal performance and the gaps for G20 those group of 20 countries in this 2020 in percentage, so, again India you can see there are of course, challenges, but, still there are ways for better performance.

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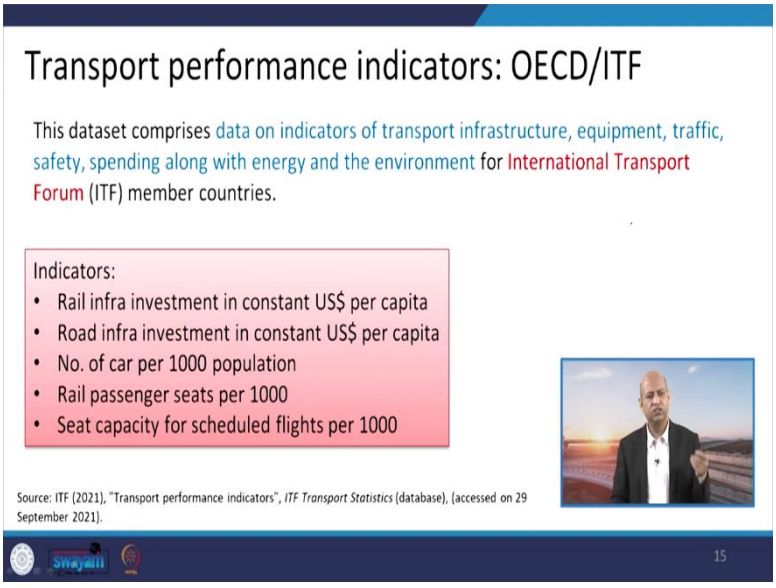

And then when we see about transport performance indicators like OECD, and then this international transport forum related countries member countries. So, there are this infrastructure related investment or number of car per 1000 population, rail passenger seats per 1000 population, all these things are used for that.

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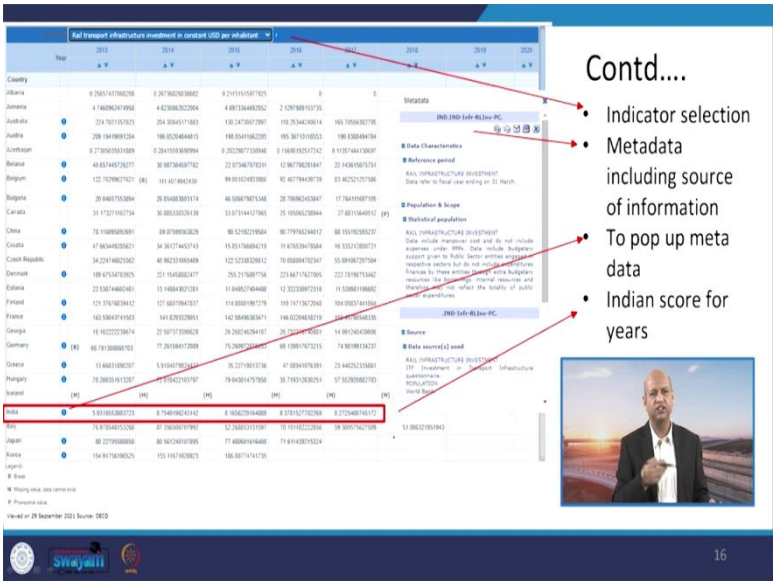

And accordingly, these kind of status is there for different countries you can see here. So, this kind of chart you can see and you can select the particular pop up this feature and you can see the data. So, according to the data you can learn you know different countries values and comparisons. So, the next is the environmental performance index of 2020.

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And this index has been developed by University of Yale and based on this they have conducted several studies and they have ranked different regions and different countries and there are other indices also but we are just discussing major important indices like we have just discussed SDG related indices and now environmental performance index.

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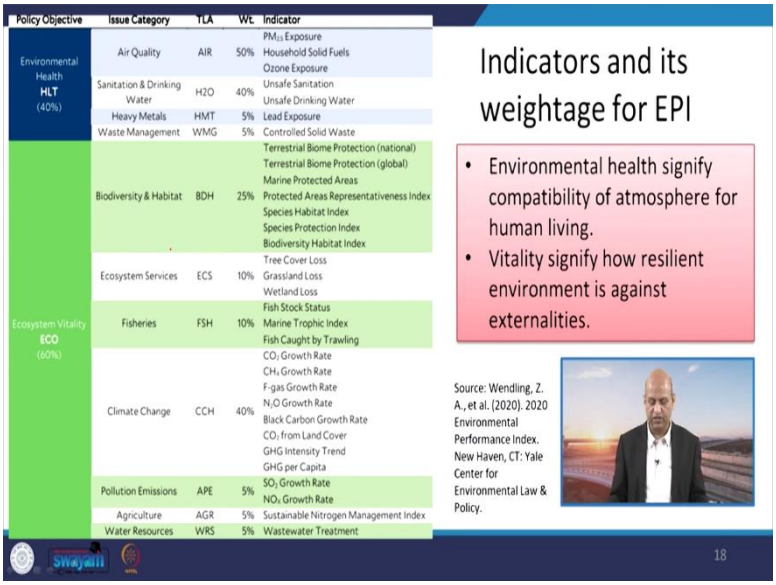

So, according to this particular index again you can see like there are air quality related data, sanitation and drinking water or heavy metals present in the air or water then waste management all these things very much focused on environmental parameters. So, in that way this is a very good index to compare different states of different sectors as well as different countries.

And it basically compatible with the atmospheric as well as human wellbeing and because if clean air is there then better index values will be there, the similarly clean water or clean ecosystems.

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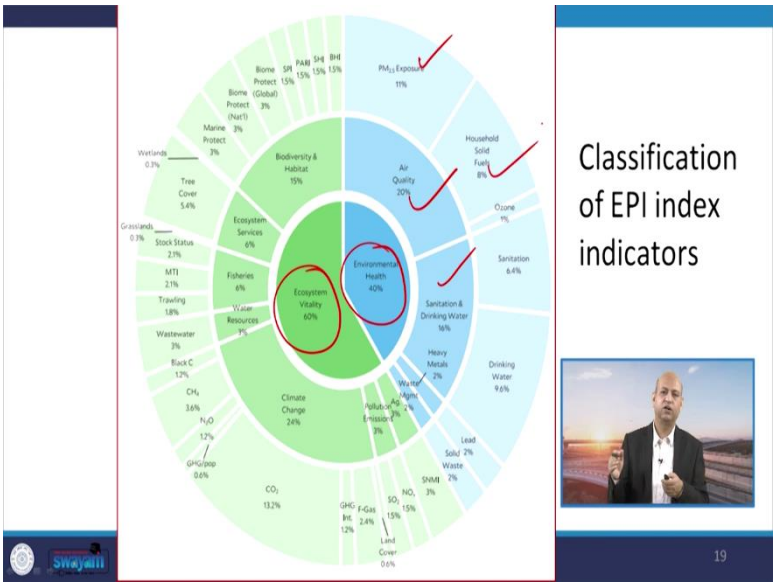

When we classify this EPI index indicator, so bigger they are category then subcategories are there, like environmental health related issues are 40 % an ecosystem annual vitality is 60 %. So, that is the ratio and within that you will see like in environmental health you will see air quality sanitation and all those. In air quality PM 2.5 exposure, household solid fuels, all these subdivisions are there. So, that way from micro to macro kind of assessment is there.

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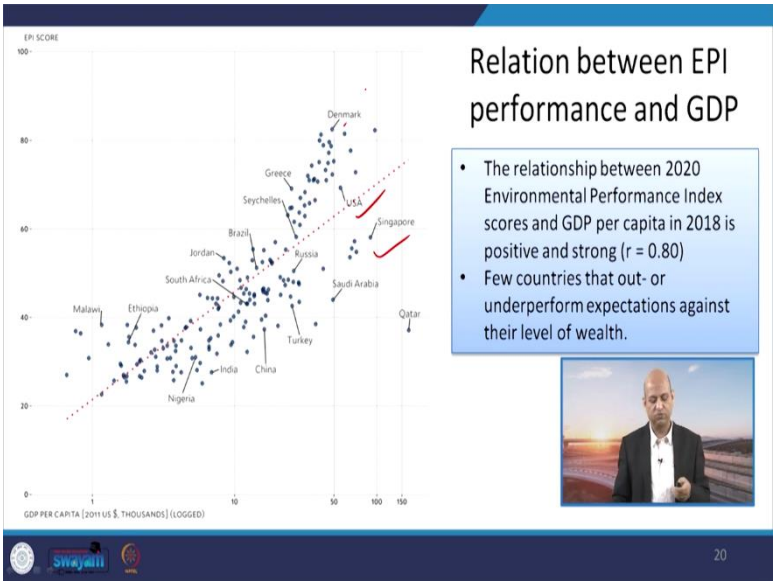

Well, when we talk about the comparison of these environmental performance index and the GDP of each country, very interesting relationship is there, because you might have heard about that that was net curve inverted U that when GDP growth pollution grows and after certain level when a lot of money is available, then governments and people try to invest to clean the environment.

So, that way GDP really helps in having better performance. So, in that sense also you can see those countries which are having very good GDP like Singapore, USA, Denmark, etcetera, they are having very good this environmental performance index score. So, that relationship is very direct.

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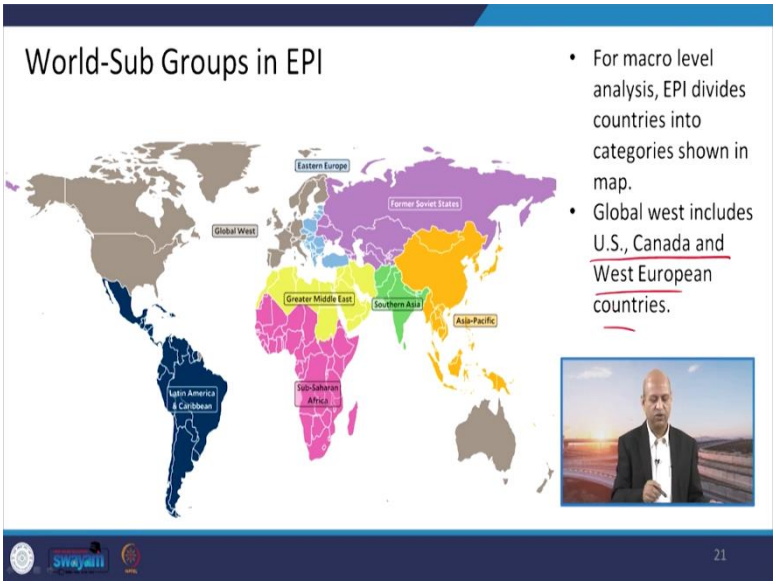

And so, that means, we should grow in economy also to tackle the environmental related problems, but initially there will be some issues and that has to be really tackled with proper policies. When we talk about these different subgroups of the world and in terms of the CPI or environmental performance index. So, again, you can see different kinds of values are there and according to the macro level, this divides into categories, which are in the map and this Global West includes US, Canada, West European countries, all these.

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So, these are the values and you can see here their performance. So, the South Asia still struggling to come up with the CPI, but the East Europe is in between and the Global West with high score, they are having good performance index of the environment.

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Now, we come to this SDG India index and dashboard which has been proposed by NITI Aayog and it is the very flagship kind of program to assess our performance in terms of sustainable development goals.

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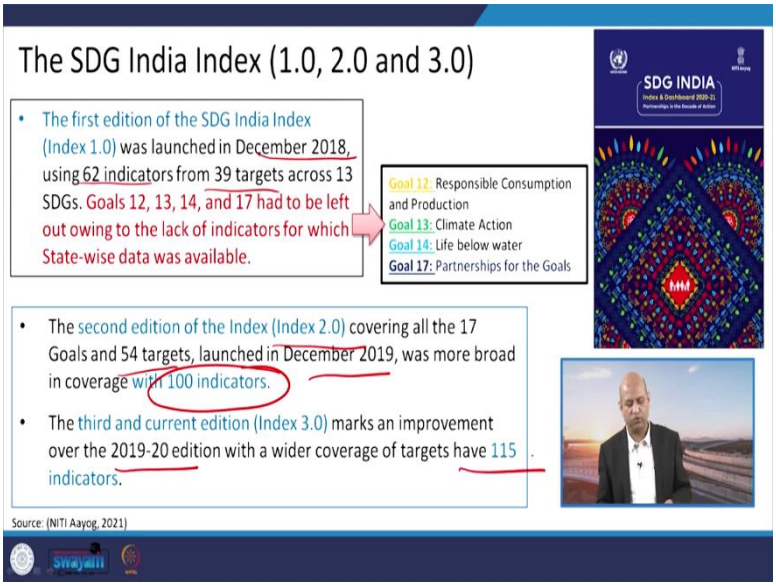

So, you can see here there are ways like different versions are there of this index particularly, like index 1.0 was released in December 2018. At that time, only 62 indicators were used with 39 targets and across 13 Sustainable Development Goals out of 17 only 13 because there were some problems. The goals 12, 13, 14 and 17 had to be left at that time, because of lack of indicators for which state wise data was available. So, that problem was there.

So, only 13 indicators were used. Later on, in 2019 with the 17 goals 54 targets. This second edition of this index was released index 2.0 and the indicators increased from 60 to 100. But now that the third version which is in this 2019-20 edition which is having around 115 indicators. So, progress is there a lot of progress is there.

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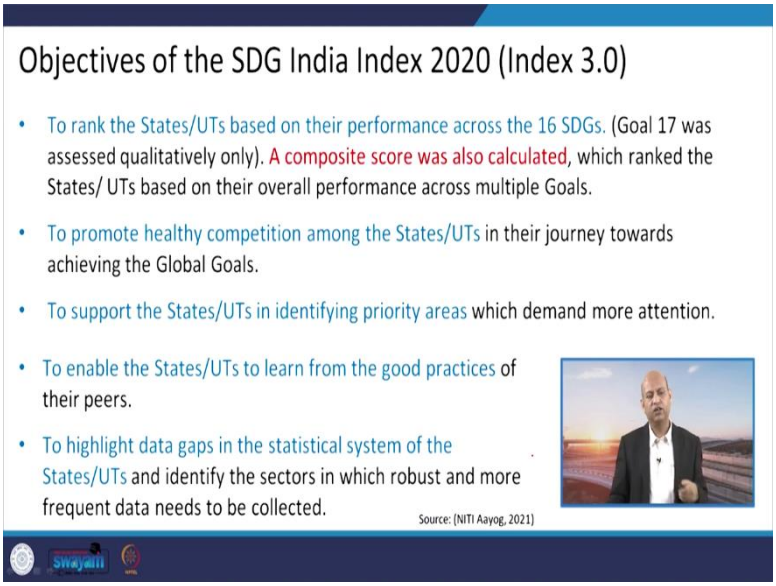

And we can see like what are the objectives of this particular index. So, it helps in ranking different states their progresses, policies progresses, how their programs implemented in different union territories or different states? And it also help in promoting this healthy competition among different states because if one state is growing then in a lot of media coverage is there then other states think that, okay come on, let us try to achieve this particular goal.

It also supports different states and UTs in identifying priority areas. Because this will help us to see in which area we are lacking. So, maybe next time we give more resources to help that particular sector or area grow. It also enables different states and UTs to learn from good practices of their peers, because if some state is for example, giving good progress for poverty reduction.

So, other states can see okay, what kind of programs they have implemented which has helped them to reduce the Poverty Index? So, so, that kind of learning process is there and then it can also highlight data gaps in the statistical system of the states and that way better statistical analysis can be done next time, if there are certain gaps.

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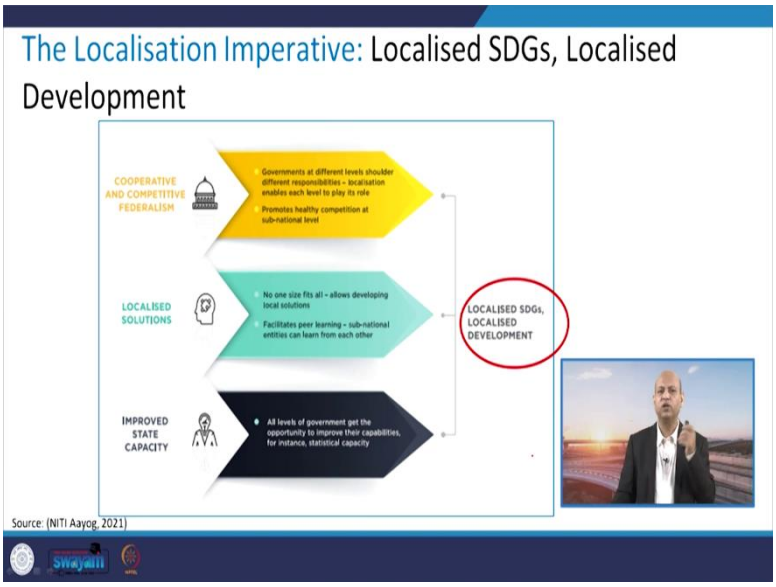

Then there are localization imperatives of these SDGs because it helps in like having a state wise some programs or policies because one size fits all solution may not help because of geographical challenges because of some socio-economic challenges different programs are needed. So, that way the states can really go for some localized kind of particular in these index or particular indicators which they want to use.

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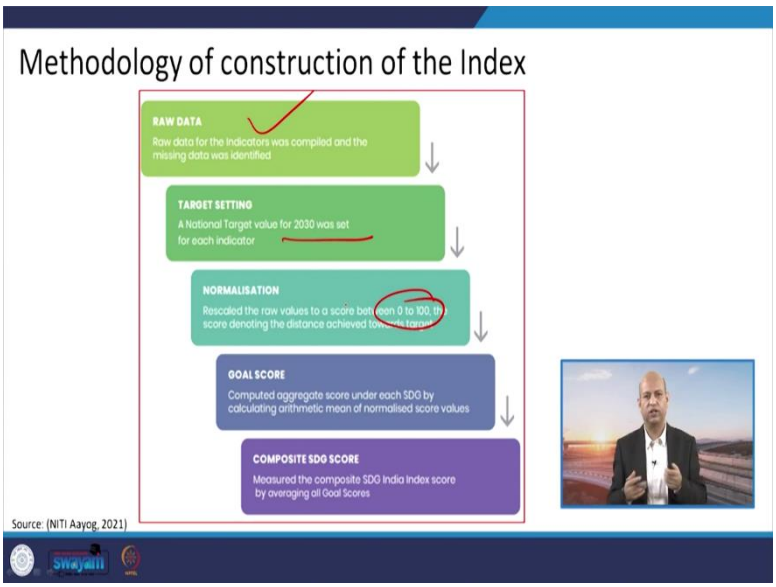

Then the methodology for construction of index as you can see the raw data is taken first of all, then the target is set this target we have to achieve at the National target for 2030 was set for each indicator. The normalization has to be done by this with the scale of 0 to 100. And then the goal is score is done by computation for each category of the SDG and the composite SDG score is calculated after all. So, means part two whole you can say integration happens after all.

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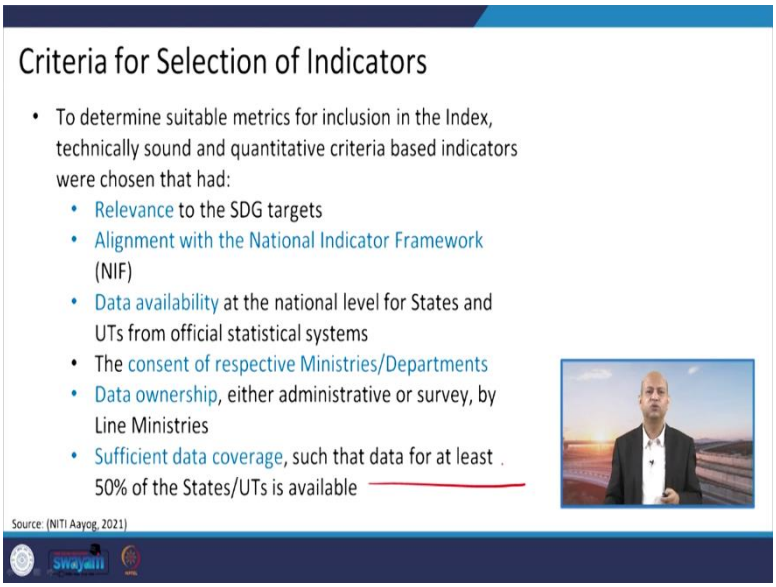

When we talk about criteria for selection of indicators. So, you can see like, it should have relevance with the SDG targets which are set already 17 goals are there which are available for us. So, whatever indicators, we are trying to propose this should be in the alignment or it should have relevance with that, and the alignment with the National Indicator Framework NIF is there so, it is not that you are proposing some very unique indicator with completely needs.

The lot of resources and a lot of time and expertise and then progress may not be there. So, it should be and the already exercise has been conducted and the National Indicator Framework is available. So, in that alignment, if you go for then it is easy for selection of that criteria. Then the data availability is very important, if data is not available and we are proposing some indicator it is useless.

So, data availability we should see and if there is a score for increasing some data availability in a particular sector that can be done and accordingly the new indicator can be proposed. So, the sufficient data coverage means, this data for at least 50 % of the states and UTs must be available otherwise national that kind of level indicator will not be achieved if we are having only a few states and then you cannot say that this is the stage of the or level of the nation in this particular field.

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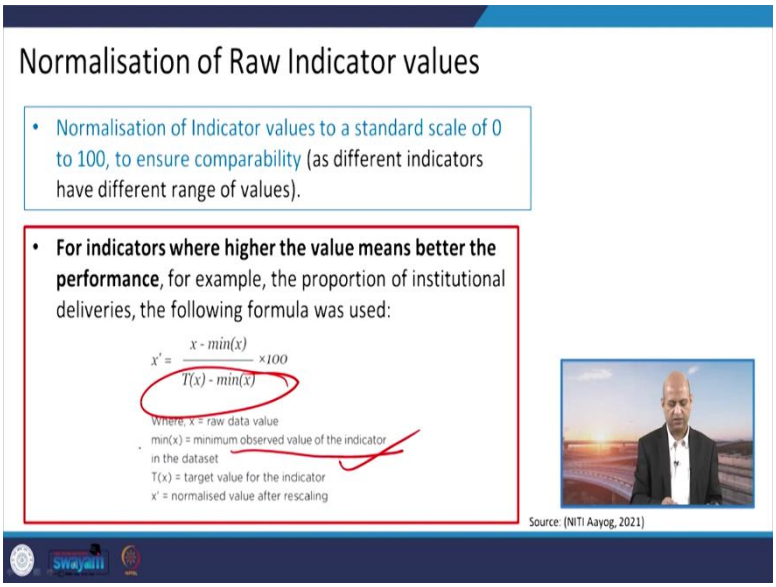

Well, when we do the normalization, so, there are ways for example, if the indicators were, higher values means better the performance, then this particular formula is used

$$x' = \frac{x - \min(x)}{T(x) - \min(x)} \times 100$$

where the denominator you can see $T(x) - \min(x)$, Tx is target value for the indicator and x, you can see this minimum observed value of the indicator in the data set minimum x.

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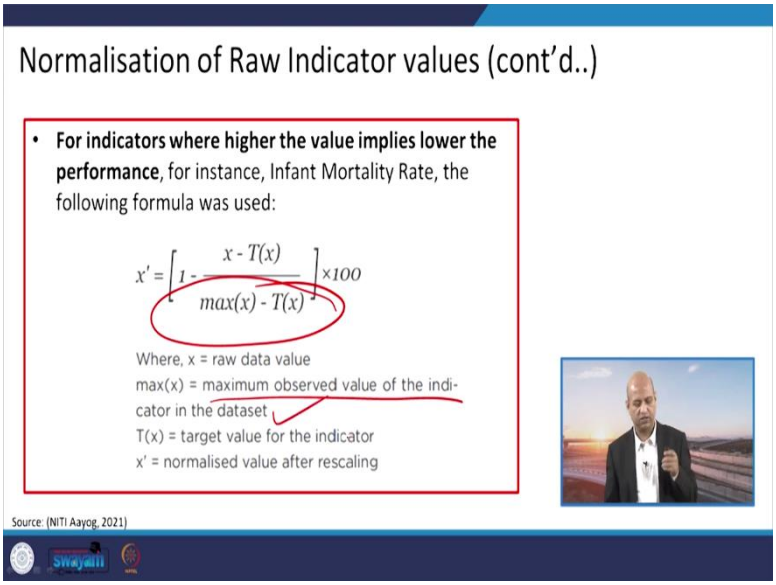

But in case of the indicators where higher values implies lower the performance so then you can see this changes:

$$x' = [1 - \frac{x - \mathrm{T}(x)}{\max(x) - T(x)}] \times 100$$

denominator changes, where $\max(x) - T(x)$. So, max x is maximum observed value of the indicator in the data set and the target value for the indicator. So, that has to be kept in mind otherwise erroneous calculations will happen.

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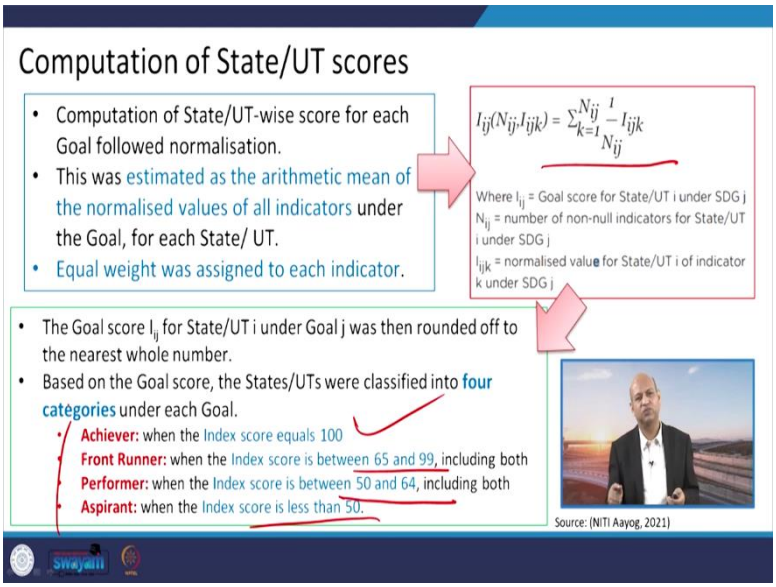

When we go for computation of state and UT so, the summation basically occurs.

$$I_{ij}(N_{ij}I_{ijk}) = \sum_{k=1}^{N_{ij}} \frac{1}{N_{ij}} I_{ijk}$$

So, different kind of goals and scores of different activities and those indicators they are combined integrated you can say. And when index score is equal to like 100 then we can say that that is the achiever and if the score is 65 to 99 then that is known as the front runner. We are really making very good progress.

Performance means 50 to 64. So, that performance is being made. So, performer that particular state or sector is performer and the score is less than 50 then we call it aspirants so all these nomenclatures are quite positive in the sense there is no kind of word like loser or something. The connotation should be like positive aspirant means if we are they are trying but they are not achieving those scores.

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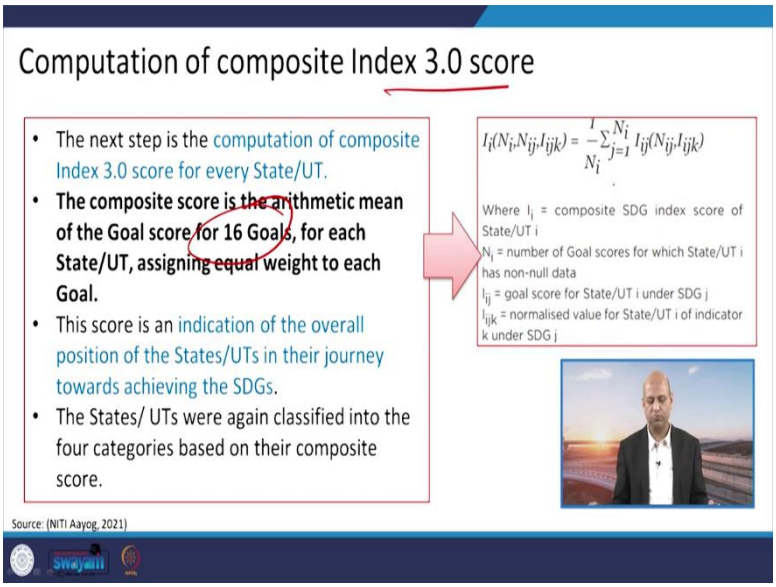

Well, when we go for composite index like 3.0 this particular version,

$$I_i(N_i, N_j, I_{ijk}) = \frac{1}{N_i} \sum_{j=1}^{N_i} I_{ij}(N_{ij}, I_{ijk})$$

so, you can see again that all these goals are there 16 goals particularly only one goal is not there, this 17 we will see. So, these 16 goals are integrated and the composite score is taken.

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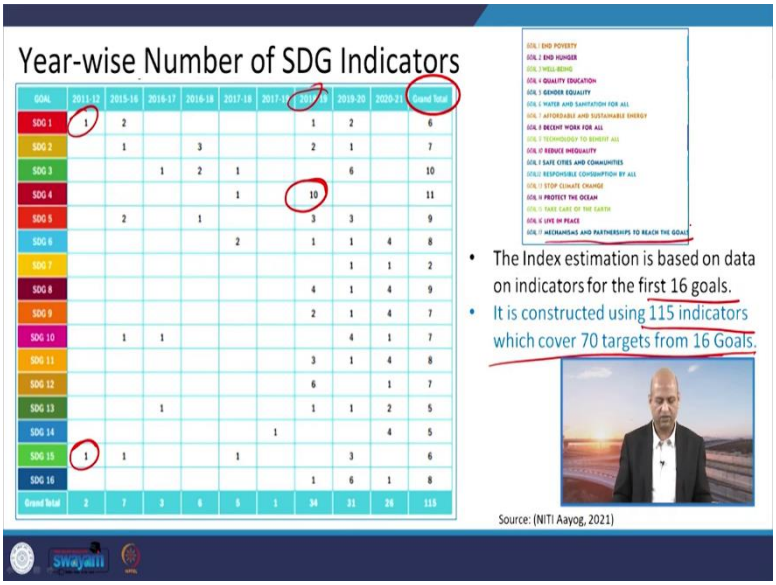

Well, here you can see the periodicity of indicators which show the number of indicators which were used in a particular year like in 2011-12 only this SDG 1 and 1 indicator for SDG 15 was 1 indicator total 2 indicators. But now, you see in 2018 and 19, 1 indicator for SDG 1, 10 indicators for SDG 4, so, that way number of indicators are increasing.

And now, at present we are having 115 indicators and which covers around 70 targets from these 16 goals. Of course, all 17 goals are not being taken, because this 17 this goal 17 mechanized when partnerships to reach the goal which have not been taken. Otherwise, every goal has been taken and considered for calculation purpose.

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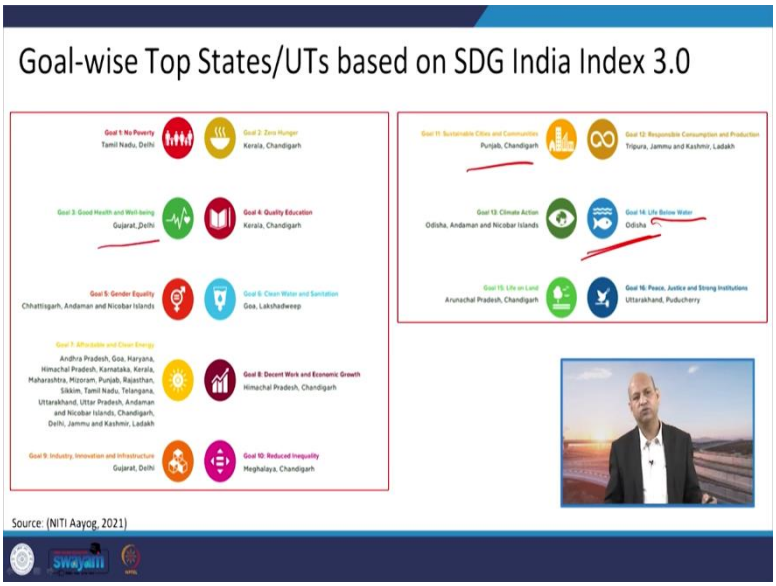

Goal wise top states so, different development goals have been achieved by different states and because they have some strengths. Every state has a strength like in Punjab and Chandigarh

goal 11 that is the sustainable cities and communities that related indicators have been properly seen and achievement is there.

Similarly, in Orissa this goal 14 that is life below the water. So, they have made a lot of efforts in that direction for Gujrat goal 3 that is the good health and the well-being. So, Gujarat and Delhi they have done very good progress in that sense. So, you can see the top states as per the goals.

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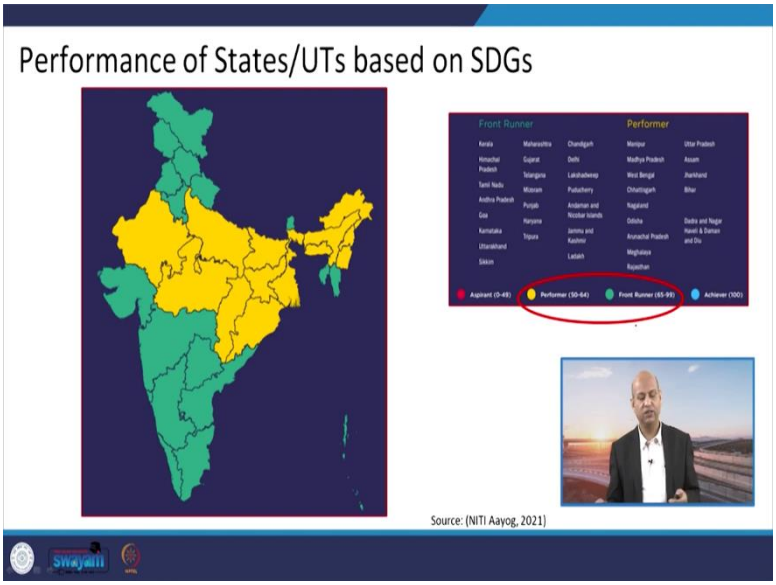

And the performance of states based on these SDGs you can see like performer so, these all the states these are in yellow, they are performance they are having indices value or score value 50 to 64 and the green one this is having 65 to 99. So, they are basically the front runners, but achievers, I cannot see. So, maybe these front runners will be included in achievers next time.

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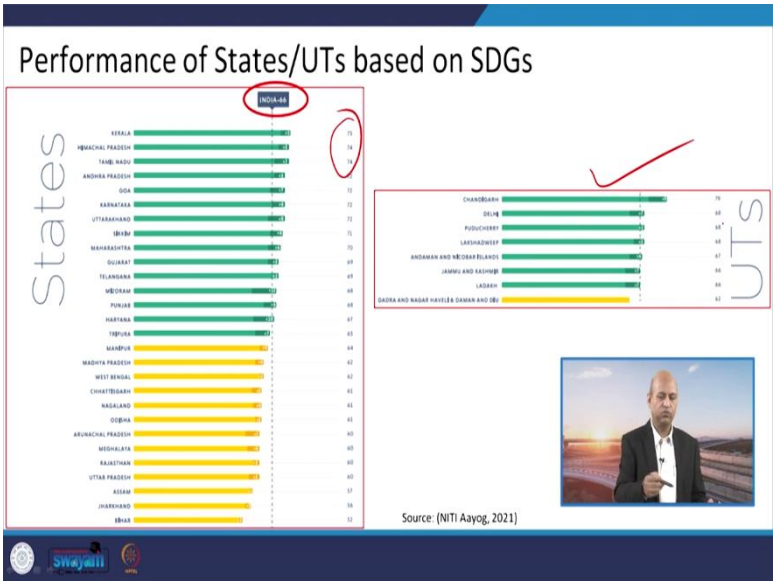

Well, when we see about like performance of different states, so, you can see like Kerala, Himachal Pradesh, Tamil Nadu they are having good score around 74-75. In UTs Chandigarh is doing very well having a score of 79. So, that way different state's scores are available for comparison purposes.

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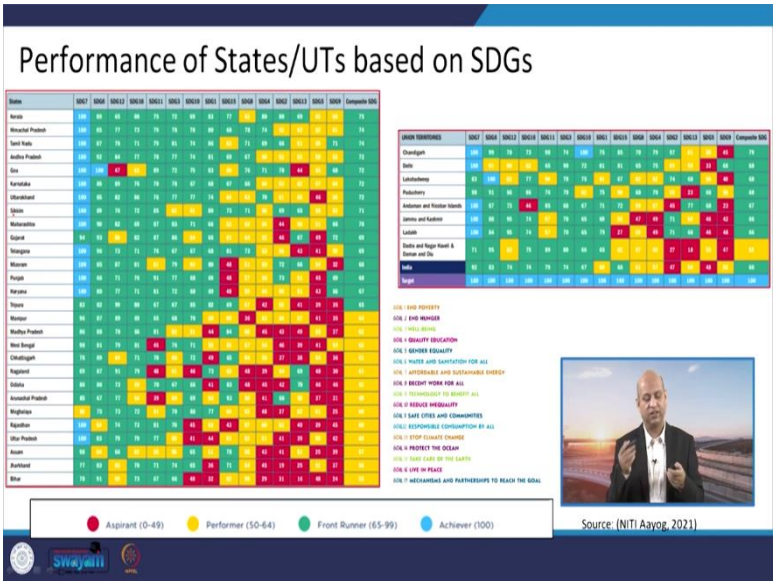

When we talk about performance of states based on SDGs so, again there are different goals and you can see in different states and different goals and their colour scheme shows where they lie? Whether they are frontrunners or they are aspirants or those kinds of things you can see.

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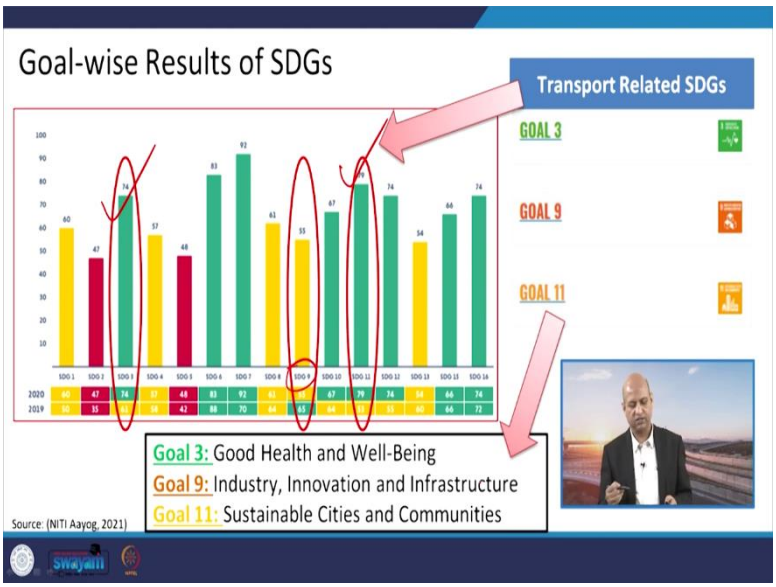

Well goal wise results for the Sustainable Development Goals when we talk about the transport related the Sustainable Development Goals then the good health and well-being industry innovation and infrastructure and sustainable cities and communities. These are the three goals which are very very important from transportation perspective. So, they our India is doing very well in that sense like this SDG 11 which is sustainable cities and communities.

So, it is front runner and then this SDG 3 that is good health and well-being again, the front runner and for this SDG 9 that is industry innovation infrastructure. We are doing good. We are making very good progress.

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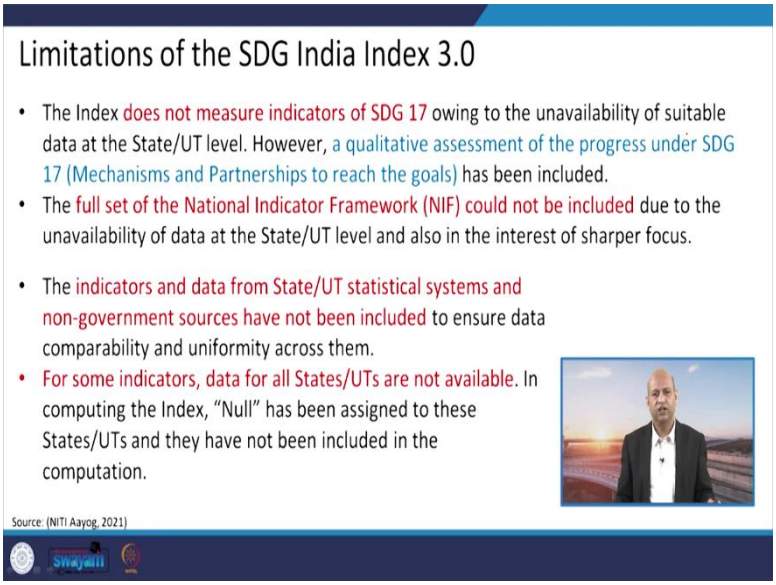

Well, when we talk about limitations of these SDG India index 3.0 then there are several limitations which are needed to be addressed and maybe the fourth version will overcome those limitations like the present index does not measure the indicator of the SDG 17 and that is because unavailability of suitable data at the state or UT level, but qualitative assessment of the progress under SDG 17 which is mechanism and partnerships to reach the goals has been included not quantitative, but qualitative.

And then the full set of the national indicator framework that is NIF could not be included due to the unavailability of data at the state and UT level and also in the interest of sharper focus so that we do not dissipate our energy everywhere let us focus on certain things where our strength lies. Then another this limitation is like indicators and data from the states and UTs statistical systems and non-governmental sources have not been included to ensure data compatibility and uniformity across them.

Otherwise, some sources have different kind of data set and then non-uniformity data compression is not good. For some indicators data for the states and UTs are not available. So, they have to be left and that has created one big gap.

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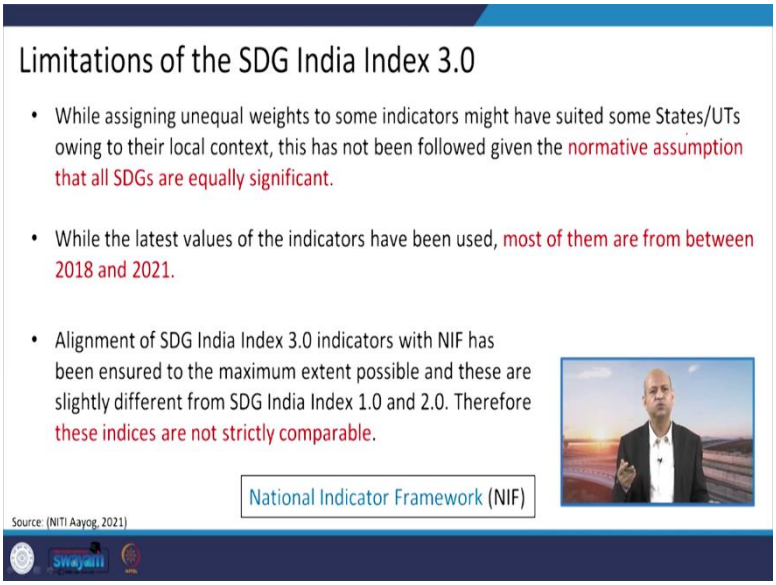

Then if you talk about like assigning unequal weights to some indicators might have suited some states because they are doing very good in that, but this we have to see this normative assumptions that all SDGs are equally significant. So, that we are not assigning different weightage, otherwise, the scoring may be different. But some people argue that because some states having some local context very powerful in that way we should give different weightage. But still we are ignoring that.

Then the latest values of the indicators have been used, most of them are between like 2018 to 2021. So, that is also like means not uniformly available for all the years or months alignment for SDG India index 3.0 indicators with NIF has been ensured to the maximum extent possible and these are like slightly different from these SDGs in the index 1.0 2.0. So, the inter compression of those indices is not good, we should not compare in that sense because the new indices are completely different in that way.

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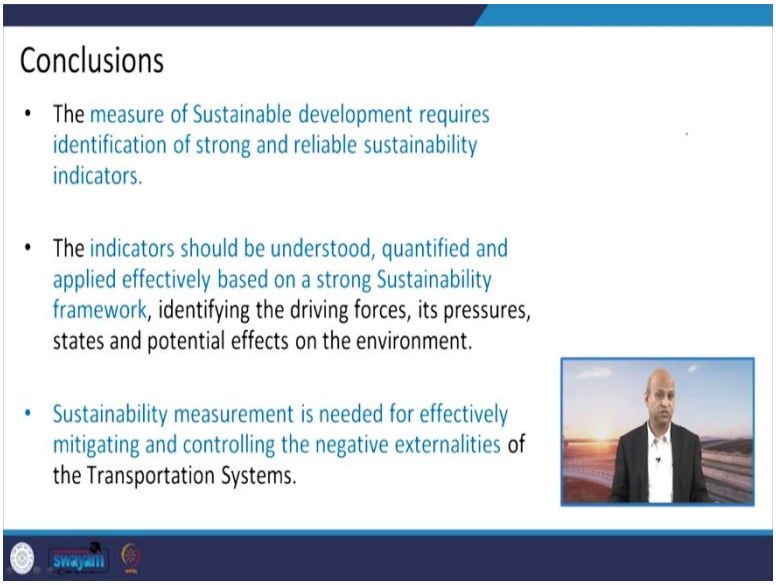

So, in conclusion, we can say that this measure the measurement of sustainable development requires identification of a strong and reliable sustainability indicators and the indicators should have been understood and quantified and applied effectively based on strong framework sustainability framework, and the identification of driving forces, its pressures, states potential effects on the environment, they should be taken into account.

Then sustainability measurement is needed for effective mitigation and controlling the negative externalities of transportation systems in particular for our case, because we are talking about sustainable transportation systems.

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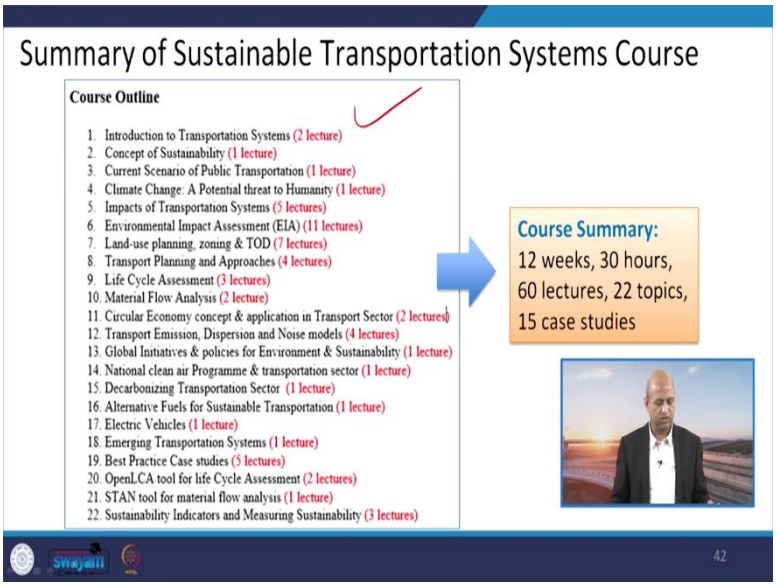

So, overall if we talk about these 12 weeks, I spent over 30 hours and 60 lectures and 22 topics and 15 case studies, all have been included in these 22 topics, like two lectures were for introduction to transportation systems, that way different lectures, we have divided so, that we can cover all important topics in that way. So, you have gone all through these topics and we hope that this course has given you the required information, knowledge and skill.

So, that you can really contribute in achieving the sustainable transportation system, wherever you work, whether at the state level or national level or if you join some NGO or multinational which are helping countries for achieving sustainable transportation systems.

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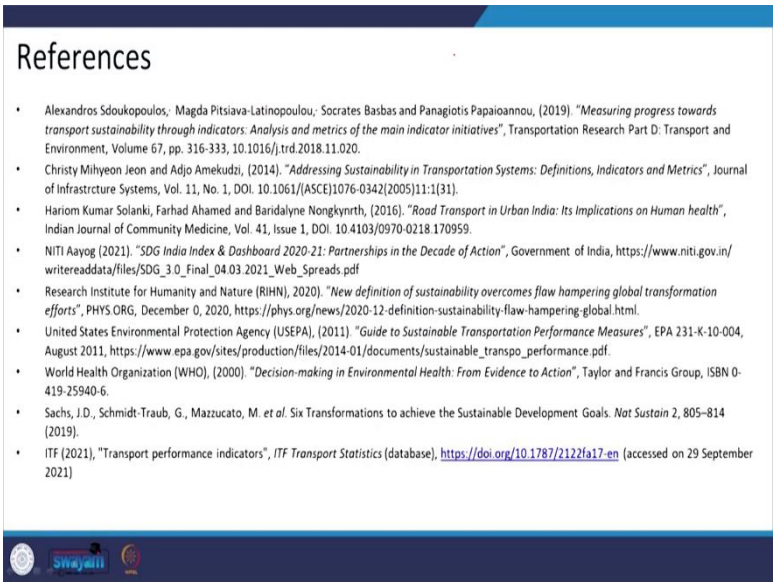

These are the references for this particular topic. So, this is all for today and this is the last lecture. So, I think, to all of you that you have given your much attention to this course, I hope you have enjoyed a lot. I am particularly very much thankful for your cooperation, which I have seen through my TA's; Aromal and Akshay, they have contributed a lot I thank them, and then this ELC that is the E Learning Centre of IIT Roorkee the entire team.

I am grateful to them particularly Binoy. They have, rescheduled scheduled many times as per our, there were limitations when we were recording the lectures. So, thanks to all of them. And thank you again and I look forward to receiving your feedback. So please stay safe and have a nice time ahead and this course must be very useful to you. This is my expectation and hope and belief. Thank you very much for attending this course. All the best, please take care.