Carbon Accounting and Sustainable Designs in Product Lifecycle Management

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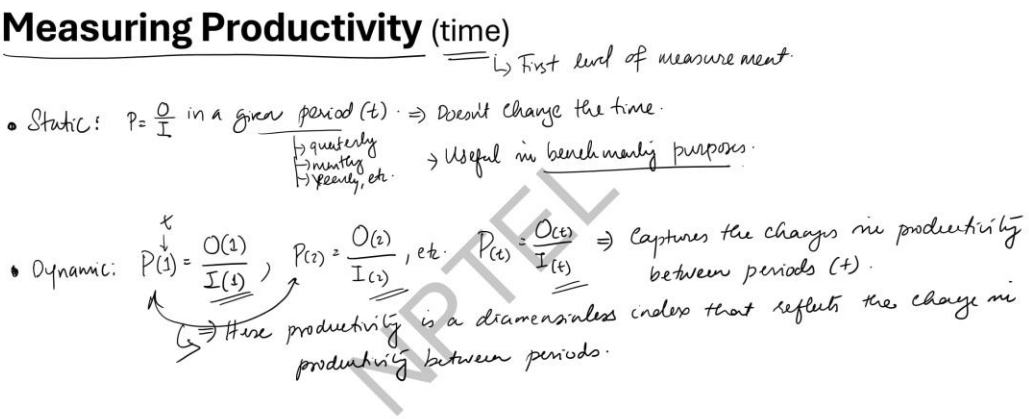
Week 01

Lecture2

Measuring Productivity

Good afternoon, everyone. Welcome to yet another lecture of the course, which is Carbon credits and Sustainability for Product Lifecycle Management. And we already mentioned in the previous lecture the need for introducing sustainability and how to measure sustainability using the carbon credits and also think about the whole thing for the life cycle of an entire product from the ideation till the disposal and so from crib to the funeral part, so that we already discussed and we also saw what's the transformation process. We also saw how to use productivity as a measure to or relationship to quantify outputs of the transformation process, the inputs of the transformation process and how is that part of the feedback? Also, we saw that and we saw the strategies to improve productivity.



And now we are in the process of Measuring productivity. So, the first point, first axis or the first factor on which we are measuring is the time. This is the first level of measurement. So, we are looking at it as the first level. So, there is two major versions of this.

Number one is called a Static.

$$P = \frac{O}{I}$$

So, this given period can be quarterly, monthly, yearly, etc. So, you can have quarterly every 3 months, every 6 months, annual, 5 years, etc. So, the 5-year plans were created.

You can think about it that way. So, this is static. So, it doesn't change. So, this implies doesn't change the time. The time remains the same. 3 months, every 6 months, every 1 year, every 2 years, etc.,

These are useful, this is useful in benchmarking purposes. Okay. So, quarter productivity, annual productivity, half yearly productivity, they are all used for benchmarking purposes.

The second one is what we call as Dynamic productivity. Here the productivity P is we can say it as

$$P(1) = \frac{O(1)}{I(1)}$$

This is a particular, this 1 stands for at.

a time period t or P(2) is

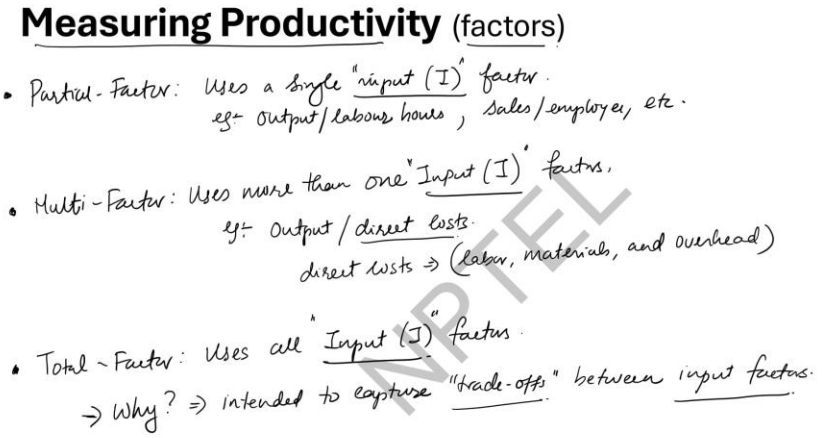
$$P(2) = \frac{O(2)}{I(2)}$$

So, then we can say is that

$$P(t) = \frac{O(t)}{I(t)}$$

So, this means this is focuses, captures, captures the changes in productivity, captures the changes in productivity between periods. So, here productivity is a dimensionless index that reflects the change in productivity between periods. So, we kind of use it at a particular time instant. Here it is for a given, you do not change the time, but this is for a very specific time instant.

So, when you have a huge collection of these, P1, P2, P3, P4, etc., you can actually measure between the P1 and P2 If you look into this, if you look into both P1 and P2, in that regard, you can see the difference, how this dimensionless quantity, captures the change in productivity for between the period 1 to period 2.



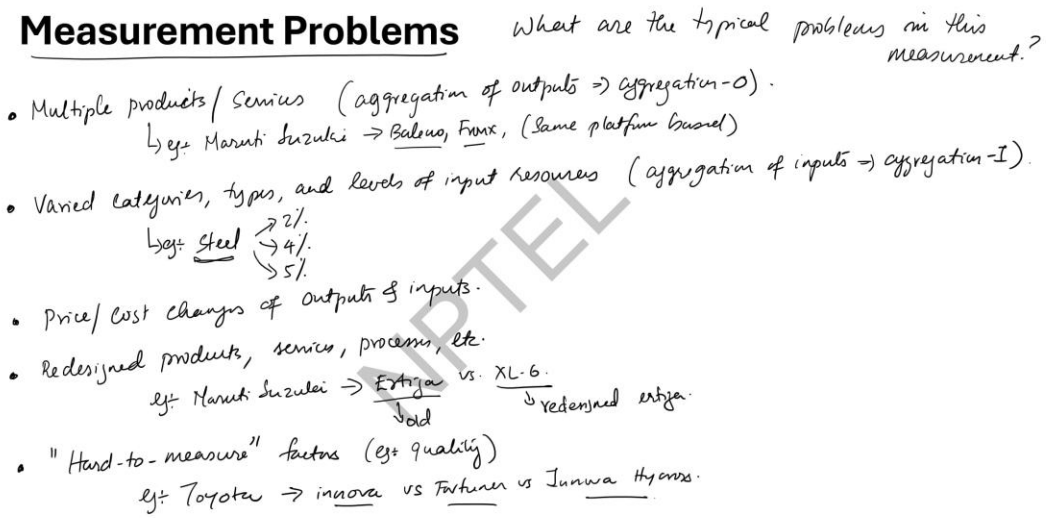
The second aspect of measuring productivity is on various factors. So, there is three main aspects to this. Number one is called as the Partial factor.

Partial factor which means uses a single “Input (I)” factor. So, the example of this is output divided by labor hours or sales by employee. etc. So, we use the output, but the input, we use a single input factor. The output is taken as such, but you use a single input factor. That is number 1. Number 2 is multi-factor uses more than one input factor.

Or you can call it as I. Okay. “Input (I)” Factors. Let's take an example of this. Output divided by direct costs. Okay. What is involved in direct costs? And here the aspect is direct costs. Okay. Implies labor, materials, and overhead. Okay. These three comprises the direct cost.

So, we have considered labor, materials, and overhead and combined them into a factor, a partial multi-factor called direct costs. Taking the ratio of the direct costs with the outputs will actually give you a multi-factor productivity. Then the third one is the Total factor. It uses all “Input (I)” factors. All input factors. So why is total factor productivity also used?

It is intended to capture trade-offs between input factors. So, the partial factors, you may not be able to find out the trade-offs between them. But if you want to capture the trade-offs, it means if one factor is growing big, the other factor may actually go negative again as said. So, wanting to find out the trade-offs between various input factors, then the total factor productivity is the most useful one.



So, those are the two important measurements we need to know for this course. There are other ways also to do it, but we are not spending too much time on that. Now, let's look at the measurement problems. When you measure this productivity, so the question here is, what are the typical problems? Problems in this measurement. This is the question that we are trying to find out. What are the typical problems in this measurement?

So, the number one issue, what we call it as the multiple products or services. When you have multiple products or services offered by the same organization, then one of the issues is you have aggregation of outputs, also known as aggregation. So, for example, l will give you a product example of this. Example, Maruti Suzuki has a car called Baleno and their car called Fronx and I think some other thing also. I do not know.

But both are same platform-based systems. With 80% of the parts exactly the same, engine, gearbox, all those kinds of things. Now, the problem is, since those two inputs that goes into Baleno and input that goes into Fronx are exactly the same, or majority of them are the same, because of these two multiple products, the Baleno and Fronx, the aggregation of the output happens, and you may not be able to separately segregate inputs, specifically. Second thing is, what we call as varied categories, Types and levels of input resources.

This is also known as aggregation of inputs. Aggregation of inputs, which is known as aggregation I. Let us look at an example of this. So, you may require, say steel, but you may have 2% carbon steel, you may have 4% carbon steel, 5% etc. So even though the material might be steel but different levels of it ends up aggregating or masking some of the issues associated with the productivity.

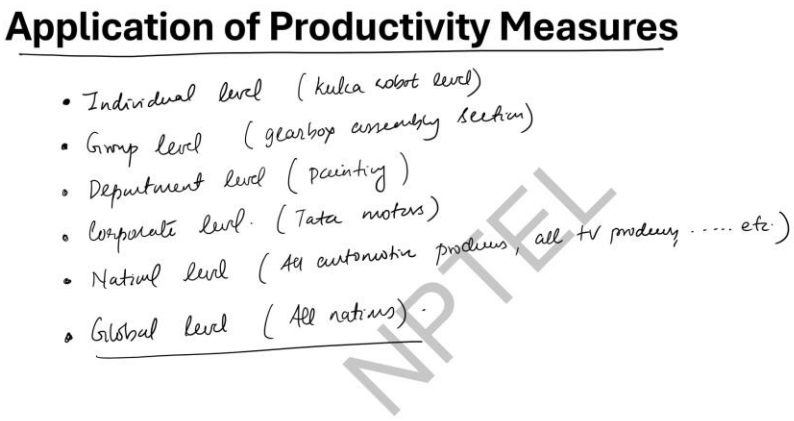
So, you may not know what actually happened. Sometimes you may find that the 4% steel is probably better. But because you are aggregating all of it, it actually becomes difficult. Then the third part is price or cost changes of outputs and inputs. In the process, so like for example, if you are making cement industry and the price of limestone, price of coke, etc. increased, then the productivity measure immediately changes because money, finance is also part of the input of the system.

So, the changes in the price of both outputs and inputs affect their productivity. Then comes something called as Redesigned products, services, processes, etc. When you redesign a product or a service, then this also causes a problem for this. Like an example is after an automotive industry. Here is an example. Maruti Suzuki.

Let's take a model of Ertiga versus XL6. Both are intrinsically the same platform and similar vehicle. But Ertiga is an old version and XL6 is a redesigned Ertiga. So, that causes lot of measurement problems again because you have now changed the product thing in a very difficult different way. Then comes what you call as the hard to measure factors.

Talking about hard to measure factors and there is an example of these are like what you call as qualities. So, people say it's yes. So, like you have the same, let's say, for example, is let's take Toyota as an example. Innova versus Fortuner versus Innova High Cross. So, these are three different products.

And you can say that if you ask people, what is the quality between them? Some people will say, oh, High Cross is the best quality, Fortuner follows that. Some people say, no, Fortuner is better than High Cross and Innova. So, something like this. But it will be very difficult to quantify and measure such kind of aspects. And I also mentioned that this redesign also sometimes changes considerably the quality and also the perceived quality of the product.



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Now, let's talk about how do you apply these productivity measures. And these productivity measures we are only talking because that's how we were quantifying the output of the system. So, it can be done in many ways. It can be measured at the individual level. We can talk about the productivity of an individual machine.

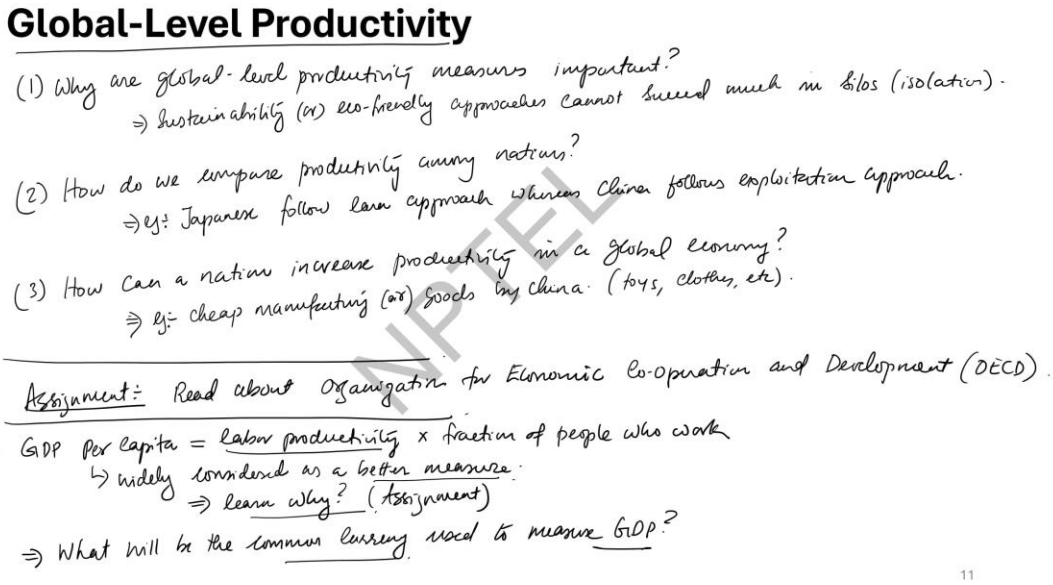
We can talk about a group level. We can talk about the productivity level of a group of lathe machines or drilling machines or something like that. Then we can talk about a department level. So, there are five painting booths and automotive vehicles are getting painted there. So, the entire productivity of the paint booth including the paint tub, drying, everything put together.

So, painting department level we can do. We can talk about the corporate level. So, an example is like, so that would be like a Tata Motors. So, let us take here as an example, let us take individual level, let us take it as a KUKA robot, okay, level. So, it is a one particular individual machine.

Let us say, take about a group level, we can say it as the gearbox assembly machine section. Okay. So, the group of machines that actually completes it. Department level, I said is the painting department. Corporate level we can talk about as for example is Tata Motors for this. Okay. So, you can see how it works. Then comes the national level.

National level will be all automotive producers. Similarly, all TV producers, etc. Okay. So, then there is all mobile phone producers. So, all of them put together. So, their entire producers in the national level go for the national level productivity.

Then comes what you call as the Global level. Okay. So, now all nations contribute to this. So, at the different level of productivity, we can measure and we can quantify where are we doing good, where are we doing bad. That kind of a thing can also be talked about.



Now let us take one step and this Global-Level Productivity. We need to take a quick look into it is, what this global level productivity and why is this global level productivity is of importance to us. And this is critical for us because there is an aspect to this. So, the first question here is why are global level productivity measures important? Because the thing is, lot of the time, one of the aspects is sustainability or what we call as eco-friendly approaches cannot succeed much in silos or isolation. So, for example, we as a country, India, works a lot on reducing carbon footprint and all those kinds of things.

And our neighbor, China, uses all resources and continues to pollute like crazy. If that happens, then the atmosphere is, the air doesn't make any distinction between China or India. It doesn't stop at the border. It flows across. So, the pollutants will definitely flow

across. And then the people of India will also face the consequences of the pollution created by China or vice versa.

So, the global level productivity is very important because if we want to drive sustainability, it cannot be done very well in silos. Number two, how do we compare productivity among nations? Okay. So, like for example, Japanese follow lean manufacturing, lean approach. Whereas, China follows exploitation approach. This is possible, right.

So, the lean approach is for the same output, reduce the input, whereas the China follows the reduce inputs, keep on increasing the outputs crazily, okay. That is the second aspect of this, okay. And then comes the third part, So, third one is, how can a nation increase productivity in a global economy? Like example of this is the cheap manufacturing or goods by China.

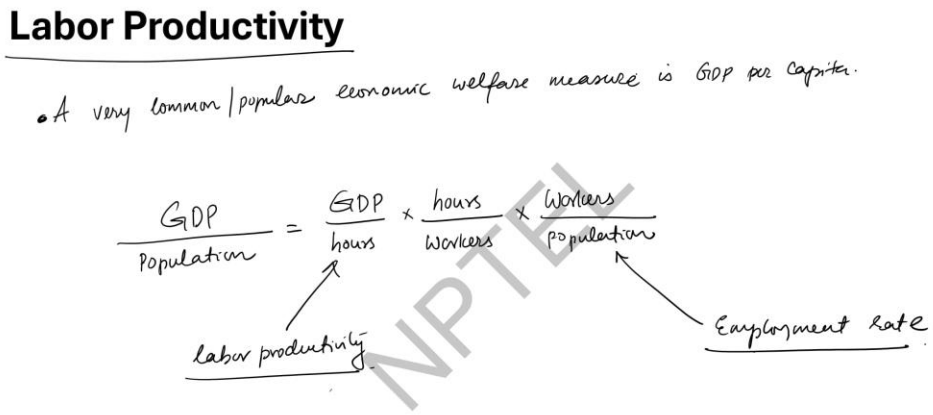
So, China started like, let's say toys, clothes, etc. So, China started making cheap mobile, cheap toys, cheap clothes, etc. which they flooded the market and then they captured the major share of the global economy. So, by driving productivity of an individual nation, it can actually impact the global economy. That's one aspect. So, these are the three major aspects of global level productivity. So, there is something that, so an assignment, okay, that is Read About

Organization for Economic Cooperation and Development Read about OECD. This is one of the assignments that you guys have to do as part of it. Then there is one more thing that we need to learn here is something called GDP per capita, which means it is given by, it's equal to labor productivity multiplied by fraction of people who work. People who work this is widely considered as a better measure, okay. The question you want to find out is learn why? So, this is your part of your assignment. GDP per capita, which is actually a product of labor productivity multiplied by the fraction of people who work.

So, the labor is producing on an average 10 cars a day and 20% of the population is working, then you can do that. The per capita is labor productivity multiplied by fraction of people who work. It is widely considered as a better measure and why it is so, that is something that you need to. So, what will be the common currency used to measure GDP. That's also something that you may need to think about.

Because when we talk about carbon footprint, it is something we will use carbon dioxide as a reference point. So, in case of GDP, what is the common currency or common

benchmark that we use? So that you need to understand. So then if that's the case, let us also talk about this thing, this word that I used, 'Labor productivity' quickly, so that you don't feel confused.

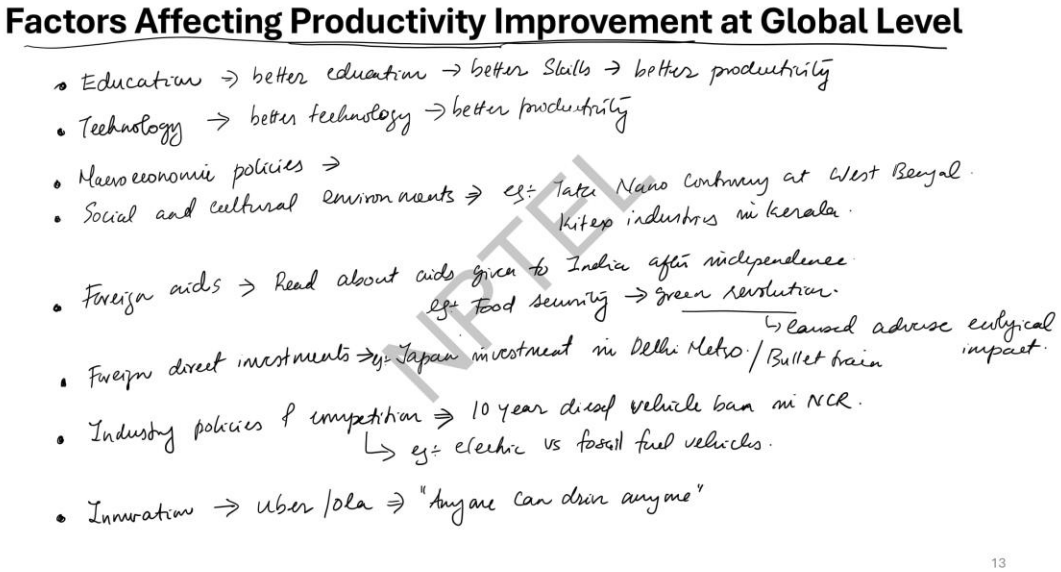


So, as I said, a very common or popular economic welfare measure is GDP per capita. I mentioned this earlier. It's very popular, right. And the question is that, you know, why is it widely considered? And the labor productivity is, so GDP per capita is given by

$$\frac{GDP}{Population} = \frac{GDP}{hours} \times \frac{hours}{workers} \times \frac{workers}{population}$$

So, $\frac{GDP}{Hourds}$ is a factor that you can call as labor productivity. Okay. So, this is something that you need to understand. And $\frac{Workers}{Population}$ is also another name for it. It is called as employment rate.

Okay, so now you know or now you have a clue of the GDP per capita, how labor productivity and employment rate are also factors or giving you indicators of how the GDP per capita can be measured as a function of labor productivity and employment rate.



Now, we'll talk about this quickly, Factors Affecting the Productivity Improvement at Global Level. Since we are talking about global level productivity, we will now talk about what are the major factors that influence the productivity improvement at the global level. So, number one, that is Education. Okay.

So, the logic is that better education translates to better skills translates to better productivity. This is the belief normally. Then one is technology. Okay. And means better technology, better productivity. Okay, this is the second part, second assumption. Then you have macroeconomic policies.

Okay, so like this will drive things to a certain point. Like an example of it is, so many of the organizations like to build their new factories in a special economic zone. Because you are taking advantage of the tax policy or reduced taxes in that area. So that kind of things. So that drives where are you going to do other kind of things.

Then social and cultural environments. Okay. So, sometimes, society, so, like at some point of time, I'll give an example of the Tata Nano controversy at West Bengal. Okay which was associated with the then current regime in West Bengal. Similarly, you can read these Kitex Industries in kerala, okay. So, these are two quick things that you can read about and find what happens. Then comes something called Foreign Aid, when you get foreign aid sometimes, that also drives how some of the productivity and things can

be improved. So foreign aid earlier when in india, when we after independence read about AIDS given to India after independence. Okay. Main example is food security or Green Revolution. Okay. So, Green Revolution was attempt where the foreign aid was given for fertilizers, high yielding varieties of seeds, pesticides and increase the productivity by farming acre of land so that we can actually reduce the or so that the large population can be fed.

But then the green revolution also now have caused adverse ecological impacts. Like use of pesticides, herbicides, weedicides, excessive fertilizers, etc., have destroyed the soil. So sometimes aids will also even though yes, we achieved, improved the agricultural productivity but we impacted the society or the ecology foreign direct investments Okay. How FDI is shaped on this. So, the Japan investment in Delhi Metro. An example. Okay. Japan investment in Delhi Metro. Okay. You can talk about the same, read about the high-speed train, the bullet train also. Delhi Metro, a bullet train.

This will give you an idea how foreign direct investment actually affect productivity improvement. Then industry policies and competition. Okay. So, there is an example of this. The 10-year diesel vehicle ban is an example. In NCR, how this National Capital Region, how 10-year diesel vehicle ban this in the policy that actually come into picture has affected the productivity of various organization. Then the competition like one example of competition is another example, you can think about electric vehicles versus fossil fuel vehicles

So that's another example, things that you can read about. Then comes what we call as the innovation. So, innovation is like an example of it is Uber, Ola, where the innovation there is anyone can drive anyone around. Okay. So, we may have business model innovation, societal innovation. We will talk about this in the FAG end of this course.

But the idea is that innovation can also change the productivity associated with these kinds of systems. So, with this, we will stop this particular session here. And we will continue the last part of this productivity related things in the next lecture. And with that, we will complete this and then we will move towards the sustainable and carbon credit aspects of it.

Thank you very much.