Carbon Accounting and Sustainable Designs in Product Lifecycle Management

Prof. Deepu Philip
Department of Management Sciences

Dr. Amandeep Singh Oberoi
Imagineering Laboratory

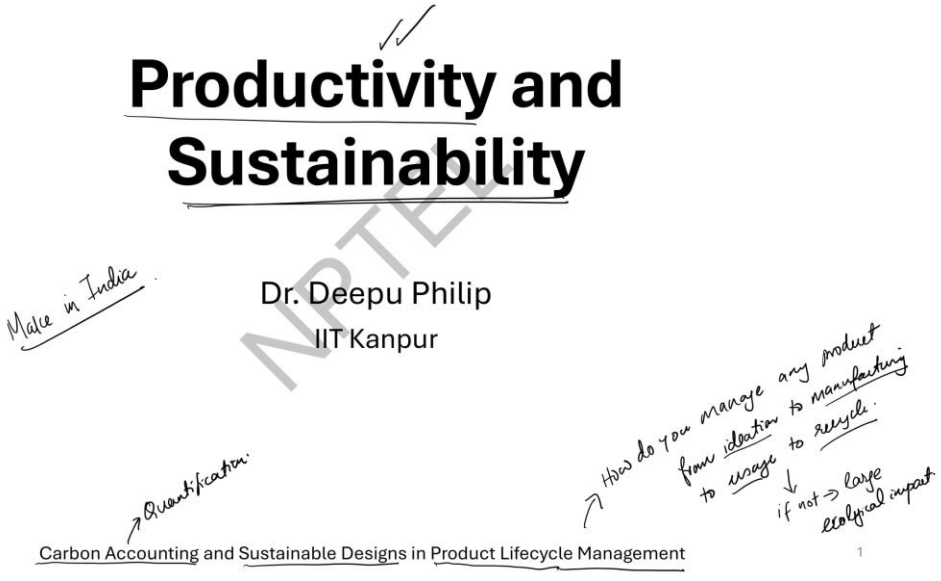
Dr. Prabal Pratap Singh
Department of Management Sciences

Indian Institute of Technology, Kanpur

Week 01

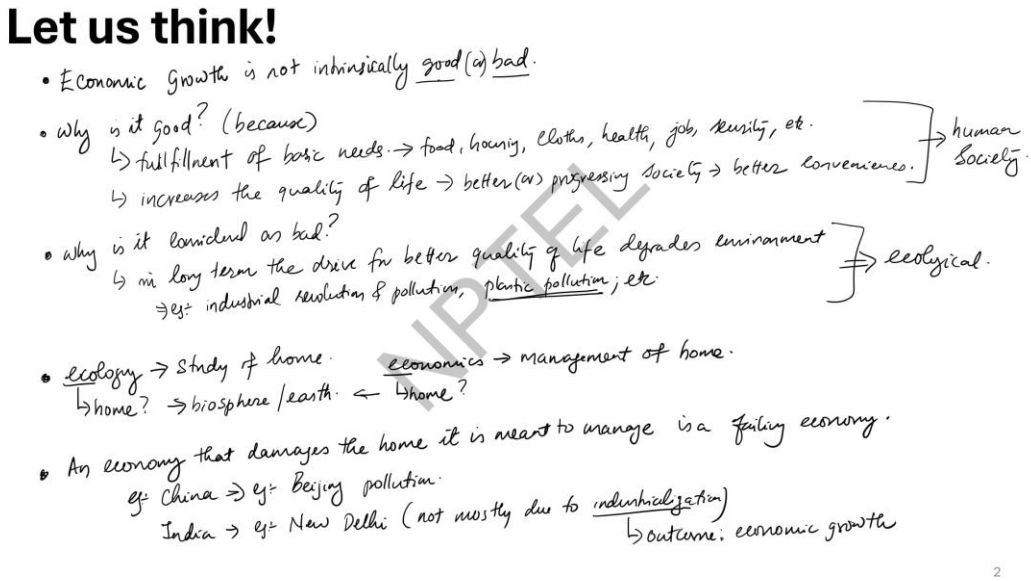
Lecture1
Productivity and Sustainability

Good afternoon, everyone. Welcome to the first lecture of the MOOCs course, Carbon Accounting and Sustainable Designs for Product Lifecycle Management. It is a very diverse course. You might have seen the introduction and multiple people are teaching this course together. One of the key aspects in India, as of now, we are all working on is something called Make in India.



Or what we call as Atmanirbar Bharat. We are working more towards producing or becoming a manufacturing powerhouse. So, when you do that, one of the key aspects of that is product lifecycle management. How do you manage any product from ideation to manufacturing to usage to recycle, okay? So, this aspect is very critical when you are actually doing because otherwise what you will do is if not, we will cause large ecological impact. So, anybody who is looking into productivity or manufacturing, we need to now understand the climate change and specifically, how to do sustainable designs. So that you can understand this entire from ideation to manufacturing to usage to recycle aspects can be done sustainably with minimal ecological impact.

And one way to do it is, how do you quantify it? This is a quantification. Quantification of the sustainability is the carbon accounting. So today we are going to look at the first aspect of it, which is called as Productivity.



So, let's think about this. So, the first point that everybody need to understand, the most important point is economic growth. Economic growth is not intrinsically good or bad.

Because most of the time people say, if you talk to the people who are following the left ideology and other things, they say economic growth, when you're looking, pushing towards capitalism and all those kinds of things, it may be a bad thing. But when you

look at the capitalistic kind of ideology, people say that economic growth is actually a good thing. In our case, we have to look at both aspects, the positive and negative aspects. So, let's say, why is it good? It is good because the reasons for it.

Because it allows for fulfillment of basic needs. So, this allows for you can think about food, housing, clothes, health, then job security, a lot of things, etc. as part of it, right. Most of these things, the economic growth allows you to easily accomplish this. It increases the quality of life. Okay. So, when you have a better society or better or progressing society, then you will have better. So, your standard of living goes up.

You will have better houses, air conditioning, electricity. All those additional new conveniences comes as part of it. Then, why is it considered as bad? This is the other part we need to think about it. So, the good aspects we talk about it is mostly, you know, human society. So, we look explicitly at the human aspect of it. Some people, they say it is bad because in long term, the drive for better quality of life degrades environment.

So, people say that an example of this will be industrial revolution and pollution, okay, plastic pollution. So, for example, plastic, etc. Plastic bottles are very convenient for us to carry water. So, I have like a plastic bottle, right. Here where I am bringing water out of it. And it's very easy, very convenient, lightweight. But the thing is, once you have the plastic bottles, the question is, after you use the bottle, you throw it someplace and it doesn't degrade very well.

And it stays in the environment and it actually pollutes it. So, a lot of the aspects that comes out of it, it is ecological. Out of the arguments that goes against the economic growth is the ecological impact. So, let's look at what is this ecology. So eco implies home. The word eco means home.

And ecology means the study of home. So, if you think about the word economics... Okay. Eco, as I said again, it is home. Okay. So, if you look at the economics as a word, then we can think about it as management of home. Okay. So, when you talk about it is, in our home, when we say what is this home?

This home is the biosphere or earth. The place, the planet in which we live in. Okay. So that is the biosphere aspect or the earth that we talk about. So, if we do development or economic growth without considering the earth, then they say that is intrinsically bad. So, one of the ways you can think about is, one of the key other points that you need to think

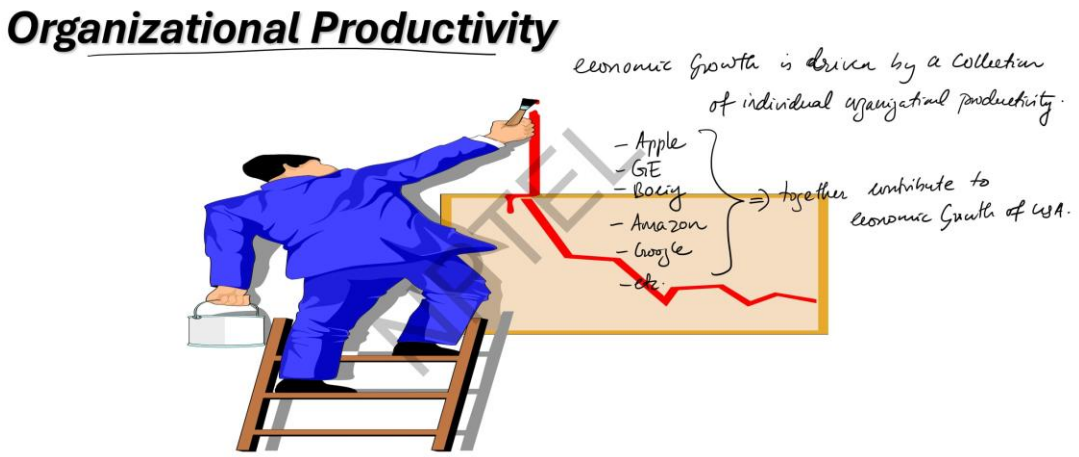
about it is, an economy that damages the home, it is meant to manage is a failing economy.

So, for example, people talk about China being growing and all those kinds of things and China drives a lot of their economic growth. So, I can give an example of iChina. Example, Beijing pollution. So, yes, they have a lot of construction, a lot of manufacturing, etc. But the outcome of all of those, the pollution associated with this is also extremely huge. And because of that pollution, their economy or the quality of life, people are getting asthma and other diseases.

Another example we can talk about it is India, where an example is New Delhi. But this is not mostly due to industrialization. There are other reasons for it. Whereas Beijing or Chinese, most of the pollution are due to industrialization. And when you say industrialization, we are the main aspects, main outcome is economic growth.

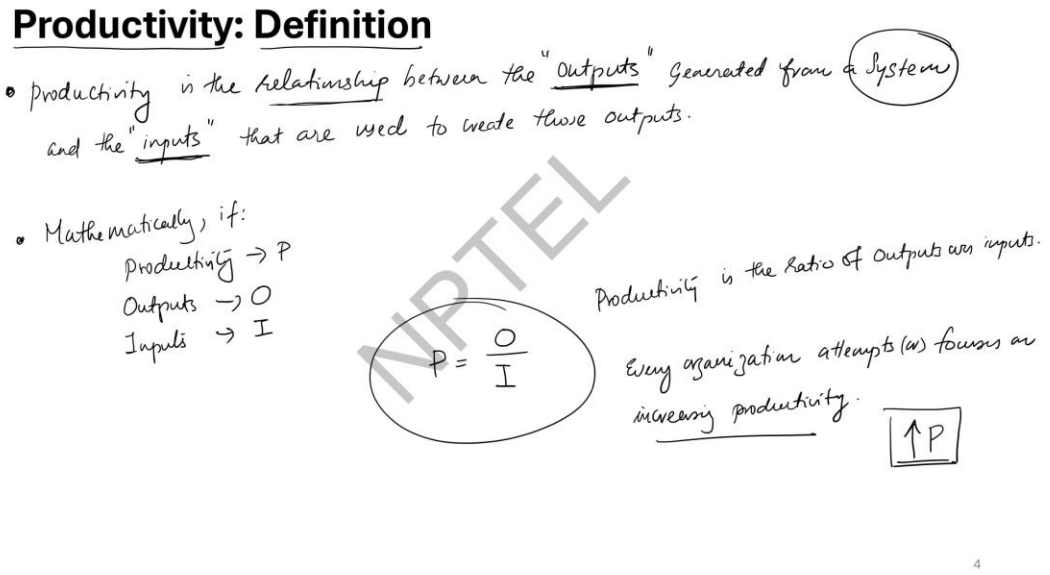
So, industrialization in itself has driven the economic growth too. A lot of people associate both of them as synonyms also. So, this is the premises for us to start our thinking process. And we talk about the economic growth aspect. And we also looked at the good and the bad aspects of it.

And we studied what is ecology and economics. And why economy that damages the home. Or the biosphere, we can think about as a failing economy.



So, let's start with a concept called the Economic growth. One of the main aspects of it is Organizational productivity. So, economic growth is driven by a collection of individual organizational productivity. Okay. So, for example, if you take like United States, they have very large organizations like Boeing, then they have Google, Cisco, Amazon, so many large, Apple, many large organizations, General Electric. So, all of them, so, like, let's say, for example, Apple, GE, Boeing, then we have what you call as Amazon, Google, there are so many, etc., organizations.

Each one of them will together contribute to economic growth of USA. Same way, in India, we can say Tata, Lallan, Bajaj all those companies together. So, the individual organizations that are in the manufacturing services that sector, they grow individually through productivity and they grow the economy also grow along with it so if that is the case let us define this productivity for this course.



How do we define productivity? Okay. And this is very important. So, we are going to define productivity is the relationship between the outputs. Okay. Outputs. That is the first keyword. Outputs generated from a system and the inputs that are used to create those outputs. So, the most important thing that you need to know is productivity, it's actually a relationship.

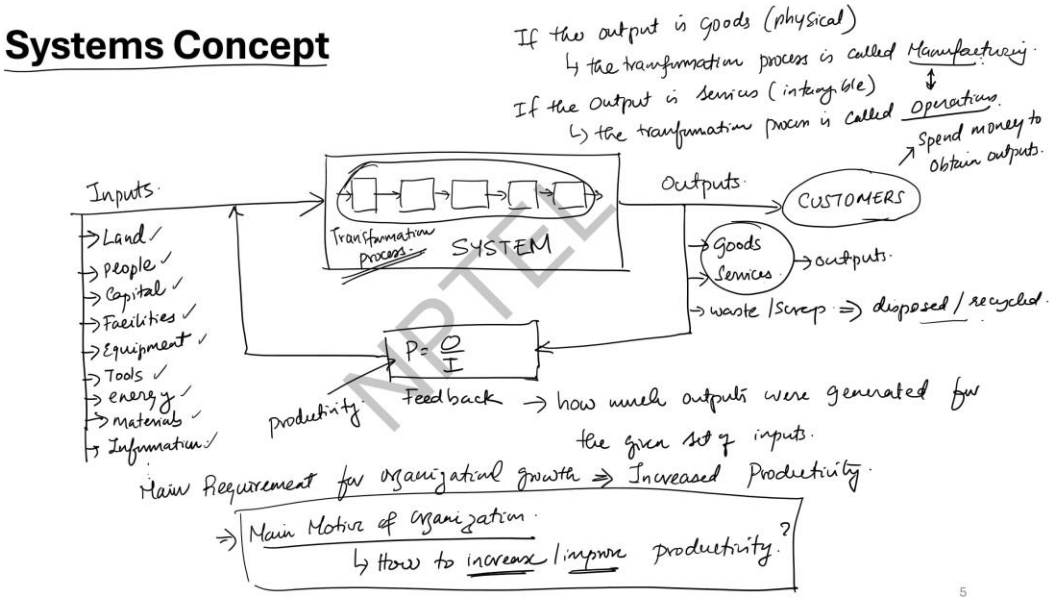
It establishes a relationship between the outputs generated from a system. So, system is there that is generating outputs and that outputs require certain inputs. And so, the

productivity actually relates both of them. So, in another way to think about is mathematically, if productivity is denoted by P, outputs are denoted by O, capital O, inputs are denoted by capital I, then

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

So, the productivity is the ratio of outputs over inputs. So, if you are producing inputs of 100 units and you are getting outputs of 100 units, then your productivity is 100%, okay or productivity is 1. So, this is the most important relationship, okay, and every organization attempts or focuses on increasing productivity. Okay. The primary goal, primary goal of any organization is, do this to productivity, increase the productivity, grow. That is the primary idea.

So, people are interested in doing this, increasing the productivity. So, I just wanted to show you that part. But here is one keyword that we have not discussed quickly here, is a system. So, what is the system that we need to now look into?



So, the systems concept, when it comes to the productivity angle. So, what is a system here? So, I am going to say that this box is the, for me, is the system. Okay. Let us take this as a box to begin with. And to this box, we have inputs. Okay. And from the box, you get outputs. Okay.

And the output goes to let's use a circle here, Customers. Okay. So, people buy these outputs and they use it. Okay. And the customers pay money. They. So, you can say that. Spend. Money. To. Obtain. Outputs. And what are the outputs?

Outputs can be goods or services. These are the outputs. Outputs that the customer is interested in. There could be outputs like waste also, which the customer is not interested in. What are the inputs as part of this?

Let's put the inputs here. One input is land, people, then capital or money, then facilities or factories, then you have equipment or machinery, you have tools. Then you have energy, electricity, water, whatever it is, materials, information, methodology, etc. So, there are inputs like this. These inputs goes into the system, comes out in the form of goods or services.

So, within the system, I am going to say there is something that happens here. It goes through different steps, okay, comes out this thing, you can call it as transformation process. So, the system has a transformation process which takes the inputs, converts it into outputs. So, and if the output is goods, which means they are physical goods, if so, the transformation process is called manufacturing. So, if you are, the output out of the transformation process is goods, physical goods, then it is called manufacturing. If the output is services, then you can think about as intangible, like healthcare, banking, etc.

The transformation process is called operations. Okay. So, people now use it interchangeably. People sometimes use this both ways. But strictly in the oldest sense, this is what we call as the, so if it is goods, it is manufacturing. If it is services, it is called operations.

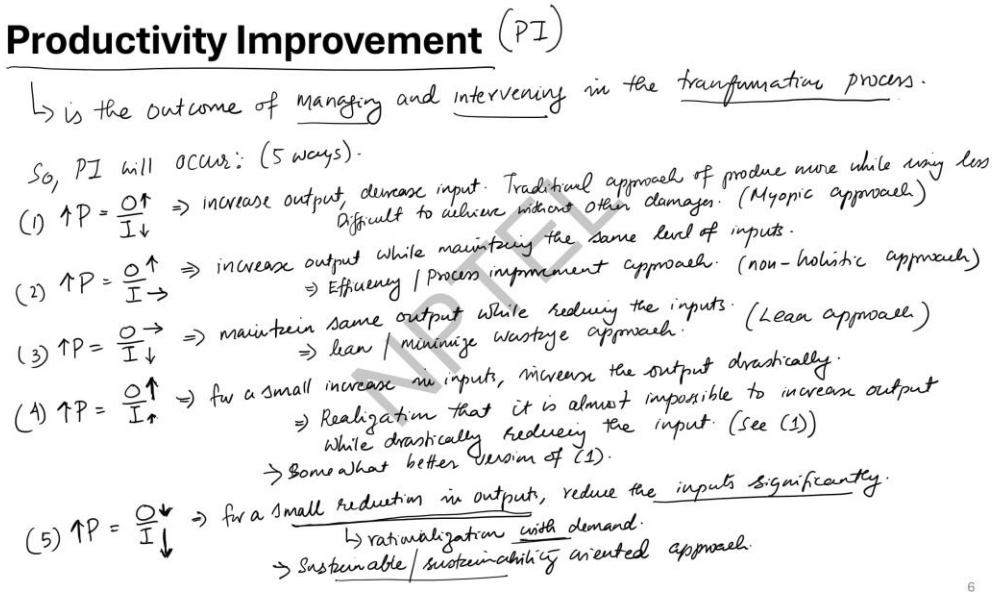
Anyway, once the outputs comes into picture, we need to connect between the inputs and the outputs. So, what we have usually here is called as the, comes back this way, this way. This is what we call as the feedback. Okay. And how do you measure the feedback? That is your productivity. The feedback occurs mostly in the form of productivity.

How much outputs? So, here is how much outputs were generated for the given set of inputs. So, one other thing I missed it, out of this, waste also comes in waste scrap, these are also part of it but they are usually disposed or recycled whatever it is, okay. So, this is the systems approach of it. You have a system which has a transformation process that transforms inputs to outputs. Outputs can be the goods or services.

If it is goods, it's called manufacturing. If it is services, it's called operation. Inputs are land, people, capital, facilities, equipment, tools, energy, materials, information, etc. All of them are used through the transformation process. We create goods or services and waste also.

Waste gets either disposed or recycled. And the feedback of this between the thing that connects the outputs to the inputs is the productivity, which is the ratio of outputs over inputs. This is the productivity. So, I think now we understand the systems concept and how productivity is useful in such scenario. Now that we have seen productivity is part of the feedback.

So, for an organization, the requirement is for organizational growth. Growth, The primary requirement. Okay. The main requirement for the organizational growth is Increased productivity. Okay. And the question then is organization, the main motive of the organization is how to increase or improve productivity This is the fundamental question that the organizations use to drive their agenda is how do you increase or improve the productivity.



So, let us talk about Productivity Improvement. So, the word productivity improvement is usually known as PI, the abbreviated as PI. So, it is the productivity improvement is the outcome of managing and intervening in the transformation process. So, you are going to

intervene, you are either going to manage or intervene the switch process, the transformation process. This is the process that you are going to intervene. So, pi will occur okay there are few ways the PI can occur actually there is five ways it can occur, okay, five ways. Number one, productivity will increase if we do this. Okay. Increase the output, decrease the input.

This means increase output, decrease input. Okay. This is the traditional approach. It's known as the traditional approach. Okay. Drive productivity, produce more while using less inputs. This is usually easy to say, but very difficult to achieve.

Difficult to achieve without other damages. So, an example of this is one way to improve productivity would be I have some waste after the production and I just don't dispose it properly, I just throw it into the river, so my cost of waste disposal significantly reduces which will improve my productivity but it will damage the environment without other damages. So, an example of this is one way to improve productivity would be, I have some waste after the production and I just don't dispose it properly, I just throw it into the river. So, my cost of waste disposal significantly reduces which will improve my productivity but it will damage the environment. So, this traditional approach, sometimes lot of people call it as also a myopic approach. So, this is also known as myopic (short-sighted approach). Even though everybody attempts for this, this is the most popular one.

The second approach, what is the second way you can do this? You can increase your productivity. Again, productivity is a ratio of output over input. You can increase productivity by if you increase the output while maintaining the inputs at the same level. If you increase the output while maintaining the inputs at the same level.

So, that is increase output while maintaining the same level of inputs. Okay. So, this is what we call as lot of the time, this is a different version of it. The inputs you are not increasing, but the outputs you are increasing. So, this is what we call as the efficiency or process improvement approach. Okay. So, while the inputs remain the same, you produce more for the same level of inputs.

So, people call it as process re-engineering, process improvement, that kind of aspects are part of this. This is not that myopic like the previous one because you are at least maintaining the same level of inputs. But the outputs you are driving, so this is also still not very holistic. So, this is also a non-holistic approach. Then comes the third approach.

Again, productivity is the ratio of outputs over inputs. Okay. And you can increase your productivity if you do the second aspect of it. Maintain the same level of outputs while reduce the inputs. Which means maintain same output while reducing the inputs, this is lot more known as the lean or no minimize wastage approach so some people call it as the lean manufacturing this is again Focuses on maintaining the same level of output.

It's better compared to the other one. But the idea is that still, you are not rationalizing the output. Whether the output is actually necessary or not. So, this is you can think about more about it as the lean manufacturing. That kind of things are part of this.

Then comes the fourth one. You have the productivity. And one way to do it is. The output over inputs. You can increase the productivity.

Where what you do is you increase the output. Okay. The output is increased. While you are increasing the input slowly. Okay. So, for a small increase in Inputs, increase the output drastically. So here what it was like a realization that it is almost impossible to increase output while drastically reducing the input. So, the first, okay, so I will say C1.

Our first approach focuses on increasing the output while reducing the input. When people realize that it's almost impossible to do it, then the thing was increase it slightly while increasing the output drastically. So, it's a somewhat better version of 1. So, these are the four main approaches. Then comes the fifth approach where your productivity again is a ratio of outputs over inputs. And you are asked to increase the productivity.

And what happens is, you are asked, what you do is, you slightly reduce the outputs, while you drastically reduce the inputs. So, you can say that, for a small reduction in outputs, reduce the inputs significantly. So, the one small deduction of output aspect is also known as Rationalization with demand. Don't produce too much, only rationalize it with demand. And when you rationalize the demand, then you know that you are not overproducing.

Then for that, you reduce the inputs. So, this kind of approach is known as somewhat like, it's more called as sustainable or sustainability oriented. Here you are not overproducing, you are not just producing for the sake of producing, but you are actually producing it, you are rationalizing it with the demand. And once you rationalize it with the demand, then you, for that output, you reduce the inputs significantly. So, that your requirements of raw materials, energy, tools, equipment, etc. are significantly reduced.

So, this is what we call as the productivity improvement aspect of it. So, now let us also talk about how many ways you can measure productivity. So, before we get into this, also I need you guys to quickly recap that productivity which is aspect of the feedback, which actually measures how effective your transformation process is happening. And so, this intervention, this managing and intervening in the transformation process is done by any one of these five strategies. Now, once we identify which strategy we are going to intervene, then we move towards the how do you measure it.

The next one is which strategy is more effective or which one actually suits you better? That is part of the next set of things. How do you measure productivity? And there are different angles to it. We will start that.

We will continue with the lecture in the next section. Thank you for your patient hearing. Bye.