

Introduction to Lean Construction
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Module 1, Lecture 04

Outline, Planning and Monitoring levels; Productivity Measurement System

Good afternoon, everyone. Welcome to this session, which is the second session on productivity and productivity measurement. And here we will go a little more detail into productivity measurement.

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Session 04 Outline

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Introduction to Lean Construction: Module 1 - Lean Basics - Session 04 - Productivity Measurement System (PMS)

So here is the outline. We will initially talk about project planning and productivity systems, the broad context, we will get a little detail into the productivity measurement system and the components, then we will look at what are the inputs and the monitoring options. Basically, what goes into the productivity measurement system, and what are the options we have for monitoring productivity.

We will go to performance factors and forecasting, and finally we will look at factors that influence productivity, and what can we do to address productivity improvement at, from their productivity, strictly from a productivity and project performance perspective and then we will broadly discuss how it fits in the lean context.

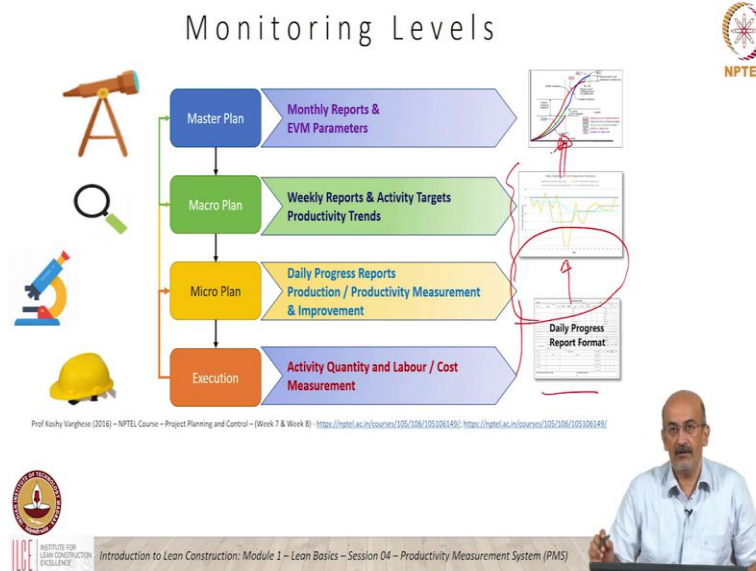
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Now, I think we are familiar with this graphic. Basically, what the shows is the different levels of planning. We have the master plan, the macro plan, micro plan and the execution. And we are familiar with the different documents that are related to each of these stages.

For example, when the, we have the major milestone stage typically shown as a Gantt chart or a bar chart. We have the CPM stage which we associate with a macro plan, and we look at, from a timeline we look at quarterly planning and in the master plan or broader, monthly at the macro plan level, weekly at the micro plan level and going to a daily plan at the execution level. So, this is when we look at the planning stages.

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And when we actually move on to the monitoring stages, we have the similar framework but now the information flows in the reverse. We have what happens in execution through daily progress report, it is reported to the planning team to the next level and from there it goes to the macro plan level where we have different other kinds of report. We will get into this briefly. And finally, to the master plan level we have project level reporting.

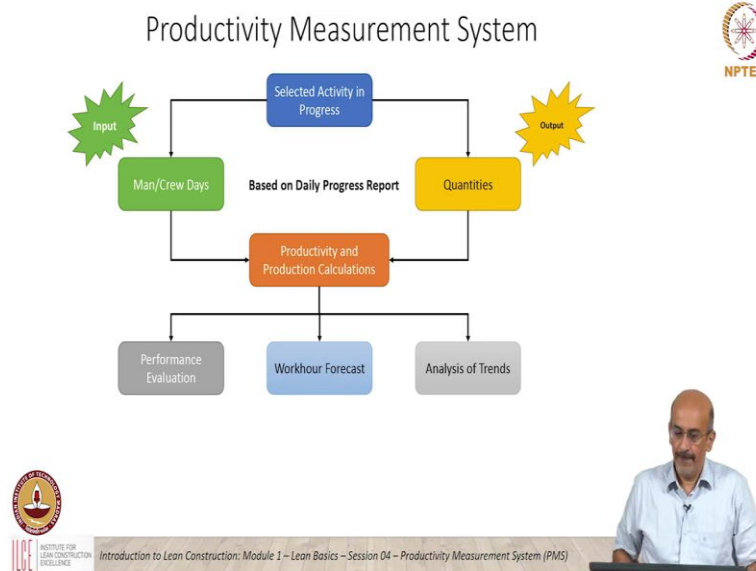
So, as you can see here, at the base level it is a daily progress report which reports basically from what is happening at the workplace to the planning team, and also to the site planning as well as the project planning team. From here we generate all periodic reports.

So once, this is raw data and translating this into this reporting format becomes important because this is the base level monitoring that takes place. And now, through these reports we are able to get more micro level control on the project, which is important. Now, from here we go from using the data from these reports, you go back into the CPM and generate the more, the macro and the project level reports which are required for project control.

The focus of what we are doing today and in our context is more in this phase. What is happening at the micro level, how are we monitoring productivity on a weekly basis, or on a daily basis, on a monthly basis, and how are we monitoring production on these

same time frames, and this obviously, only if we have that level of control we can ultimately control the project.

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So, if we look at the productivity measurement system the whole lecture today focuses basically on this framework. What we have is different elements of what is a conventional productivity measurement system. And what we are going to do is take each of these elements in detail and discuss it, and show the kind of calculations, the kind of reports that can be generated.

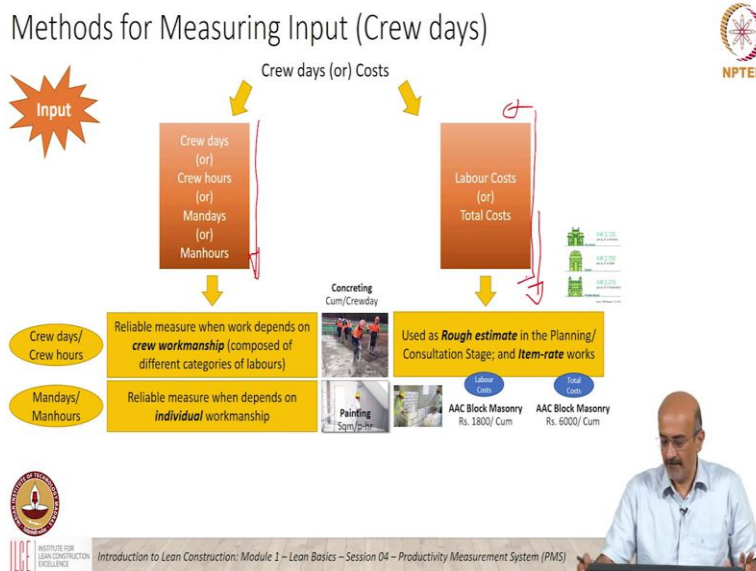
Now, there is a lot of numerical calculations and numerical dealings in this session. It might, you might have to actually review the session offline as well as go through the supplementary material to understand the calculation details. So, in this lecture session we will go through the conceptual details and illustrate the concept through what calculations take place, but definitely some offline work is required to get into the detail of the computations and to be able to understand it from a very fundamental perspective.

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So, if we go into, when we look at, we are looking at, interested in productivity or production, so if we look at the basic calculations we see there are two inputs as we covered earlier. We have the, the man days, or labor cost, or crew days or the total cost input, which is, we take it as input, and then the output which is the quantity of material. And we have covered earlier how both of these kinds of are, are the components of productivity as well as production.

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Now, as we go to looking at the input side of things, if we look at how do we get input, we have many alternatives as we had discussed in the last class. We have crew days, crew hours, man days, man hour or we have labor cost or total cost, and which one to use actually depends on the activity, and the kind of monitoring and control which you have planned for your project.

The reason, we have discussed this in the last lecture to some extent but I am just reemphasizing again here, a lot of times when you are looking at monitoring requirements it is adequate to use the crew day, crew hours, man day or man hours depending on the type of activity and your monitoring requirement.

This does not give you your accurate, what you say, control of costs and time to the, from a documentation and a reporting standpoint, but it gives you enough information from a monitoring and control standpoint. So, later on when you are doing your project documentation and billing requirements you will definitely want to go to the total cost side of it, but for a monitoring and a daily, weekly perspective the man days or the crew hours is the best metric and this is globally been found, and it is also very good metric because this is typically what we call the variable component of a project. This is the highly variable component.

So, if we understand the variability that is happening here and are able to somewhere control it, we have a better chance of getting a more, what do you say, stricter control on the project. So, as it is written here, whether we want to do crew days or man hours it just depends on the type of project, on the type of activity and the type of work that is going on and the diversity of crew in a particular activity. And when we use costs, we definitely have more work to do, more computations to do, but in terms of recording and documentation this is what is required from an accounting perspective.

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Data Collection Formats

The form is titled 'PROJECT DATA' and includes sections for 'PROJECT NAME', 'PROJECT LOCATION', 'PROJECT #', 'DATE', 'MATERIALS AND EQUIPMENT', and 'SITE'. Below these are columns for 'TRADE', 'PERSONS', 'START TIME', and 'STOP TIME'. A list of trades is provided, including 'GENERAL LABORER', 'IRONWORKER', 'CONCRETE FINISHER', 'CONCRETE FORMWORKER', 'CONCRETE REINFORCER', 'CONCRETE CURER', 'CONCRETE PUMP OPERATOR', 'CONCRETE PUMP DRIVER', 'CONCRETE PUMP ATTENDANT', 'CONCRETE PUMP OPERATOR', 'CONCRETE PUMP DRIVER', 'CONCRETE PUMP ATTENDANT', 'CONCRETE PUMP OPERATOR', 'CONCRETE PUMP DRIVER', 'CONCRETE PUMP ATTENDANT'. The form is filled with red lines indicating data entry.

The digital form is titled 'Daily Report' and includes fields for 'Project Name', 'Date', 'Project #', 'Trade', 'Work Performed', 'Persons', and 'Hours'. A table below these fields is used for data entry. The interface includes a keyboard and navigation buttons.



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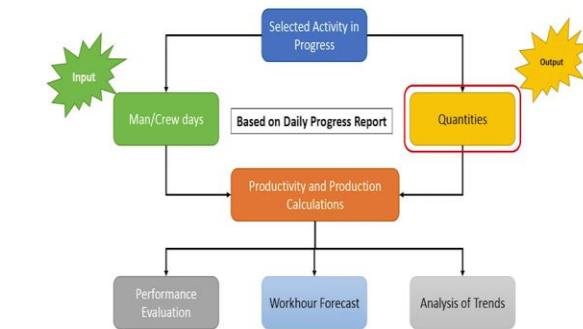
Now, as we go in further into data collection, at the inputs there are several formats that are used on sites, whether you can see in the format here, it talks about the different trades, the number of workers that are there, the total number of hours, the area in which people worked. So, this is a way in which you can get man hours or crew hours or who, how much time was spent, what the input was there.

In a more different format this is, you can see, it is a tablet or a smartphone format, you can see there is, again, the type of trade that is used, the work performed, the number of people, the number of hours spent. So again, these are all forms in which you can get inputs, and the worker hours that have been spent on different activities.

These can be, today you can have forms like this, might be in the future these can be in a more automated form, or the people recognize who is in which area and doing what work but all these ultimately get you to collecting the input required for the activity of the project.

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Productivity Measurement System (PMS)



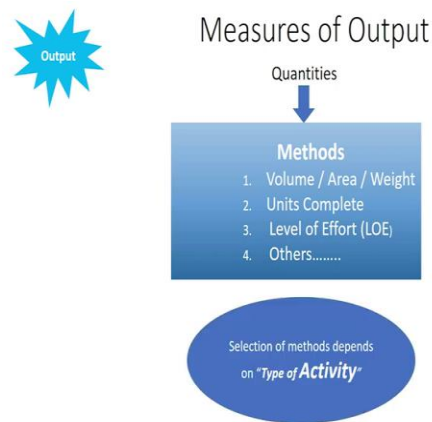
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Next, we go on to the output which is the quantities. Again, this should seem to be simple to be able to calculate quantities of a work but there are its own complexities.

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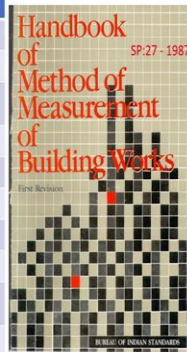
So, if you look at different, there are different methods to calculate outputs, whether it is volume, area, weight, units complete, level of effort which we will cover in a little bit of detail, and there are other units which you might want to use, but again, it depends on the type of activity.

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Measurement Units for Construction Activities

Activity	Unit(s)
Earthwork	Cubic metres ✓
Foundations	Running metre, Square metre, Cubic metre
Concrete works	Cubic metre, Square metre, running metre or numbers (precast components - beams unit and columns, trusses)
Brickwork	Cubic metre, Square metre
Stone Masonry	Cubic metre, Square metre
Formwork	Square metre
Woodwork and Joinery	Square metre
Steelwork and Ironwork	Weight in kgs, Running metre, Square metre
Hardware	Running metre (material, finish, size, pattern and method of fixing)
Glazing	Square metre stating the thickness

(Above unit is recommended unless otherwise mentioned as per SP 27 - 1987)



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So, here is an example. This is from a Bureau of Indian Standards handbook which talks about various types of activities or which specifies and the type of units to be used for measurement. So, you can see that you have here, we have volume, we have running meters, we have area, we have, again, volume, we have weight in kilograms, we have numbers or units of measurement for precast components.

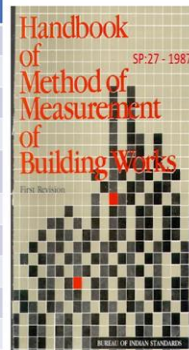
So, the type of unit you use, again, in for example, in a similar work like steel and iron you have not only weight but you have running meter and square meter. So, one has to be fairly judicious in selecting the kind of unit based on activity and consistent with it across in your project. So, this inconsistency can mean that your output measurement is wrong, and if your output measurement is wrong your productivity measurement system or all the other systems can be faulty. So, this is extremely important.

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Measurement Units for Construction Activities

Activity	Unit(s)
Paving, Floor finishes, Dado and Skirting	Square metre
Roof Covering	Square metre
Ceiling and Lining	Square metre
Plastering and Pointing	Square metre, Running metre
Whitewashing, Colour washing, Distemping and other finishes	Square metre
Painting, Polishing, Varnishing, etc.	Square metre
Demolition and Dismantling	Running metre, Cubic metre, Kgs
Waster Supply, Plumbing and Drains	Running metre
Water and Sewer lines	Running metre
Roadwork including airfield pavement	Square metre

(Above unit is recommended unless otherwise mentioned)



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And here is another slide, again, that shows the various types of units that can be used for conventional construction activities. This is, as it is, as you can see it is a Bureau of Indian Standards handbook, so this is fairly standard practice, but has to be implemented on a project, standardized and be consistent.

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Measuring Output - Level of Effort (LOE)

Activities having several sub-tasks contributing to final output

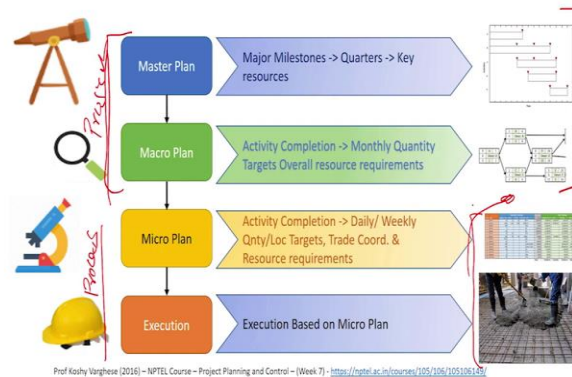
- Effort is required at each of the sub-tasks
- Measuring Output as Units complete can be misleading!!



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Planning Levels



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Now, let me stop with this. At this stage, is there any questions on what we covered so far? It was basic inputs and outputs. Is there any question?

Student: Yes, sir. The execution part.

Professor: Yeah.

Student: So, you have mentioned that the course is very much focused on the execution. So why we need to focus on the execution part?

Professor: Yeah, we need to focus on the execution part because this is, because a lot of our critical path method is focused here.

Student: Because the inputs, whatever the data we are getting from the execution.

Professor: Right. No, so, CPM, generally the focus is here. Assuming that this data is available.

Student: Yes.

Professor: And we take this data for, as inputs and then do all of our processing. Now, but obviously, what we are, so when I say we are focusing here, it is not, does not mean that we should not focus there. There is already a whole area which focuses on the project planning and control part. We are looking at how good the data is, that is, not only how good, how to collect the right data and how to do the monitoring, the micro and the execution level monitoring because that is where the processes come.

So again, when we discuss project management and process management this is typically project management side of things, this is typically the process management. So, if I say this is project and this is more like process, that is roughly, it is not, I mean that is roughly the way it is divided. And in terms of lean we are looking more at process.

Student: The collected data...

Professor: Not only the data, the whole, the framework, we are looking from a process perspective. So, if I am looking at project management, when we look at project planning and control, I am justifiably looking at the higher level. And then we assume that the processes are going up.

But we really know that sometimes, we have been on site, we know how, how challenging it is to get the process going or you know that there is a big separation between the planning team and the execution team. What the planning team plans need not be what is actually feasible. So, we are trying to fill that gap by starting from here.

Student: Because if the process is going good then only the project will be...

Professor: Exactly, exactly, exactly.

Student: So, it is better to focus on process than project.

Professor: You need to focus on both. You need to focus on project, as well as process. And there is already a lot of focus on project level tools. We are bringing in the focus, through this course, on the process level tools. That would be another way to put it.

Student: We are going bottom up now.

Professor: We are going bottom up. Correct. The top down is already there. It does not mean you can ignore project levels. There is project, or it does not mean process is more important than project. Both are important. But today a lot of spotlight is on project. We are also showing the spotlight on process, saying that, look unless this is also in place your project management will not yield the results you want. Good. Good question. Anything else?

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Quiz



1. Consider the following statements and select the correct option: with respect to units of measurement

Statement 1: Unit of measurement is same for all the construction activities

Statement 2: There are different units of measurement for the same activity

Statement 3: There is only one type of measurement for a construction activity

Statement 4: Need to follow same unit of measurement for a construction activity throughout in a project

- a) All Statements are True
- b) All Statements are False
- c) Statements 1 and 3 are True
- d) Statements 2 and 4 are True
- e) None of the above



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