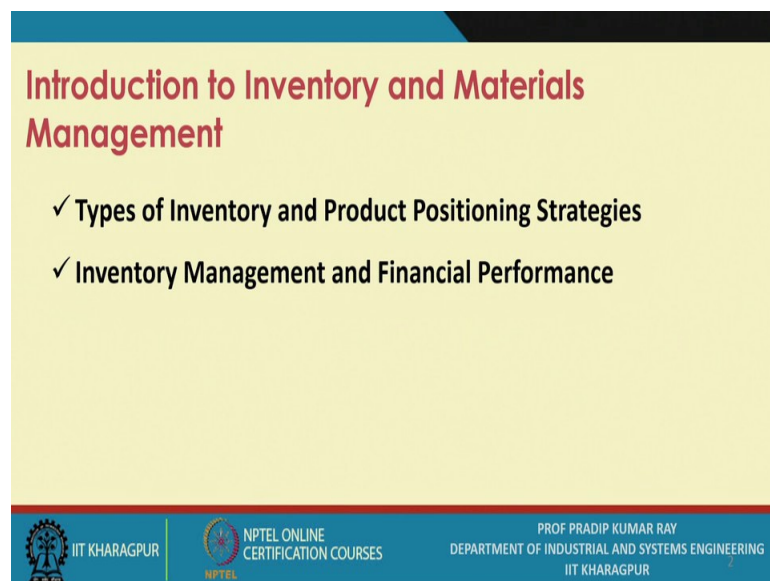


Management of Inventory Systems
Prof. Pradip Kumar Ray
Department of Industrial and Systems Engineering
Indian Institute of Technology, Kharagpur

Lecture – 04
Introduction to Inventory and Materials Management (Contd.)

During this session the fourth session related to Introduction to Inventory and Materials Management; this is a introductory lecture sessions.

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I will be referring to two other issues namely the types of inventory and product positioning strategies., You know for marketing a product for selling a product there could be the there could be different types of product positioning strategy you may adopt and depending on what type of product positioning strategy you adopt you need to the create the different types of inventories.

So, the types of inventories you will like to have in a particular so, the manufacturing systems of the production systems very much dependent on what kind of product positioning strategies you have opted for. So, this issue will be discussing in depth. And, the next will bring in very important the concept or the very important issue that is what extent the inventory management effects of financial performance of an organization, ok. So, there are you know the clear cut there must be clear cut understanding about this

relationship, ok. So, and once you are convinced about the, these relationship then we will come to know that how important for a company is materials management.

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Types of Inventory and Product Positioning Strategies

- Manufacturing companies may have different strategies for product manufacturing and selling. These are referred to as 'product positioning strategies' that have a bearing on the kinds of inventory to be stocked and processed.
- There may be many types of product positioning strategies. Some of the important product positioning strategies are: **Make-to-Stock, Assemble-to-Order, Make-to-Order, and Engineer-to-Order.**

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Now, let us talk about the product positioning strategies. Manufacturing companies may have different the strategies for product manufacturing and selling, ok. So, I will highlight some of the important of product positioning strategies there are many in fact. Now, this strategies referred to as the product positioning strategies; that means, when you try to get the product what you need to do you have to follow a particular process that means, from the raw materials to the finish goods stage; that means, you must have say the upstream stages and the downstream stages till you get the finished product.

Now, it may so happen that you have created a manufacturing system in such a way that the certain stages you do not have, but you do not to have you do not need to have certain stages, either because of you know because of certain you know you do not want to have a those stages because your inadequacy knowledge or it could be a corporate strategy. So, that I will be only focusing on assembly part, I will not be bothering about manufacturing or I will be bothering about the manufacturing are the design part are not aware of.

So, I will bring the design from some other source, but once the design is made available I will go for manufacturing and their subsequently I will go for assembly and then I may produce these assembly to stock; that means, I will assume that it may sell today, but

definitely it will sell tomorrow; that means, it is a mass produced item there is a constant demand, is it ok. So, they produce to stock. And you create the stock and subsequent in the time periods the stocks will be depleted. So, that could be your assumptions. So, that could be your strategy.

In other cases you say that I will produce to in the order; that means, what the given product I will be getting the order and as per the order requirements I will produce the inventory I will manufacturer it and I will get the assembly or the final product and I will send the those assemblies are those products to the persons or to the companies the placing the orders. So, you come across different kinds of situations and the different kinds of the decision you take like whether you will go for manufacturing whether you will go for design and all.

So, these are referred to as the product positioning strategies that have a bearing on the kinds of inventory to be stocked and processed, ok. So, whether you need raw materials inventory or you need WIP inventory, whether you need finished goods inventories whether you need m MRO inventories or not. So, these all depends on what kind of production product positioning strategy you will be using.

There may be many types of product positioning strategies has have been telling you some of the important product positioning strategies are make-to-stock that is one assemble-to-order I am not going for a manufacturing ok, I am not going for making it is it. I will just get the items from some other sources outside supply and then I will do the assembly and I will send it against a particular order; make-to-order, I get the order and I will manufacture.

Next one is engineer-to-order I will get the order now I will start the engineering process; that means, maybe the design process, right. So, is a new design we have to create for that particular order. So, this could be one strategy. Now, obviously, the kinds of inventories you will be dealing with for this strategy say make-to-stock will be different then the kinds of inventories will you are supposed to do the deal with when you adopt engineer-to-order positioning strategy.

So, let me explain in brief all these the four the strategies.


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Types of Inventory and Product Positioning Strategies

These strategies are briefly explained below:

- i. **Make-to-Stock:** concerns availability of F/G when order is received.
- ii. **Assemble-to-Order:** concerns assembly of a group of parts/subassemblies available as inventory when order is received.
- iii. **Make-to-Order:** concerns manufacturing of parts and assembly for the final product, in inventory, when order is received.
- iv. **Engineer-to-Order:** concerns design and manufacture of specialty products with required inventory as per order requirements.

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So, these strategies are very very common and there could be many other combinations of sub strategies. A company may have ah. So, the different of you know, but the product divisions, it may have a product mix and not only one product it is could be a multi product manufacturing forms or it could be a single product manufacturing form. For the single product manufacturing form just one at a particular point in time just one particular strategy they hold on. Maybe in the next the year or the next the planning period they may adopt to where the new strategy, but usually just at any point in time there will be following just one strategy, is it ok so, the more or less that inventory control system remains stable one.

Whereas, suppose in it say multi product manufacturing forms and for each suppose you have in your other product mix so, there are five types of products five types of divisions. So, each division may have depending on the type of product and whether it is a jobbing industry or the mass produced industries. So, you may have different types of marketing strategies.

So, what you try to do; that means, the division wise or the product wise you try to create a separate inventory or materials management systems. Yes, there could be some commonality there could be some you know the common features , but essentially you know in this particular case the kinds of materials management systems or the inventory

management systems we create for a specific product it ultimately it becomes a unique one, right.

So, first make-to-stock what actually do; that means, it concerns availability of finished goods when order is received, that is it; that means, you are main controlling aspect is the finished goods is it ok; that means, are the right point in time whether you are in a position to the supply the finished goods in the required quantity as per the order ok. So, that is for make to stock; that means, your stocking it assuming that in course of time this stock will be depleted; that means, the some demand will occur. So, this is the make-to-stock.

Second one is assemble-to-order. I get the order, but I do not have any manufacturing facilities. So, what I do, I get it imported, I get all the parts imported, and I do the assembly, is it. So, this is one example of assemble-to-order. Concerns assembly only I do assembly of a group of parts are the subassemblies available as inventory when order is received the; that means, I am not bothering about the raw materials inventory management systems, ok. In many cases I may not be bothering about, ok.

Even the WIP inventory control make-to-order, this is make-to-stock; that means, is mass produced here make to order concerns manufacturing of parts and assembly for the final product in inventory when order is received. That means you start manufacturing when you get the order you start manufacturing design is already know, ok. You do not need to work on the design and engineering aspect. So, that design is frozen I need to start my manufacturing and for that the types of materials required it is types of inventory requires that definitely you must have control on all those materials and you start producing, ok. So, you have a production control and parallelly you must have a material control.

So, last one is the engineer-to-order then you concerns design and manufacture of specialty products the special one with required inventory as per order requirements. So, we have this four strategist make-to-stock, assemble-to-order, make-to-order, engineer-to-order is it ok? There could be assemble to stock, there could be you know assemble-to-order it is ok. So, there could be many other such a strategies you may adopt.

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Inventory Management and Financial Performance

- In any organization, financial performance is closely linked with inventory management. If inventory management is poor, financial performance goes down.
- An efficient inventory management ensures a healthy working capital.
- For continual assessment of financial performance, two important documents are prepared at regular intervals, as per statutory obligation, and reviewed for understanding the growth or decline of financial health of any organization or company:

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Now, so, this aspect to be considered and because, this will affect the flow of materials, what kind of the flow of materials you have within your manufacturing systems, now, let us the talk about an important issue a in this particular lecture session that is the inventory management and the financial performance as have been telling you that the inventory management system or the materials management system is closely linked with the companies the performance. Now, the companies now there are two dimensions. So, the two ways you look at a company's performance one is the operational performance and the second one is the financial performance.

Now, the first thing you need to establish that at this point in time to what extent you know your inventory control systems. So, inventory management systems materials management systems is contributing to the financial performance of the systems, is it ok? So, that relationship we have to established. Now, obviously, you must have must have as an inventory management expert you must have you know enough expertise or knowledge above the financial management systems at least you must know that how do you how the financial performance system is measured and you know the evaluated.

So, this evaluation you must know in any organization financial performance is closely linked with the financial performance is closely linked with inventory management. If inventory management is poor financial management performance goes down there are numerous such cases. In fact, in fact one of the main reasons that why is a company may

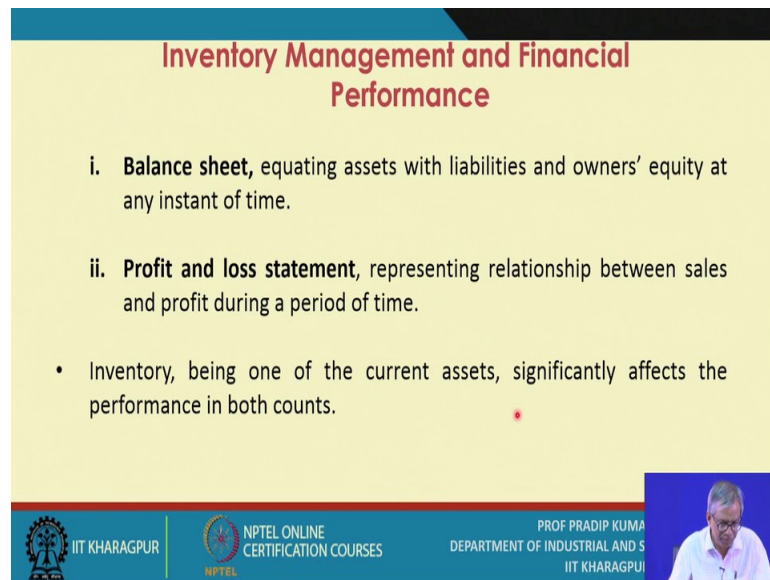
go for you know are they may become sick all out of the market. So, it just you know it goes to the blue.

So, one of the main reasons is there two specific reasons in majority of the cases. The first reason is that your marketing function marketing and market research is not working adequately, efficiently that is the first reason and the second reason is obviously, your materials management the system is it is performance is very very poor and if it remains the poor a consistently obviously, the company's performance financial performance will be hard it. There are many such cases and we should be aware of; that means, at any point in time you must know that to what extent your inventory management system is affecting the financial performance.

An efficient inventory management ensures a healthy working capital, is it ok? So, you just you must know that what is this working capital, is it ok? Just you find out that what is this definition, what do you mean by the working capital and later on we will get few cases where we will come to know that how the working capital is affected by the inventory management system. So, this is a very important issue.

For continual assessment of financial performance a this is a must; two important documents are prepared at regular intervals as per statutory obligation and reviewed for understanding the growth or decline of financial health of any organization or company. So, I repeat that means there are two documents we need to create and this two documents you create as per statutory obligation. And, this and when you get these documents now you thoroughly study this document the content of this documents, for understanding the growth or decline of financial health of any organization of a company, is it alright?

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Inventory Management and Financial Performance

- i. **Balance sheet**, equating assets with liabilities and owners' equity at any instant of time.
- ii. **Profit and loss statement**, representing relationship between sales and profit during a period of time.
- Inventory, being one of the current assets, significantly affects the performance in both counts.

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Now, these two documents one is the balance sheet and the second one is the profit and loss statement. So, what is the balance sheet balance sheet actually it equates assets with liabilities at any instant of time and the owners equity that means, the equating assets with liabilities and owners equity at any instant of time; that means, as on thirty first of March, ok. So, balance sheet is created, there are many items in the balance sheet you get there the figures or the values and you must be able to interpret them and when you start interpreting these values.

Now, you get a feel that whether my inventory system is running alright or not, is it ok? So, if you find that the inventory system is working as per the norms or it is improving there will be reflection reflected in the balance sheet related items and their values profit and loss statement representing relationship between sales and profit during a period of time say for a 6 months you create a profit and loss statement and the whole year from the first of April to thirty first of march next year you create a profit and loss statement, is it ok? So, where if you look at those items; that means, from how to what extend the sales is related to your profit, profit after tax profit before tax profit, profit before interest and tax ok.

So, all these details you get and you try to interpret. While the interpretation is on now, you also start interpreting you know the directly or inter or inter or indirectly the, what do you can say the performance of your inventory or materials management systems, is it

ok? Along with many other systems definitely, but the core issue here is the to what extent your financial performance is related to inventory control systems. So, inventory being one of the current assets as you are aware of significantly affects the performance in both counts.

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Typical Balance Sheet			
Current Asset	(in Rupees)	Current Liabilities	(in Rupees)
Cash and securities	40,000	Accounts payable	80,000
Accounts receivable	100,000	Notes payable	20,000
Inventory	300,000	Accrued expenses	10,000
Prepaid expenses	10,000	Current Long term debt	50,000
Fixed Asset		Long Term Debt	300,000
Net plant & equipment	550,000	Owners' Equity	
		Preferred stock	140,000
		Common stock	300,000
		Retained earnings	100,000
Total Assets	1,000,000	Total Liabilities & Owners' Equity	1,000,000

So, now, this is an example. This is a typical balance sheet. So, what you have on the left hand side you have the current asset and there are four types of current assets; cash and securities the first one, the second one is the accounts receivable and the third item is inventory and the fourth item is prepaid expenses, is it ok?

Now, always this order is maintained there is a reason for this one. So, will ask you to find out the reason it not the that the inventory write it over here, right or the cash and securities is write it over here at the fourth place. So, there is a reason for this one, is it ok. So, this is the current asset. So, the inventory is an asset. Sometimes we make a statement that inventory is essential, but you know we say that it is inventory is also an evil. So, sometimes we say the inventory is a necessary evil just make a note, that sometimes inventory is treated as a necessary evil it is necessary because without inventory you cannot run the production, right.

So, at any point in time would look at the production system essentially you look looking at different kinds of inventories, but if you lose control and inventory what will happen? That means, the entire system will fall apart; that means, entire system will be sick, ok.

So, you are you have to produce you have to terminate your the production system there is no no other way so, no way out. So, if you have enough stock, more than enough some extra inventory suppose and we do not bother about you know the amount of inventory which you have and you have huge amount of overstock excess, you need you know the one machine there is your requirement or month.

Now, you have enough money what you have done that you have installed three more four more machines. So, you do not bother about when you have extra inventory, you do not bother about you know the maintenance of the inventory say the capital equipment. So, slowly we will find that as you feel that you are alternatives in course of time very quickly all the four machines or the six machines, ok. All the ten machines there in you know the breakdown conditions whereas; if you have just one machine what you will find that you know that if it is not in working condition. So, you are going to lose you cannot your whole production system will stop.

So, what do you ought for? So, you tried to create the best possible prevent preventive maintenance schedule for certain equipment and we will find that the that equipment will be running all the time, is it ok. So, in this context so, many a many a time we face this sort of problem or this sort of the situations and almost all the situations we say that the inventory is a necessary evil, ok. So, later on we will explore this concept further.

Now, there is a fixed asset. So, what is this? This is a net plant and equipment, right. So, that is the valuation evaluation based on there is a procedure you can go for depreciations and all those, right now, I am not discussing this point. Now, this is equated with the current liabilities and the owner's equity. So, the current liabilities; accounts payable, notes payable, accrued expenses and current long term debt, is it ok? So, that these are the four elements you have ok, four types of current liabilities and then you have the long term and long term debt, is it ok. So, this is the long term debt. So, that is this one, right.

So, the owners equity you have the preferred stock you have the common stock, and you have the retained earning, right. So, this is the retained earnings you have. So, at any point in time the total assets is equated with the total liabilities and the owners equity is it ok. So, that is why it is called is a balance sheet. Now, obviously, there is one item which is direct related to inventory, ok. So, this will explore it what extent I use the data or the

information from the balance sheet to get an idea about the efficacy or the efficiency of inventory control systems.

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Typical Profit and Loss Statement		
Sales		1,000,000
Direct material	400,000	
Direct labor	200,000	
Factory overhead	100,000	
Cost of Goods Sold	700,000	-700,000
Gross Profit		300,000
Selling expenses	50,000	
Administrative expense	100,000	
Total Selling/ Administrative Expense	150,000	-150,000
Operating Income		150,000
Interest Expense		-50,000
Net Income Before Taxes		100,000



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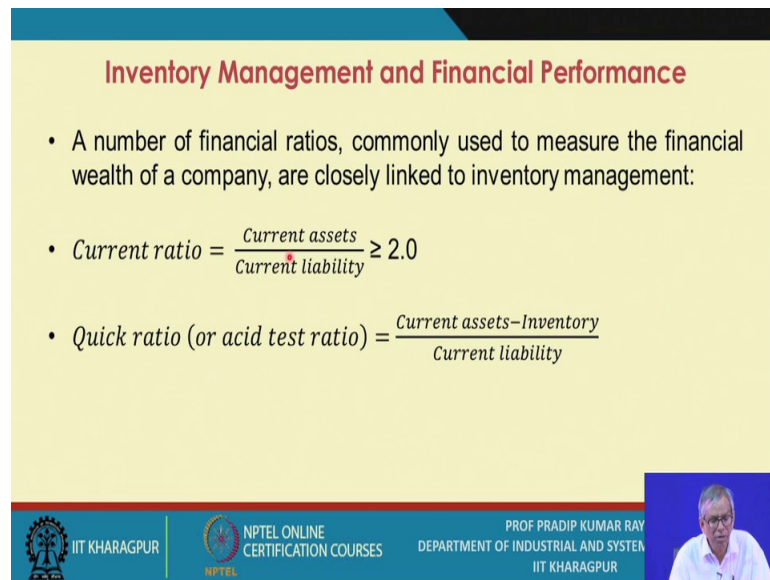


So, now when you look at it typical profit and loss statement what do you find? That the first one is the sales, ok. There is one item not considered you were here that is the depreciation. So, forget about the depreciation. So, essentially depreciation will be there. So, the first is the sales then you have the direct material, direct labor and the factory overhead.

So, if you add all these three it is called cost of goods sold, is it. So, then if you sales minus cost of goods sold what do you get that the gross profit. Then you have the selling expenses and administrative expenses, is it ok? So, if you add them then you get total selling or administrative expenses this is just an example then ah. So, you have the operating income or operating profit, is it ok?

So, that is basically the sales minus cost of goods sold minus the selling and administrative expenses. So, this is called operating profit or operating income then you subtract the interest, is it and you get net income before taxes, is it. So, this one is essentially the net also the income before interest and the taxes. So, now, what do you find over here? This cost of goods sold is very much dependent on the kinds of inventory system that you have. So, this is the profit and loss statement.

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Inventory Management and Financial Performance

- A number of financial ratios, commonly used to measure the financial wealth of a company, are closely linked to inventory management:
- $\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liability}} \geq 2.0$
- $\text{Quick ratio (or acid test ratio)} = \frac{\text{Current assets} - \text{Inventory}}{\text{Current liability}}$

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Now, when you refer to the profit and loss statement as well as the balance sheet you can identify the several kinds of financial ratios, is it and the host of financial ratios you refer to. So, among these financial ratios commonly used to measure the financial wealth of a company these are closely linked to the inventory management. So, there are many financial ratios you may be aware of among all these ratios these are the ratios which are closely linked to the inventory management system.


So, first one is the current ratio current assets by the current liability. So, the preferred value is it should be greater than equals to 2. Quick ratio or acid test ratio; that means, the current assets minus the inventory; that means, inventory part I will it should be greater than at least greater than equals to 1 so, current rate 1. So, I will be meeting the liability part without you know the touching the inventory. So, I want to check that whether you have reached that condition or not, ok. So, that is the quick ratio. It is also known as the acid test ratio.

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Inventory Management and Financial Performance

- $\text{Inventory turnover} = \frac{\text{Cost of goods sold}}{\text{Average inventory}}$ (As high as possible)
(e.g. in Toyota, inventory turnover may be as high as 80!)
- $\text{Throughput time} = \frac{\text{Operating days per year}}{\text{Inventory turnover}}$
- Inventory turnover and 'throughput time' are to be calculated and assessed for each type of inventory (R/M, WIP, F/G).

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Then an important ratio is inventory turnover when you trying suppose the first time you want to get an idea about the quality of inventory control systems of a company. So, so, at the aggregate level you tried to compute the value of this particular ratio for a given year that is called the inventory turnover. So, the cost of goods sold I have already explain the, what is this cost of goods sold and the divided by the average inventory, it should be as high as possible.

For example, in Toyota inventory turnover may be as high as 80, is it ok? It means what? that means, how quickly you are transforming the raw materials through a series of steps of the operations to the finished goods; that means, the manufacturing cycle time should be very very less if we can reduce the manufacturing cycle time, is it ok. As well as the throughput time you can reduce is simultaneously what will happen; that means, this the raw materials is getting converted in the finished goods quickly so.





So, the inventory turnover should be as high as possible and if there inventory turnover increases what do you conclude about the company's performance? That means, the companies you know the materials flow is maintained at a steady rate it is increasing and it is products are selling now; obviously, you have a demand and the demand is supported means increasing demand; that means, is well supported by your inventory control systems.

Throughput time is also a very very important you refer to the diagram, is it ok? Like say you know the accumulation the cost profile with respective manufacturing systems have already discussed. So, with this throughput time is operating this per year divided by the inventory turnover. So, these are the four the ratios you should be bothering about. So, the inventory turnover and the throughput time are to be calculated and assessed for each type of inventory for assessed for each type of inventory; that means, for the raw materials, for the WIP and for the finished goods, is it ok. So, it is say regular practice it is a well adopted practice world.

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Inventory Management and Financial Performance

- **Current ratio** = $\frac{\text{current assets}}{\text{current liabilities}} = \frac{450,000}{160,000} = 2.81$
- **Quick ratio** = $\frac{\text{current assets} - \text{inventory}}{\text{current liabilities}} = \frac{450,000 - 300,000}{160,000} = 0.94$
- **Inventory turnover** = $\frac{\text{cost of goods sold}}{\text{inventory}} = \frac{700,000}{300,000} = 2.33$
- **Throughput time** = $\frac{\text{operating days per year}}{\text{inventory turnover}} = \frac{360}{2.33} = 154.5 \text{ days}$

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So, now with respect to the data which have given, is it ok, that is a representative when or say typical balance sheet and loss statement. So, we have computed these ratios like the current ratio you find this 2.81; that means, this is acceptable. Quick ratio is current assets minus inventory divided by the current liabilities, it is slightly less than 1. So, that is 0.94. So, now, what you need to do; that means, whether you will be releasing some amount of money or the capital from the inventory so, that is to be decided.

Inventory turnover cost of goods sold by the inventory it is 2.33 is definitely you know it is a good one, but further improvement is necessary; that means, today the value is 2.33. What is your next target, if it is 5, then to what extent you know you need to change or to what extent you need to improve good inventory control systems that you have to look into, is it ok? So, some so, the stepwise manner you set the target and always to

achieve the target what sort of you know the action. So, what sort of the new decisions you have to take with respect to your inventory control systems which to be look into. Similarly, the throughput time is 154.5, can it be reduced? So, that means, is the operating days per year, right. So, if you can reduce that it will have a you know the reflection on your improved inventory control systems.

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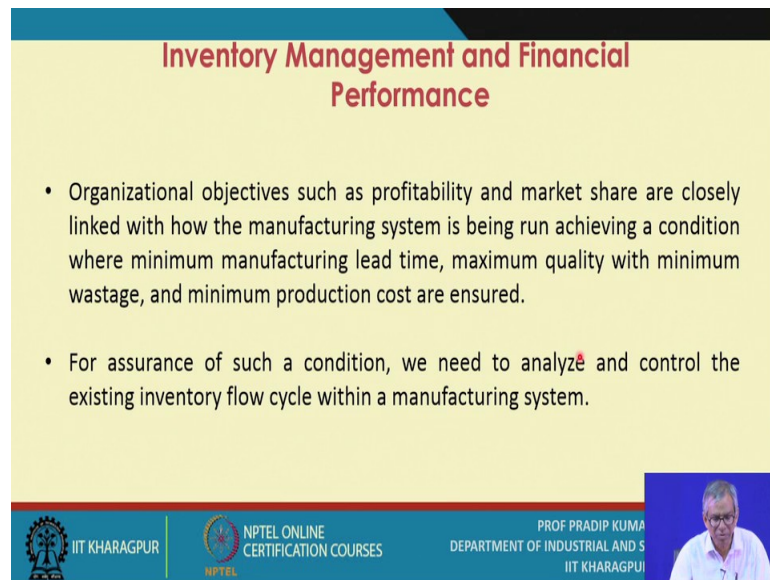
The slide is titled "Inventory Management and Financial Performance" in red text. It contains a single bullet point: "In today's industrial context, JIT concept as developed in Japanese organizations, needs to be applied to develop the best possible inventory management system in an organization with the assurance of minimum waste, maximum turnover, and minimum cost of inventory." The slide footer includes the IIT Kharagpur logo, NPTEL Online Certification Courses logo, and the text "PROF PRADIP KUMAR RAY DEPARTMENT OF INDUSTRIAL AND SYSTEMS IIT Kharagpur". A small video inset of the professor is visible in the bottom right corner.

So, in Today's industrial context JIT concept just in time concept as developed in Japanese organizations just you make a note of this points. Now, this JIT concept as developed in Japanese organizations for many many years from the early sixties the late fifties they have adopting they have been adopting the JIT based manufacturing systems as a part of the Toyota production systems of the TPS.

So, one of the important goals of the JIT based manufacturing system is to reach a goal of zero inventory. So, now, this concept needs to be applied wherever feasible in any manufacturing systems anywhere, to develop the best possible inventory management systems in an organizations, is it ok? So, there is a traditional approach there is also a JIT based approach for inventory control. So, we will be discussing we will be referring to the JIT based approaches in detail in subsequent lecture sessions.



Now, if you adopt the JIT concept there is an assurance of minimum waste, maximum turnover and minimum cost of inventory, is it ok. So, it directly are the meets the requirements or the characteristics of an excellent inventory management systems.

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Inventory Management and Financial Performance

- Organizational objectives such as profitability and market share are closely linked with how the manufacturing system is being run achieving a condition where minimum manufacturing lead time, maximum quality with minimum wastage, and minimum production cost are ensured.
- For assurance of such a condition, we need to analyze and control the existing inventory flow cycle within a manufacturing system.

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Organizational objectives such as profitability and market share are closely linked with how the manufacturing system is being run, achieving a condition when minimum manufacturing lead time maximum quality with minimum wastage and minimum production cost are ensured. For assurance of such a condition we need to analyze and control the existing inventory flow cycle within a manufacturing system.

So, I conclude this session with these comments.