

Course on E-Business
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Indian Institute of Technology, Kharagpur
Module 04
Lecture Number 21
Supply Chain Management - IV

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Welcome back to the fourth lecture

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in this week where

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we will continue our discussion on supply chain management and specifically we will be talking on logistics and distribution part of the supply chain. So

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A presentation slide with a yellow background and a blue header. The title "We are going to learn" is in red. Below it is a bulleted list of four items. At the bottom, there are logos for IIT KHARAGPUR and NPTEL ONLINE CERTIFICATION COURSES.

We are going to learn

- Typical activities under logistics and distribution
- Components of a logistics information system
- Warehouse management system
- Transportation management system

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we are going see what are typical activities on the logistics and distribution system; the components of a logistic information system, about we will be talking about warehouse management system and transportation management system.

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Logistics

- logistics concerns the efficient transfer of goods from the source of supply through the place of manufacture to the point of consumption in a cost-effective way whilst providing an acceptable service to the customer.
- Supply Chain = Suppliers + Logistics + Customers
- Logistics = Materials management + Distribution

Rushton, Alan, Phil Croucher, and Peter Baker. *The handbook of logistics and distribution management: Understanding the supply chain*. Kogan Page Publishers

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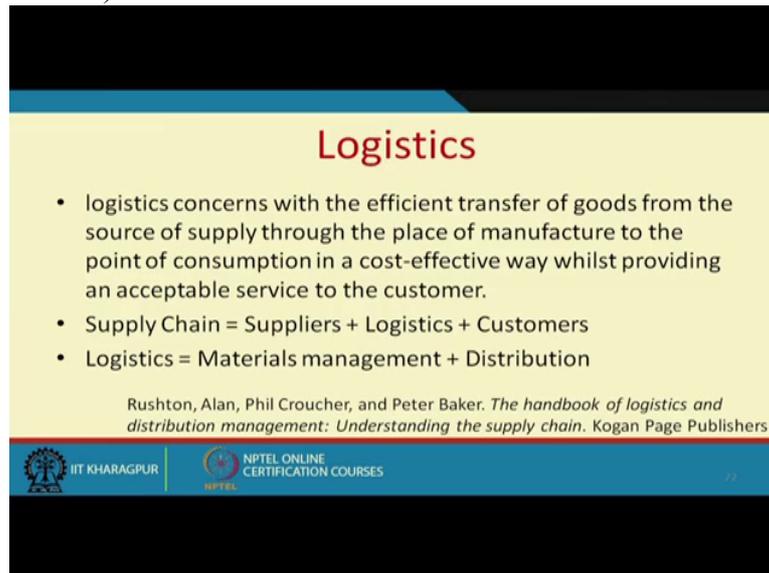
Many times, in fact many people use supply chain and logistics interchangeably. However formally the logistic concerns efficient transfer of goods from the source of the supply to the place of manufacturer.

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So the logistics concerns

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Logistics

- logistics concerns with the efficient transfer of goods from the source of supply through the place of manufacture to the point of consumption in a cost-effective way whilst providing an acceptable service to the customer.
- Supply Chain = Suppliers + Logistics + Customers
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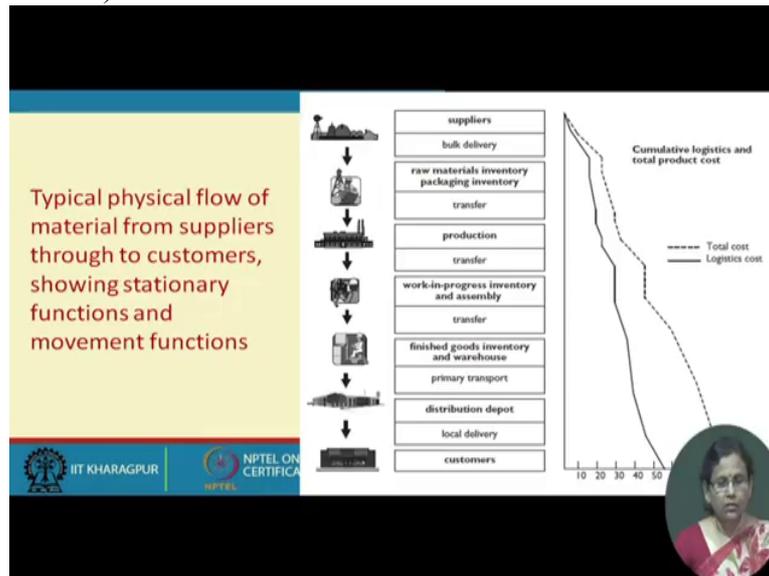
with efficient transfer of goods from the source of supply through the place of manufacturer to the point of consumption in a low, in a cost effective way while providing an acceptable service to the customer. In fact, as it has been defined, your supply chain, logistics is a part of supply chain where in addition to taking care of the customers and taking care of the customer management and supplier management. And logistics itself has two parts. One is your materials management; another is your distribution management. In fact as I have told you we have been using 3 books

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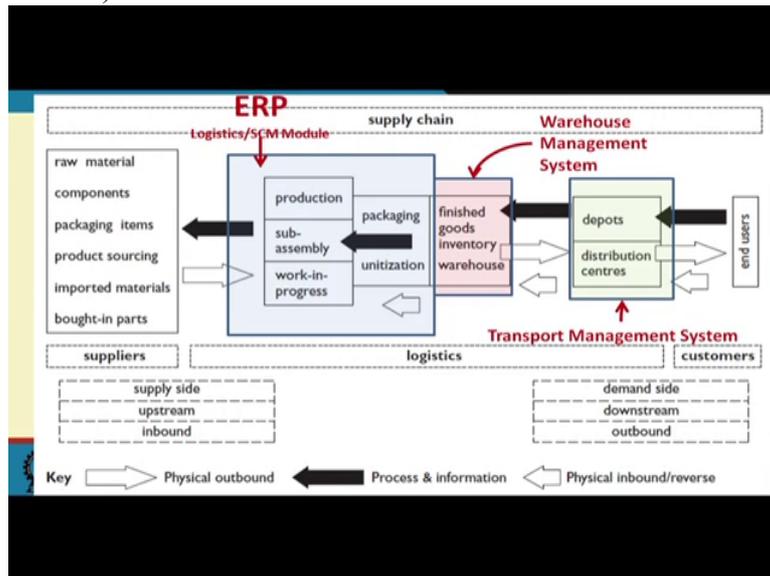
and whenever there is any additional source I will be mentioning it explicitly the site, if I don't mention it explicitly it is basically from those books only. Ok.

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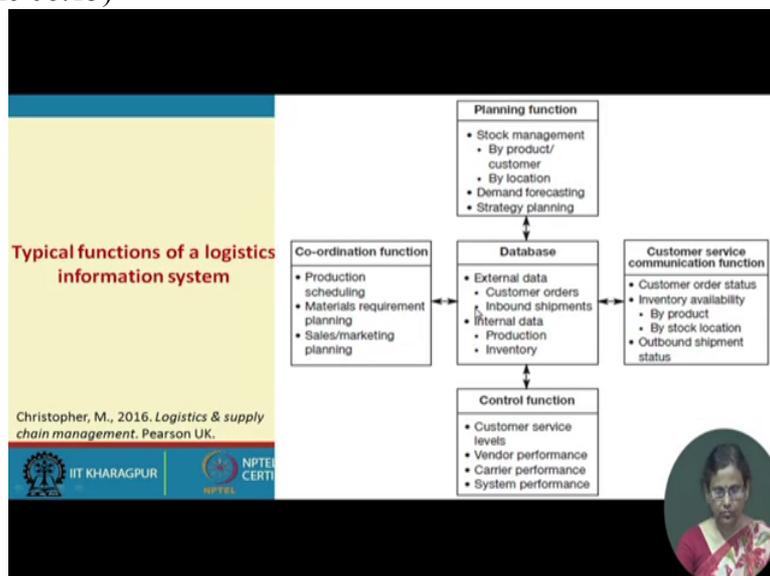
So if you look at the typical flow of material from suppliers to the customers, there are many stationary functions and there are many movement functions. For example, here every transfer that we say, see is actually a movement function. And this particular diagram shows the cumulative logistic and total product cost when the item moves from the supplier till the end customer. If you look at this diagram, forget about what exactly the exact steps that happen here, you can read it out but the point that we can see here is if we, by the time the item reaches the end customer the total the logistics cost is actually half almost, I mean more than half of the total cost. This is a typical scenario. So therefore, it is, it can be understood that how important it is to optimize, to minimize this transport, this total logistics cost so that ultimately either the cost of item decreases and more profit is made by the members in the supply chain.

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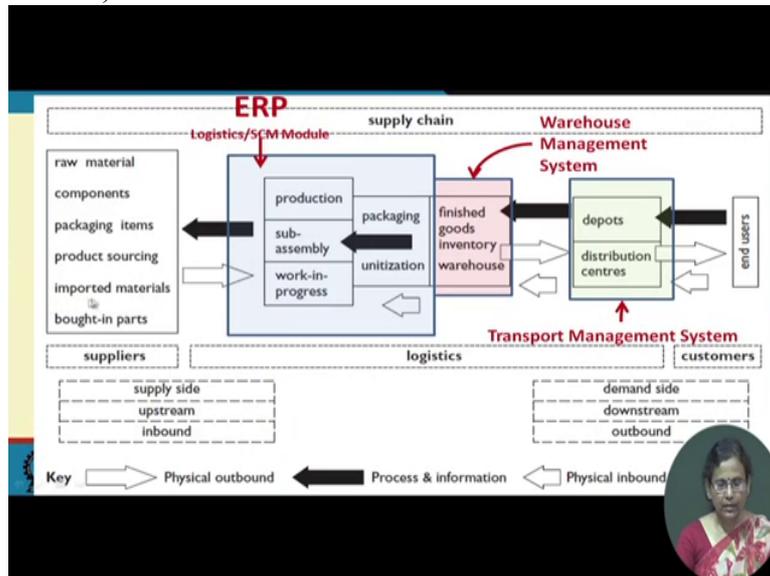
This is a typical, scenario of various information systems that is involved during this logistics and distribution operation. As I told you this, as it has been defined that supply chain is about connecting suppliers with customers through logistics operations. So there are many activities which are related to the supplier and many activities which are related to the end user. And if we look at only this logistics part this has 2 broad systems associated with it, two independent systems. One is a transport management system and the other one is a warehouse management system. So in this, the, this warehouse management system as well as this transport management system, both these systems though they are independent, they get the data from the E R P system and they send some data to the E R P system as well. So, these as shown, these data about both material as well as the related information flows in this system.

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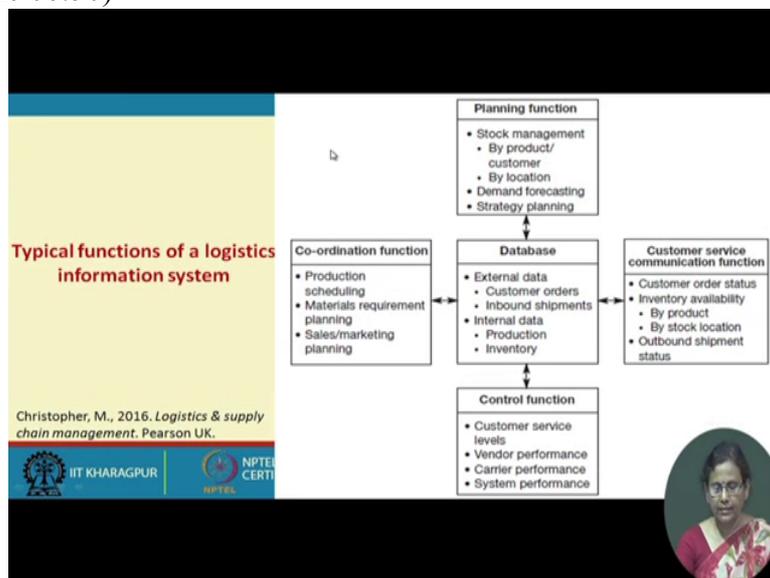
So what are typical activities of a logistics information system? Look, this,

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here the ERP will have a corresponding logistics or SCM module to which has to be connected, with logistics and supply chain module which has to be connected with a warehouse management system and with a transport management system. Now this module of ERP, this logistic and SCM module has typically

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many functions. What are they? Some will be planning functions, some will be coordinating functions, some will be controlling functions and some will be customer service and communication functions and there will be a centralized database and all these subsystems will be taking data from the centralized database and restoring the updated information. So what are various data that is there? It has some external data like customer orders, inbound

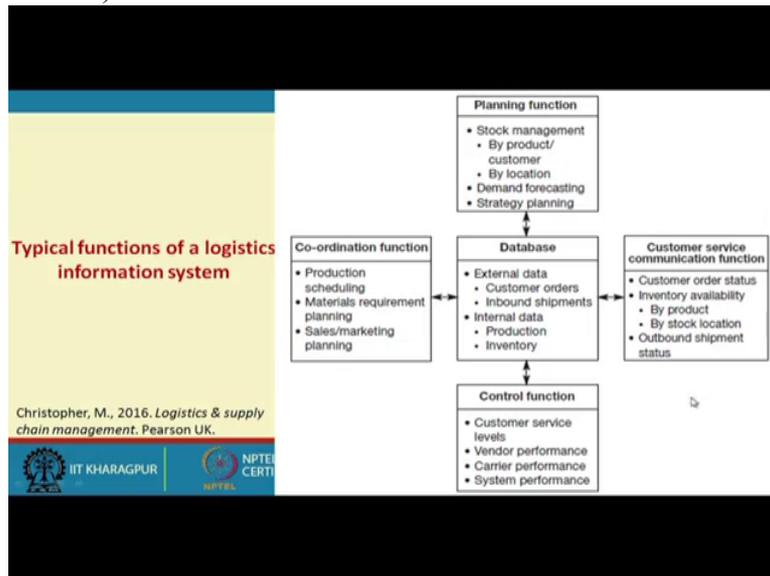
shipments et cetera. It has certain internal data like that of your production and inventory. And what are various planning functions? Stock management, then this stock management by product, by customer and by location, then demand forecasting, strategy planning then coordination functions are production scheduling, material requirements planning, sales and marketing planning. Then there are customer service and communication functions, customer order status, inventory availability then your this inventory availability by product as well as by stock location, availability of inventory by product as well as by stock location, then outbound shipment status, then control functions such as understanding what is the current customer service level, what are vendor performance, what are the carrier performance and what is the overall system performance. Corresponding metrics has to be designed for all these. But this logistics information system which can be either part of the E R P or it can be some,

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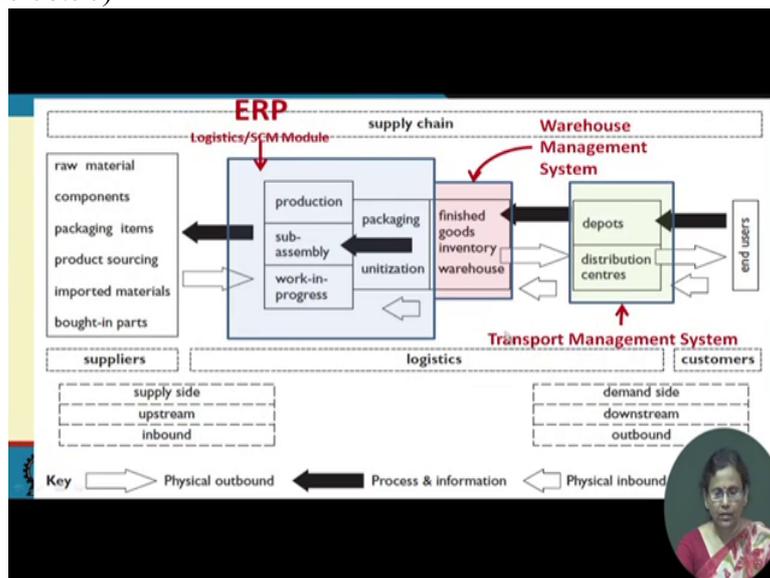
, it can be some legacy system which is exists, which exists at the, at the manufacturer's side has to be ultimately connected. I mean,

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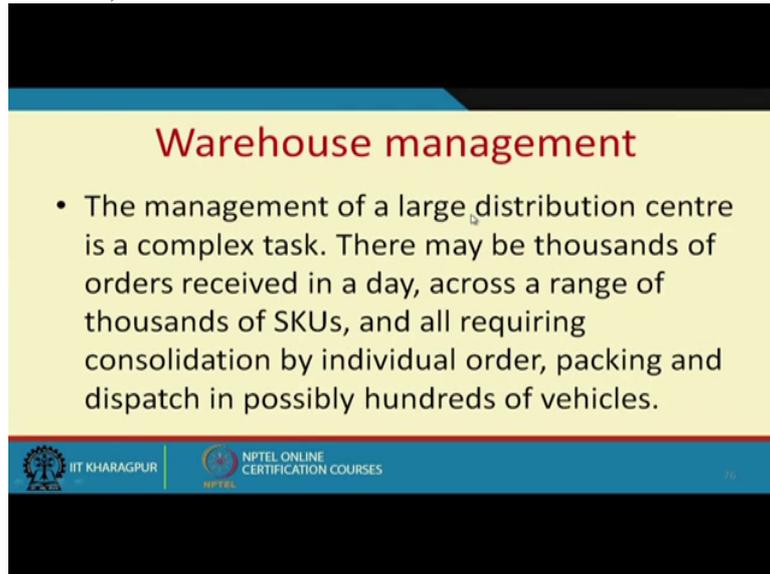
has to be ultimately connected with that of transportation system,

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with the transportation management system or with warehouse management system.

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Warehouse management

- The management of a large distribution centre is a complex task. There may be thousands of orders received in a day, across a range of thousands of SKUs, and all requiring consolidation by individual order, packing and dispatch in possibly hundreds of vehicles.

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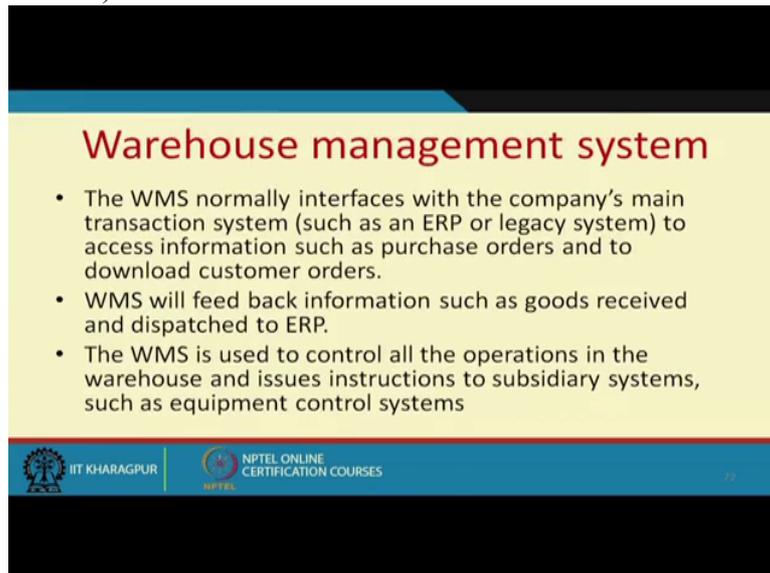
So we are now going to talk about the warehouse management system. Typically the management of a large distribution center is a very complex that, complex task because there may be thousands of orders which may be received in a day across the range of thousands of S K Us and all requiring consolidation of individual orders, packing and dispatch in possibly hundreds of vehicles. So this is a typical

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large warehouse scenario. Now to manage such

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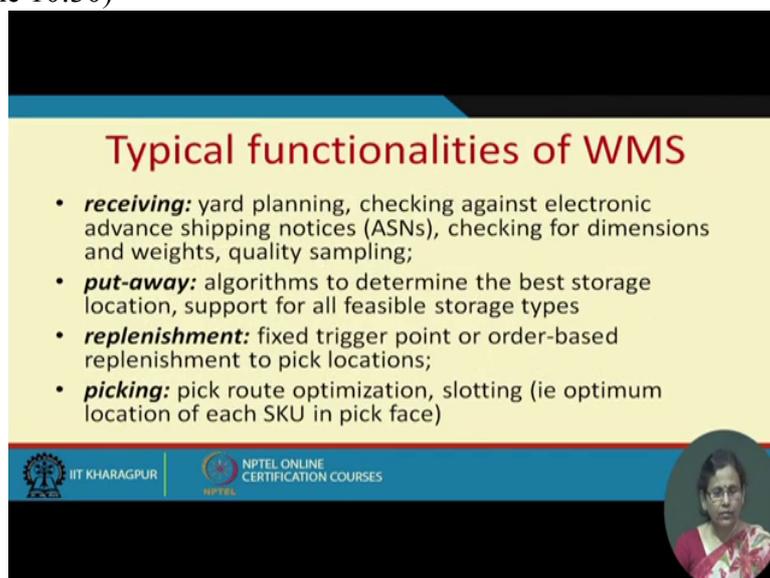
Warehouse management system

- The WMS normally interfaces with the company's main transaction system (such as an ERP or legacy system) to access information such as purchase orders and to download customer orders.
- WMS will feed back information such as goods received and dispatched to ERP.
- The WMS is used to control all the operations in the warehouse and issues instructions to subsidiary systems, such as equipment control systems

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large warehouses, this system has to get the data from corresponding E R P system. So this has to be interfaced with the company's main transaction such as E R P or some kind of legacy system which has to have the functionality that we have already discussed; to access the information such as purchase order and to download the customer order and so on. This W M S will feedback the information such as goods received, and dispatched back to E R P. Then W M S is used to, can also control all the operations in the warehouse and issue instructions to subsidiary systems such as equipment control system.

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Typical functionalities of WMS

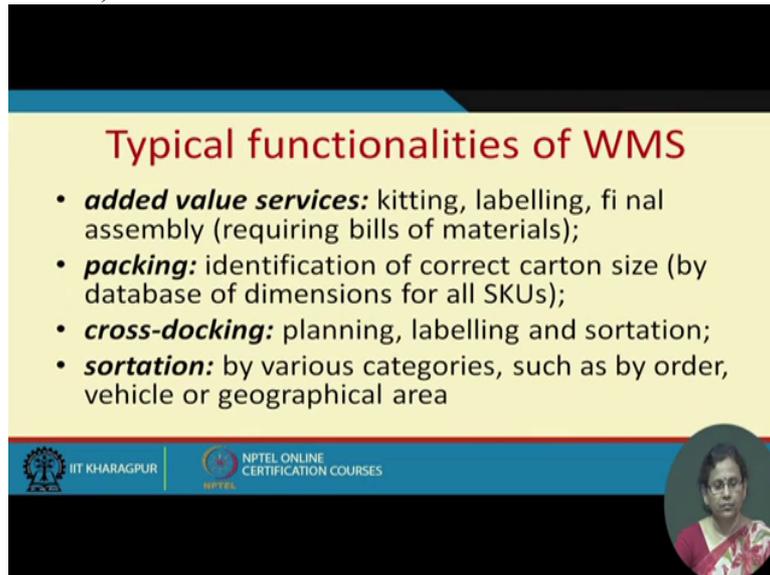
- **receiving:** yard planning, checking against electronic advance shipping notices (ASNs), checking for dimensions and weights, quality sampling;
- **put-away:** algorithms to determine the best storage location, support for all feasible storage types
- **replenishment:** fixed trigger point or order-based replenishment to pick locations;
- **picking:** pick route optimization, slotting (ie optimum location of each SKU in pick face)

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What are the typical functionalities of W M S? Receiving which includes yard planning, checking against electronic advance shipping notice, checking for dimensions and weights, quality sampling and so on. Then next function is put-away.

It has to have the algorithms to determine the best storage location and it has to support all possible storage types. Then replenishment. It is about giving fixed trigger points or, or order-based replenishment to pick locations. Then picking, deciding about the pick route, because the your, warehouses will be so large so that again you have to run some kind of good routing algorithm to to optimize the pick route within the warehouse itself, then slotting, that is about optimum locations of each S K U in the pick face.

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Typical functionalities of WMS

- **added value services:** kitting, labelling, final assembly (requiring bills of materials);
- **packing:** identification of correct carton size (by database of dimensions for all SKUs);
- **cross-docking:** planning, labelling and sortation;
- **sortation:** by various categories, such as by order, vehicle or geographical area

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It can have many value-added services like kitting, preparing kits, labeling, final assembly which of course requires bill of material, then another activity is packing, which requires identification of correct carton size by the database dimension for all the S K Us. Then it has to, it may carry out cross docking activities and planning, labeling and sortation. Then it has to have sortation by various categories, by various orders, vehicles and geographical area. Then

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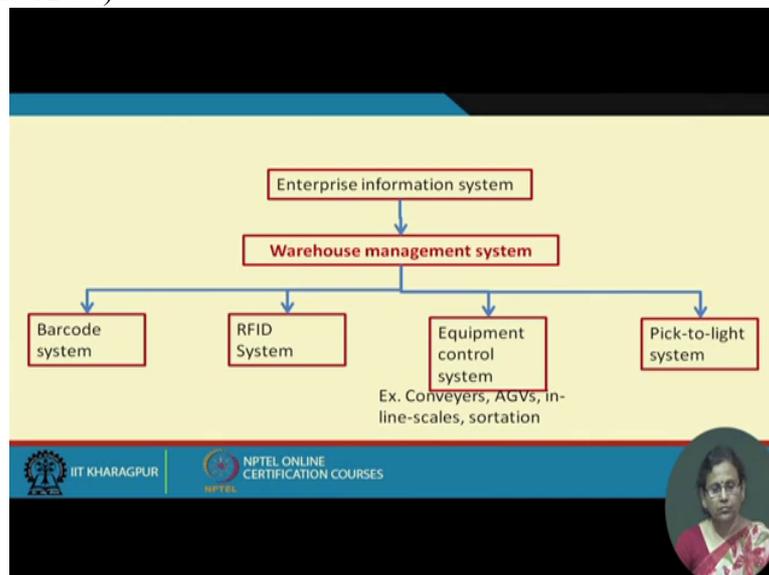
Typical functionalities of WMS

- **dispatch:** documentation, transmission of ASNs;
- **management:** workload planning, performance measurement, productivity schemes, modelling, billing, pallet management, customs reporting;
- **stock counting:** full count and perpetual inventory.
- **Tracking goods** by inward batch numbers

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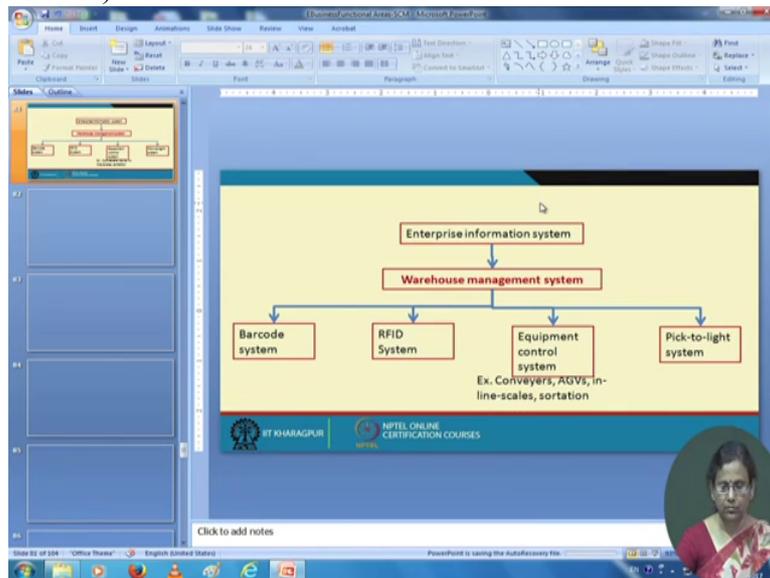
it has to carry out, it has to provide support for dispatch operation as well which involves documentation and transportation of advanced shipping notices, then many management activities like workload planning, performance measurement, productivity scheme modeling, billing, palette management and customer reporting has to be carried out through W M S, then stock counting for full count and perpetual inventory, for tracking goods by inward batch number

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and so on. So a typical, a, this shows how a warehouse management system is, which carries out the activities we have discussed just now, gets information and sends information to various others, other subsidiary systems. For example it gets the data and sends some data to enterprise information system.

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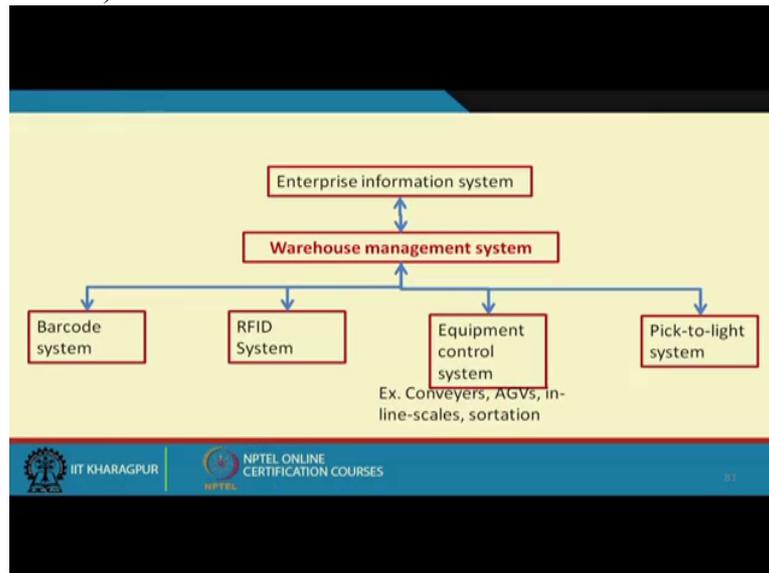


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So this warehouse management system

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gives some data to the enterprise system and also gets the data from the enterprise system. There is two way information flow. And similarly there is also two way information flow between barcode system and R F I D system which are for tracking and traceability and automatic data capture. Then there has to be again two way information flow between the equipment system such as, equipment such as conveyors, A G Vs, inline scales, sortation systems and so on and again, same thing, same two way information comm, information flow between pick to light systems.

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WMS and ERP

- WMS accesses information such as purchase orders and to download customer orders.
- WMS feeds back information such as goods received and dispatched
- WMS controls all the operations in the warehouse and issues instructions to subsidiary systems.

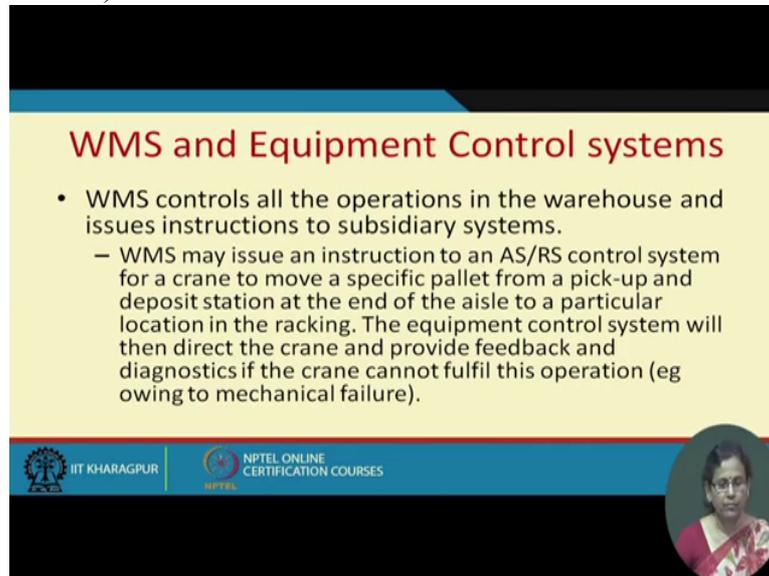


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Now when it comes to the data flow between W M S and E R P, W M S accesses the information such as purchase order to download, and to download the customer order. Then W M S feeds back the information such as goods received and dispatched. And W M S

controls all the operations in the warehouse and issues the instructions to subsidiary systems based on the data available from E R P.

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WMS and Equipment Control systems

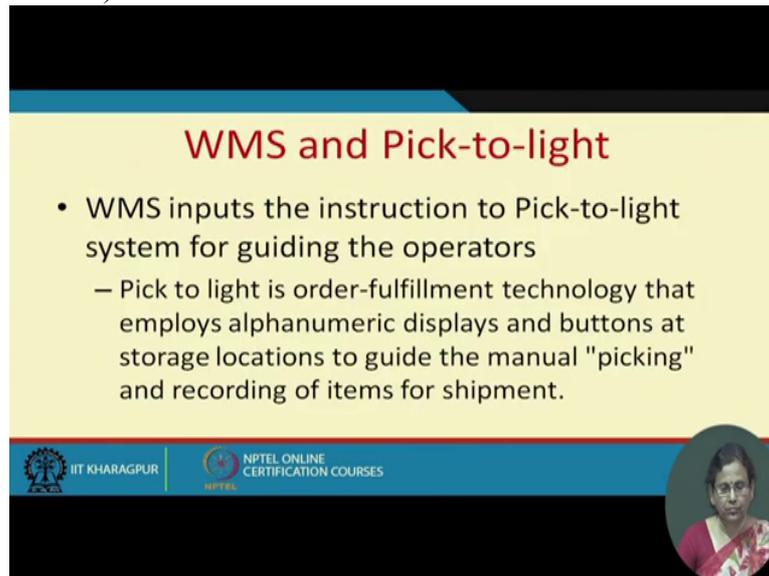
- WMS controls all the operations in the warehouse and issues instructions to subsidiary systems.
 - WMS may issue an instruction to an AS/RS control system for a crane to move a specific pallet from a pick-up and deposit station at the end of the aisle to a particular location in the racking. The equipment control system will then direct the crane and provide feedback and diagnostics if the crane cannot fulfil this operation (eg owing to mechanical failure).

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So now how this is connected to various equipment control systems? We saw that it can be connected to cranes; it can be connected to A G Vs and so on. So the W M S controls all the operations in the warehouse and issues instructions to subsidiary systems. So there is information flow between the subsidiary system and W M S.

This is one example. This W M S may issue an instruction order to a control system for a crane to move a specific palette from a pick and deposit station at the end of the aisle to a particular location in the racking. The equipment control system will then direct the crane and provide the feedback and diagnostics if the crane cannot fulfill its operation. So it is the whole set of the point that we are going to make, this is just one example. The point that we are going to make is, this is a whole set up, complex information flow which is not only the traditional information system but the flow is from information system and back to the information system from the control system of the equipment.

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WMS and Pick-to-light

- WMS inputs the instruction to Pick-to-light system for guiding the operators
 - Pick to light is order-fulfillment technology that employs alphanumeric displays and buttons at storage locations to guide the manual "picking" and recording of items for shipment.

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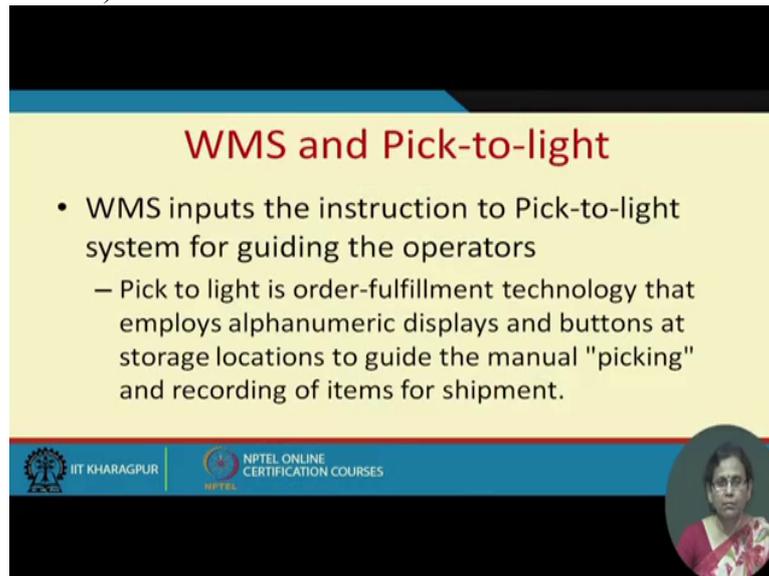
Then W M S can be connected with these pick to light systems. This W M S inputs the instructions to pick to light system for guiding the operator. Now what, this is for basically when this, manual picking takes place because it is a very large warehouse. Whenever there is a manual picking taking place,

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the lights will be guiding the operator starting from his current position till the point where he is supposed to go. So this pick to light order fulfillment technology employs

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WMS and Pick-to-light

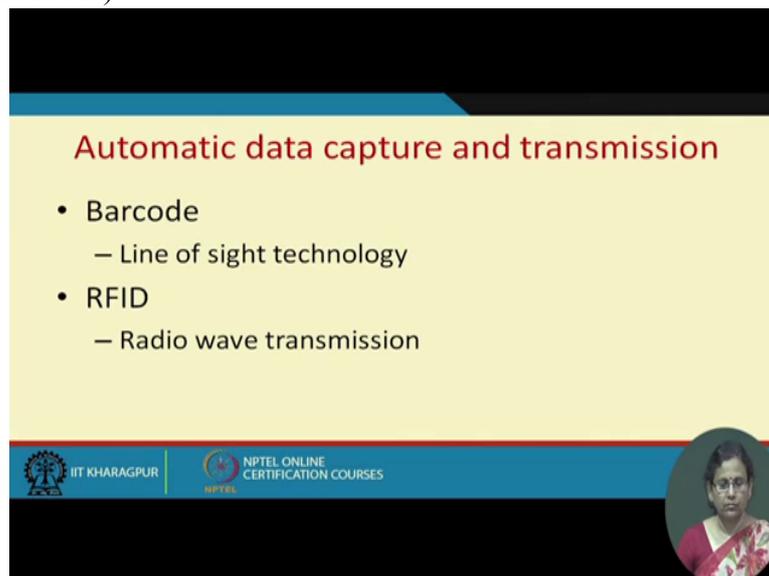
- WMS inputs the instruction to Pick-to-light system for guiding the operators
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alpha numeric displays and buttons at storage locations to guide the manual picking and recording the items for shipping.

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Automatic data capture and transmission

- Barcode
 - Line of sight technology
- RFID
 - Radio wave transmission

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Then this W M S also has to be connected with automatic data capture

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and transmission systems like that of bar code and R F I D where this bar code is, as we know bar code is line of sight

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Automatic data capture and transmission

- Barcode
 - Line of sight technology
- RFID
 - Radio wave transmission

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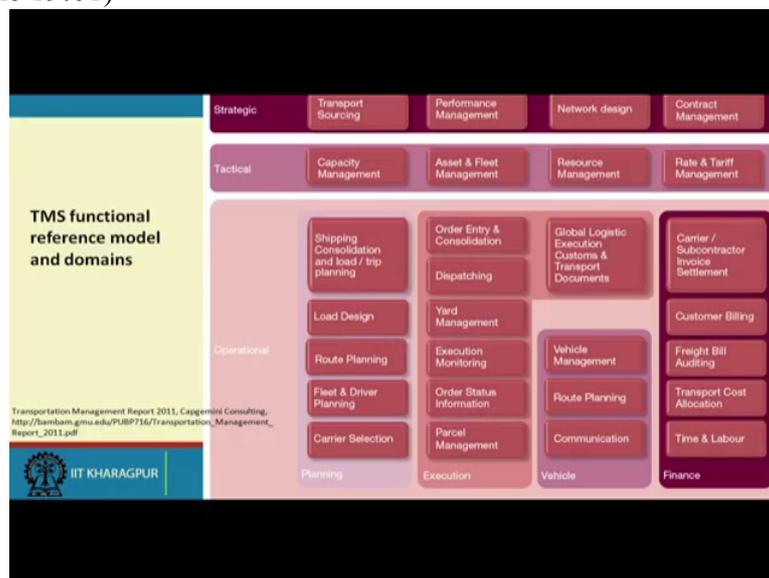
technology where barcode has to be read by certain, reading device which has to be kept

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close to the, item, to the barcode tag so that this system can automatically read. Then we have R F I D system in which the data that is stored within the, within this R F I D tag can be transmitted back to the antenna and give the details of the item on which the tag is put.

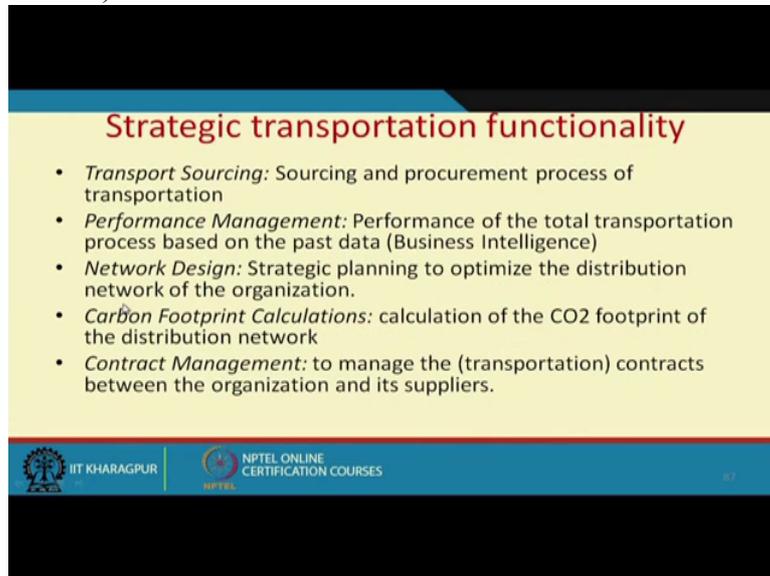
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Now next one is our transportation management system. This is a transportation, a functional component of transportation, typical transportation management system and the, all the elements, all the functionalities that are represented here may vary from, depending on the type of the business the company is. But these are more or less the various activities under a transportation management system. Now let us individually see, if we look at this, this can be strategic, tactical and operational and this spans over various departments, planning department, execution department, vehicle management department, finance department and

so on. So let us individually see at each level what are various functions which has to be, I mean which are part of the, part of a typical transaction management system.

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Strategic transportation functionality

- *Transport Sourcing*: Sourcing and procurement process of transportation
- *Performance Management*: Performance of the total transportation process based on the past data (Business Intelligence)
- *Network Design*: Strategic planning to optimize the distribution network of the organization.
- *Carbon Footprint Calculations*: calculation of the CO2 footprint of the distribution network
- *Contract Management*: to manage the (transportation) contracts between the organization and its suppliers.

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So first one is the list of the strategic activities which are part of a transport management system. First one is transport sourcing. So this is about deciding,

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this is about deciding which kind of, which kind of transportation, I mean how to

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Strategic transportation functionality

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- *Performance Management*: Performance of the total transportation process based on the past data (Business Intelligence)
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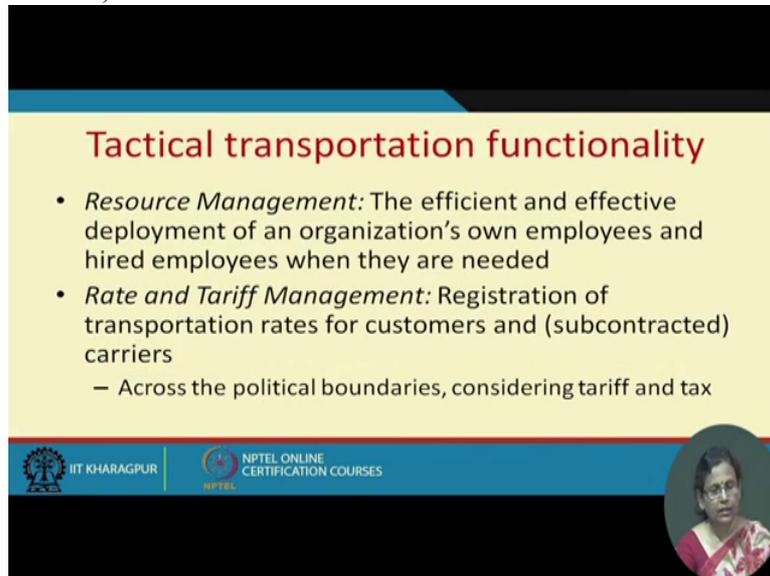
acquire a transportation system and how to source a particular transportation agency. So this is about sourcing, and procurement process of the transportation service.

Then next one is your performance management. This is his performance management of the total transportation process based on the past data. So many business intelligence activities, intelligence functionalities are added to this particular component. Then there is network design which is about strategic planning to optimize the distribution network of an organization to decrease the cost. This is some kind of optimization takes place. Then is your carbon footprint calculation. Depending on your transportation network, your movement of the vehicle, you calculate the carbon footprint. Then next activity is your contract management. It is about how to manage the contract between the organization and its suppliers. Then you have many tactical transportation functionalities in the, in a typical software. First one is your capacity management. The transportation of the, I mean the management of transportation capacity; it ensures that management of transportation capacity, to ensure that it is available when it is needed. It uses many analytical tools like that of forecasting, simulation etc.

Then next activity is your asset and fleet management which deals with various management activities to control the assets that are owned or for which the long term usage contract is made. So because those items are actually, I mean the, keeping those items in proper condition is the responsibility and liability of the organization. Then it also includes fleet management. I mean, this also has fleet management activities which includes the functions such as vehicle financing, vehicle maintenance, vehicle telematics, wheel management, health and safety management. Then also it takes care of transportation units such as trucks,

trailers, rail carts, ships etc. And it also takes care of the management of reusable load units like your container or palettes.

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Tactical transportation functionality

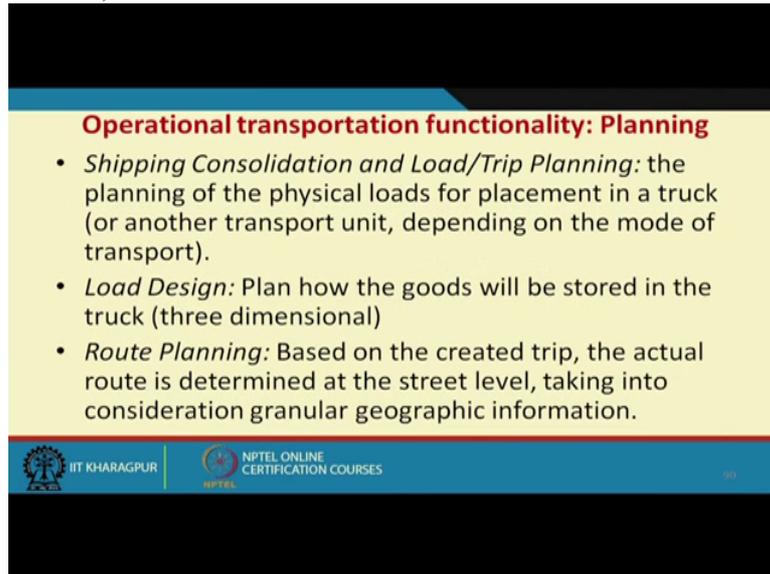
- *Resource Management:* The efficient and effective deployment of an organization's own employees and hired employees when they are needed
- *Rate and Tariff Management:* Registration of transportation rates for customers and (subcontracted) carriers
 - Across the political boundaries, considering tariff and tax

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Then another two more activities under tactical transportation functionality are resource management which is, and rate and tariff management. And its resource management is about the efficient and effective deployment of organization's own employees when they are needed. Then next is actually, your rate and tariff management which is about registration of the transportation rates and rates per customers and subcontracted carriers. Actually this transportation activity, this carriers, this transportation activity can, is, involves crossing the political boundaries of the country. As the rules and regulations vary, different tariffs and tax structures are adopted in different places and accordingly it has to be calculated.

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Operational transportation functionality: Planning

- *Shipping Consolidation and Load/Trip Planning*: the planning of the physical loads for placement in a truck (or another transport unit, depending on the mode of transport).
- *Load Design*: Plan how the goods will be stored in the truck (three dimensional)
- *Route Planning*: Based on the created trip, the actual route is determined at the street level, taking into consideration granular geographic information.

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Then next activity under, under this warehouse management system is at the operational level. Again in operational level we can have

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2 types of activities; one is planning activity, set of planning activities and set of execution activities. Coming to planning activities we have the activities like shipping, consolidation, and load or trip planning.

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Operational transportation functionality: Planning

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Here the planning of the physical load for placement in a truck or some other transportation unit depending on the mode of the transport. So it is deciding which load will go to which kind of transportation unit. Then it also provides the functionalities, planning functionalities on load design. By load design we mean, how to put a load in a truck or some kind of other, other transportation, transportation unit. So it can be, it has to be, for example see, if you are, it is a, you have to plan, the plan will be three dimension depending on your S K U sizes or, or the good that is to be transported and the nature of the good. For example if you are transporting let's say, let's say some glass material but, some cartons involving glass material and all and along with others, then you have to make sure that those glass material has to go to the top.

Or depending on the carrier's capacity, you have to decide how much load you will be putting and how the items are to be organized so that, so that the space while taking care of the load, the not much space is wasted, I mean minimize the waste, minimize the waste of space, the space wastage within the carrier. And if all of, some of you have already taken some courses in operations optimization, operations management, you might be realizing that these are, that all these that we are discussing are actually quite n p hard optimization problems. In fact, in fact we are not going to discuss about the optimization problem but all of them are high end optimization problems. Then is your route planning. This is based on the created trips and actual routes. The actual routes are determined at the street level taking into consideration the granular geographical information of your area through which this distribution activity has to take place.

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Operational transportation functionality: Planning

- *Fleet and Driver Planning:*
 - In case own equipment is used to execute the actual shipment
 - allocates vehicles and drivers to planned loads and routes.
Constraints: driving hours, the current location of drivers, equipment and the condition of the equipment.
- *Carrier Selection:*
 - transport mode selection
 - the selection of the actual carrier.

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Then two more activities under these are fleet and driver planning. In case your own equipment is used to execute the actual shipment like you are allocating vehicles and drivers to plan loads and routes it takes care of many constraints such as driving hours, driver has to, let us say one driver has to maximum drive per day, some 8 to 10 hours et cetera, the current location of the drivers so that, so that they can be, driver can be picked up from, come from nearest location, then condition of the equipment and so on. For example if some carrier has to go for maintenance and all, then carrier selection, it is about transport mode selection, whether it is a road transport, rail transport or it has to be maritime transport and so on, then selection of the actual carrier.

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Operational transportation functionality: Execution

- *Order Entry and Consolidation:* Registration, validation and management of orders.
- *Dispatching:* The carriers or own drivers need to be informed.
- *Order Status Information:* The process used to record the information related to the pick-up/collection and delivery of shipments.
- *Global Logistic Execution/Customs and*
- *Transport Documents:* Supporting international transportation with trade compliance for import and export.

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Then so far, whatever we

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have discussed at the strategic level, at the tactical level and operational level, all of them are actually either intensive data, they use either intensive data analysis and business intelligence, or they are optimization problems. But just like any other system, this W M S is also, has many kind of transaction activities. Now those are, are grouped under these execution, operational execution activities.

Let us see what are those transaction activities are. First of all, order entry

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A slide titled "Operational transportation functionality: Execution" with a yellow background. The slide contains a bulleted list of activities. At the bottom, there are logos for IIT Kharagpur and NPTEL Online Certification Courses.

Operational transportation functionality: Execution

- *Order Entry and Consolidation*: Registration, validation and management of orders.
- *Dispatching*: The carriers or own drivers need to be informed.
- *Order Status Information*: The process used to record the information related to the pick-up/collection and delivery of shipments.
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and consolidation which involves registration, validation and management of orders. Then we have dispatching which about, about, about the carriers, about the carriers or your own drivers whenever and when they are supposed to be informed. I mean your system has to give

some kind of alert. Then your order status information, the process used to record the information related to pickups and collection and delivery of shipments. These are very mundane items, transaction kind of items. This has to be, there is no complex decision making involved here, once the procedure is established, they has to be carried out. Then global logistics execution and customs, then transport documents, I mean the global logistics execution customs and transports documents which is for supporting international transportation with trade compliance and import export,

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then

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A slide with a yellow background and a blue header. The title is "Operational transportation functionality: Execution". Below the title is a bulleted list of three items: "Yard Management", "Parcel Management", and "Execution Monitoring". The slide also features logos for IIT KHARAGPUR and NPTEL ONLINE CERTIFICATION COURSES at the bottom.

Operational transportation functionality: Execution

- *Yard Management*: This deals with the management and administration of a company's yard and the dock doors of the distribution center.
- *Parcel Management*: A mode of transport that has specific requirements for the execution. (Express parcel)
- *Execution Monitoring*: The fulfillment of a transport order is monitored and corrective actions are supported
 - Visualization and traceability

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you have your yard management which deals with management and administration of company's yard and dock doors of the distribution center. Then you have parcel management

which is about deciding the mode of transport and putting appropriate labels and sending them in appropriate vehicles, then it is about execution monitoring which is about fulfillment of a transport order and monitoring and taking corrective actions if something is not right. And it involves use of visualization and traceability tools like

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showing it on a G I S system, use of G P S for vehicle tracking, I mean your transport carrier tracking, or use of R F I D technologies, and sensor network et cetera. While talking about the technologies we will be talking about them more. So with this we finish, thank you very much.