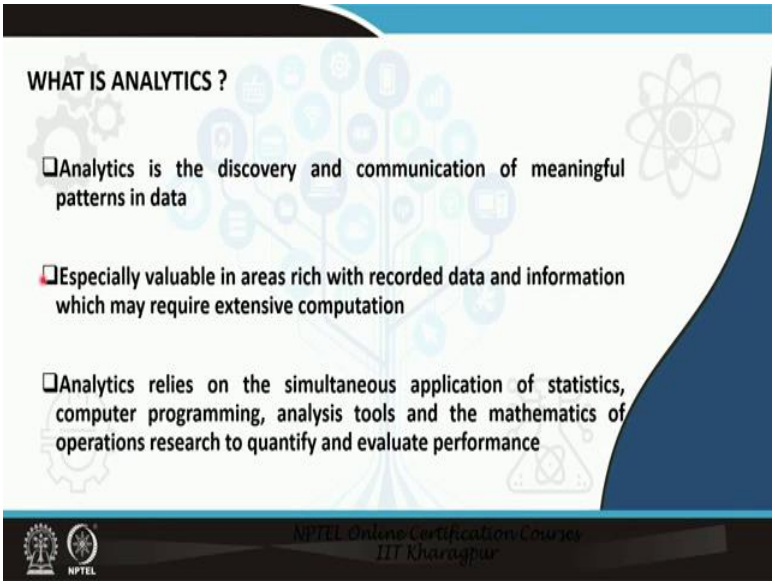
Modelling and Analytics for Supply Chain Management
Professor Kunal Kanti Ghosh
Vinod Gupta School of Management
Indian Institute of Technology Kharagpur
Lecture 04
Introduction to Analytics in Supply Chain

(Refer Slide Time: 0:15)

Good afternoon, we welcome you to our module four, which deals with the introduction to analytics in supply chain of our course Modelling and Analytics for Supply Chain Management.

Today, we will cover the following broad concepts covering what is analytics? Category of analytics techniques, supply chain analytics in each category, then we will do something with what is big data? We will discuss about the characteristics of big data. And the, we will spend some time on how big data can be leveraged in managing supply chain.

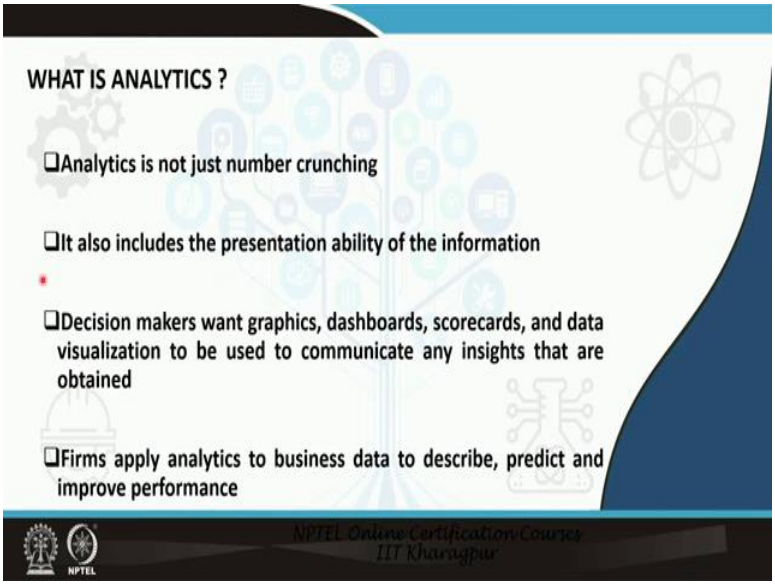
(Refer Slide Time: 1:06)



Now coming to this topic on what is analytics? I would like to say that analytics is the discovery and communication of meaningful patterns in data. Especially analytics is valuable in areas where there is recorded data and information and to analyze this information to analyze this data, we may require extensive amount of computation. Analytics basically relies on the simultaneous application of statistics, computer programming, analysis tools and the mathematics of operations research to quantify and evaluate performance.

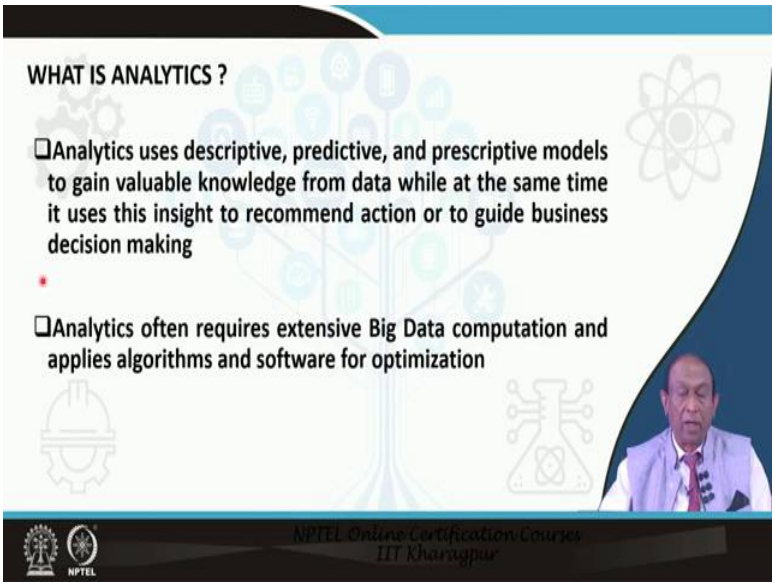
Now, why this background of analytics is necessary? Because supply chain analytics mainly relies on analysis of the data that we had discussed, which are collected at different stages of the supply chain? And we will discover certain hidden truth by such kind of analysis. So, supply chain analytics when we talk about we must know first, what is analytics? What are the different types of analytics in use and how it can be leveraged for improving the performance of supply chain?

(Refer Slide Time: 2:56)



Analytics is not just numbers crunching. It also includes the presentation ability of the information because a picture is what much more than words, decision makers, they basically want graphics, dashboards, scorecards, and data visualization to be used to communicate any insights that are obtained from analysis of this data. Firms, they basically apply analytics to business data to describe, predict and improve performance.

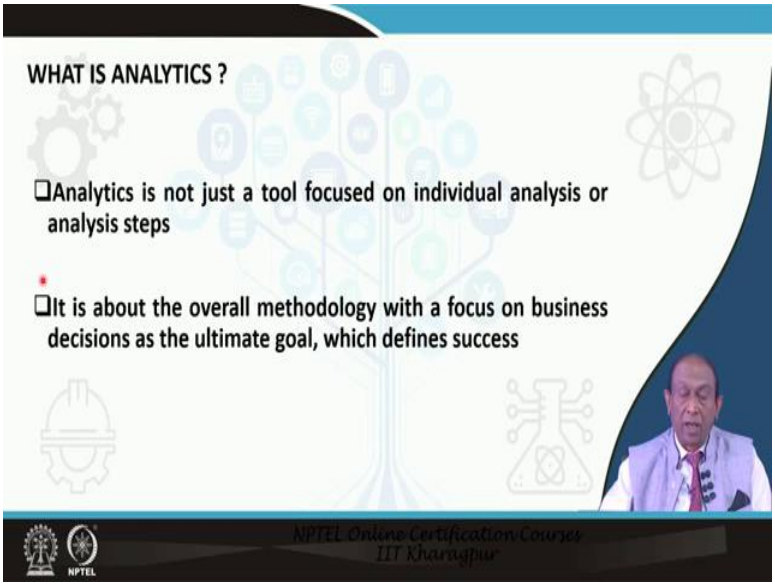
(Refer Slide Time: 3:50)



Analytics uses descriptive, predictive and prescriptive models to gain valuable knowledge from data. While at the same time it uses this insight to recommend action or to guide business decision making. Now, you might ask, what is the difference between descriptive, predictive and prescriptive models? Which we will discuss right now after sometime.

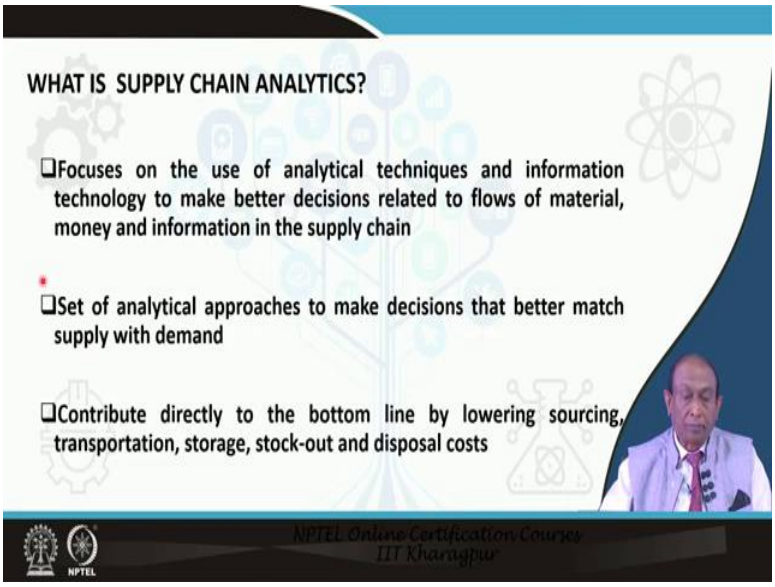
Analytics often request extensive Big Data computation and it applies different algorithms and software for optimization.

(Refer Slide Time: 4:50)



Analytics is not just a tool focused on individual analysis or analysis steps. Analytics is all about the overall methodology with a focus on business decisions as the ultimate goal and this basically defines success in any business undertake.

(Refer Slide Time: 5:21)



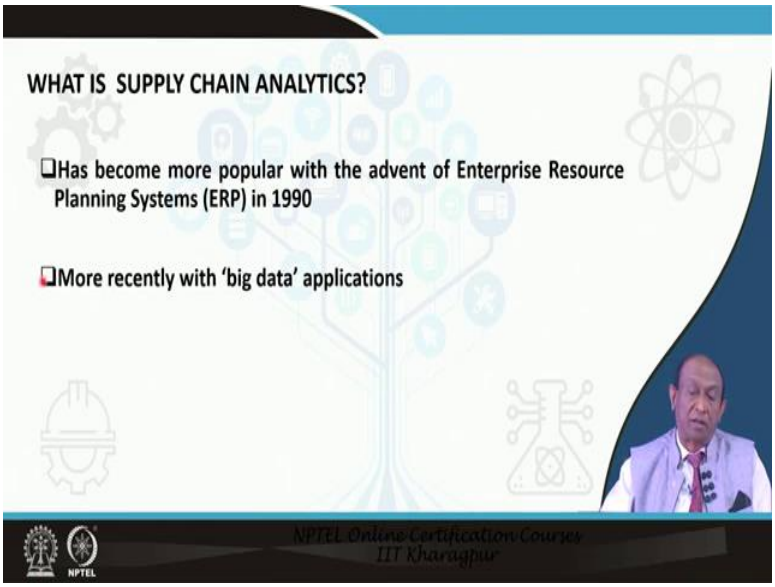
So now, having understood what is analytics? There is a need to first understand the meaning of the term supply chain analytics. Because there is lot of confusion about this particular subject supply chain analytics. People really do not understand what is the role of analytics in

supply chain? And they confuse it with general understanding of Supply Chain Management, while it is really necessary to understand, what is supply chain management to apply analytics for better decision making? But supply chain analytics is something different from typical subject like supply chain management.

Supply Chain analytics basically focuses on the use of analytical techniques and information technology to make better decisions related to flow of material, money and information in the supply chain. Supply Chain Management we basically discussed that it is management of flows, flow, bi-directional flows of material money and information to fulfill a customer request at the lowest possible cost. But in order to attend that particular objective of balancing the supply and demand and managing this bi-directional flows, we need to use analytical techniques. We have to analyze the data collected at each stages.

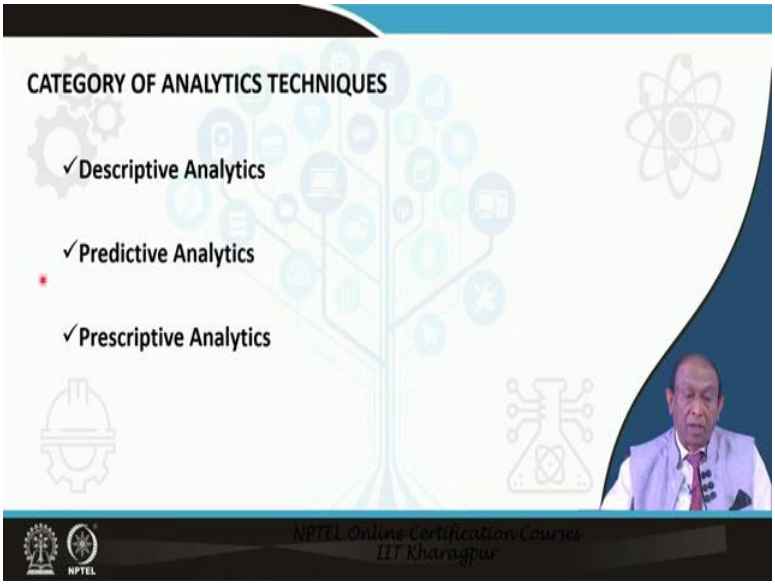
So, supply chain analytics is a set of approaches which consists of all these statistics, operations research, methodologies to make decisions that better match supply with demand and supply chain analytics contribute directly to the bottom line by lowering, sourcing, transportation, storage, stock out and disposal cost. This is all about supply chain analytics.

(Refer Slide Time: 7:57)



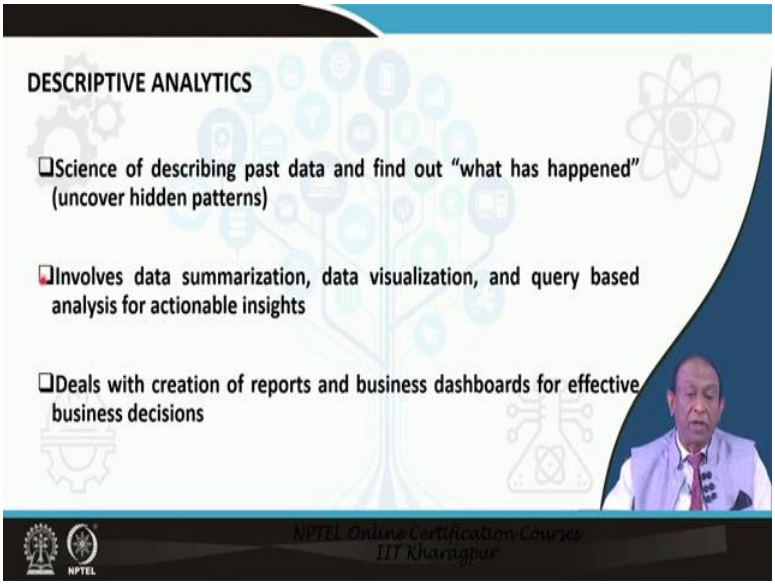
And this subject has become more popular with the advent of enterprise resource planning systems ERP in the year 1990. And more recently, with the advent of big data and related applications, supply chain has become widely popular and it is extensively used in various multinational and also in domestic organizations to improve their bottom line and other other people performance indicators.

(Refer Slide Time: 8:39)



So, when we talk about the category of analytics techniques, we have already mentioned that analytics basically deals with three classes of techniques. One is descriptive analytics, number two predictive analytics and number three prescriptive analytics. Now, you might ask me, so what are the differences between all these three techniques?

(Refer Slide Time: 9:14)



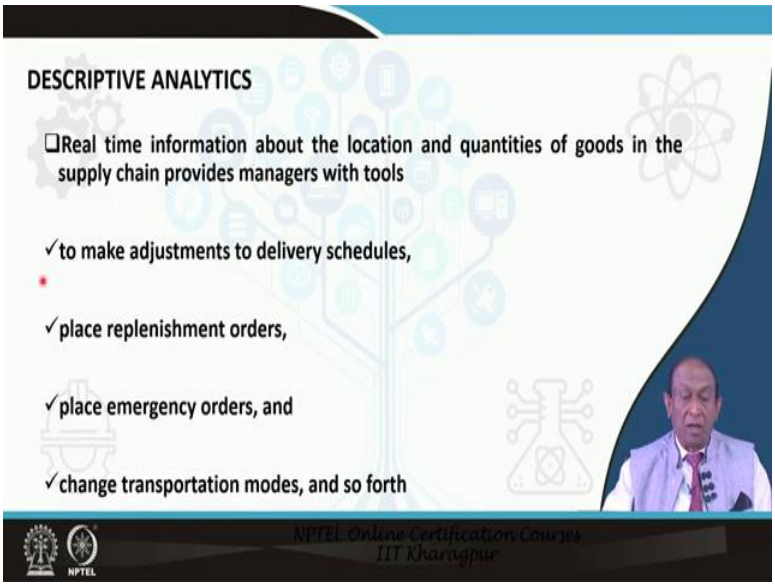
So, we start with descriptive analysis. Descriptive analysis is a science of describing past data and find out what has happened. That means, we are trying to uncover hidden patterns in the wealth of data that is being accumulated in our corporate or enterprise database, okay. Huge amount of data due to transactions processing, lots of data have been accumulated over the

years and mostly organizations, they used to take decisions based on certain reports and MIS type of manager typical management information system applications.

But when we talk about analytics, we are basically interested to find out patterns or trends in those data. So, it involves data summarization, data visualization and query based analysis for actionable insights because see there is no point in summarizing data, producing lots of reports and looking at those reports until and unless as managers, we are able to take actions based on the insights that we obtain from the data.

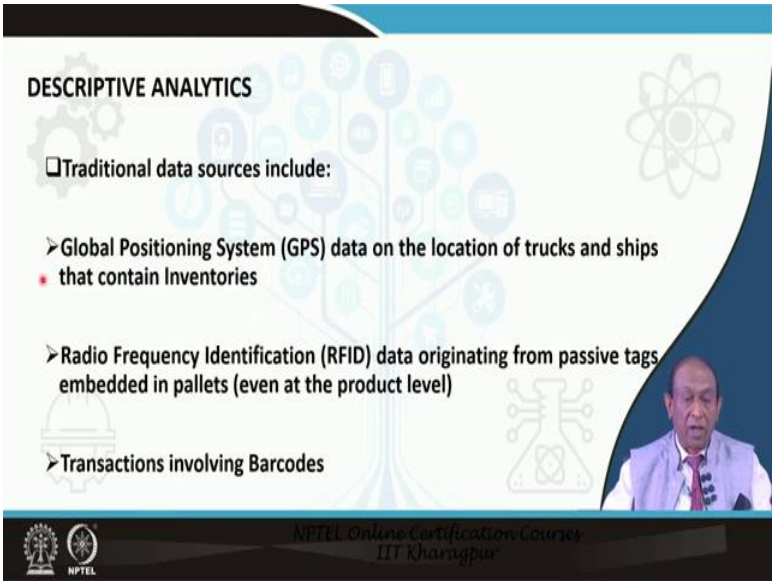
This kind of application of techniques has got no meaning. So, descriptive analysis deals with creation of reports and business dashboards for effective business decisions and business dashboards will tell you where the performance is lagging, what needs to be done? So, based on that, actions can be taken by managers.

(Refer Slide Time: 11:19)



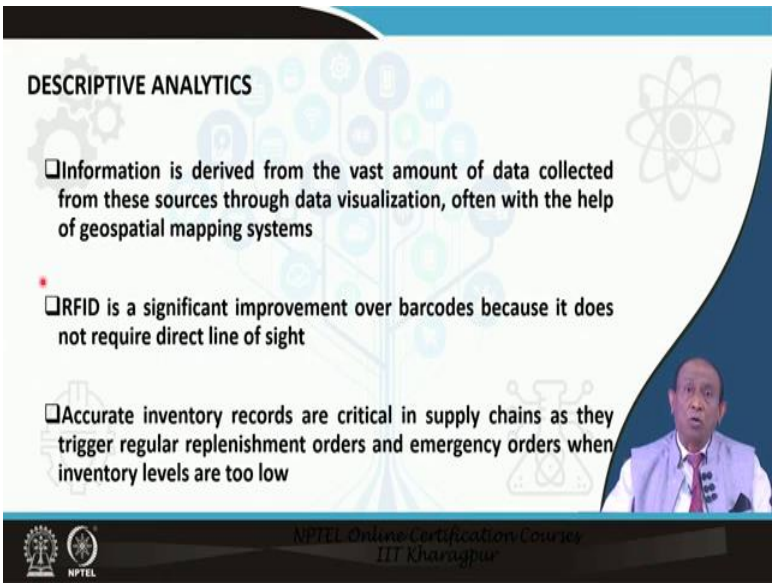
Descriptive analytics when you talk about then we are basically also talking about analyzing real time information. A real time information about the location and quantities of goods in the supply chain provides managers with tools to make adjustment to delivery schedules, place replenishment orders, place emergency orders and change transportation modes, and so forth. These are typical applications of descriptive analytics.

(Refer Slide Time: 12:04)



Now, whenever we talk about descriptive analytics, we also need to know where from we are getting this data. So, traditional data sources include Global Positioning Systems like say GPS data, which are now these GPS systems are now embedded inside the trucks. So, GPS data can be found on the location of trucks and ships that contain stocks of materials. Radio frequency identification data originating from the passive tags embedded in pallets even at the product level. And also descriptive analytics talks about or deals with analyzing the transaction data involving barcodes.

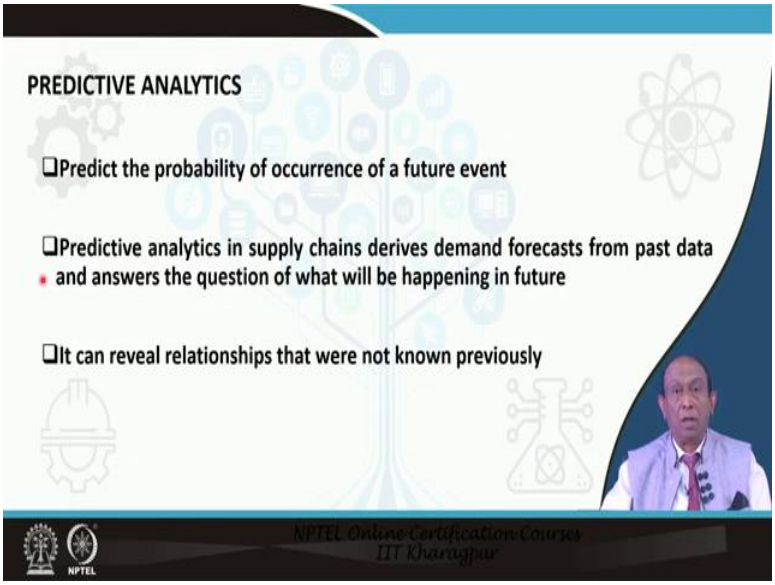
(Refer Slide Time: 13:00)



So, in descriptive analytics, information is derived from the vast amount of data which are collected from the sources which we have just mentioned and this analysis is done through

data visualization, often with the help of a geospatial mapping systems. RFID is a significant improvement over barcodes because it does not require direct line of sight. And through RFID our inventory records are much more accurate compared to what it was in yester years. Accurate inventory records are critical in supply chains as they trigger regular replenishment orders and emergency orders when inventory levels are too low.

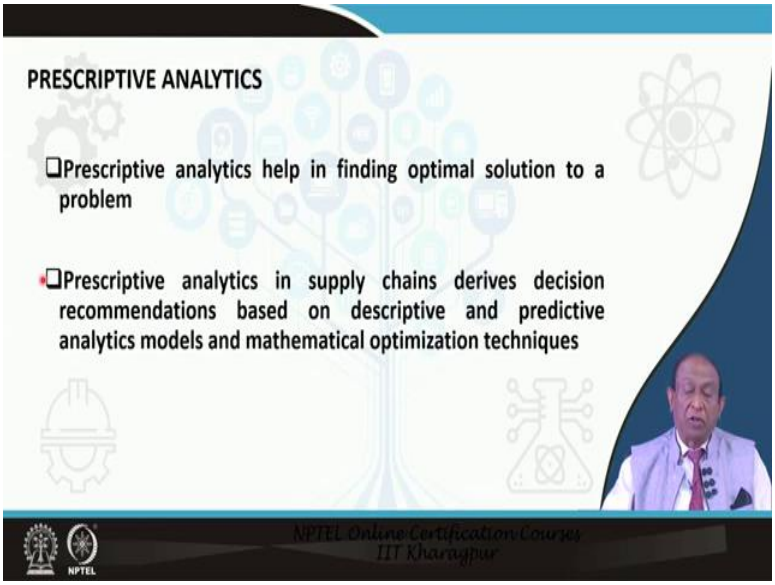
(Refer Slide Time: 14:08)



Now, let us having known a little bit of what is descriptive analytics? Let us try to find out what is there in predictive analytics? Predictive Analytics mainly deals with predicting the probability or the chance of occurrence of a future event. So, whereas descriptive analytics deals with what is what has happened? Predictive analytics will deal with what is going to happen or what will happen? Predictive analytics in supply chains derives a demand forecast from past data.

And answers questions like what will be happening in future? So, there lies the difference. Descriptive analytics deals with what has already happened and predictive analytics is going to tell you what will happen in future. So, predictive analytics can reveal relationships that were not known previously okay.

(Refer Slide Time: 15:30)



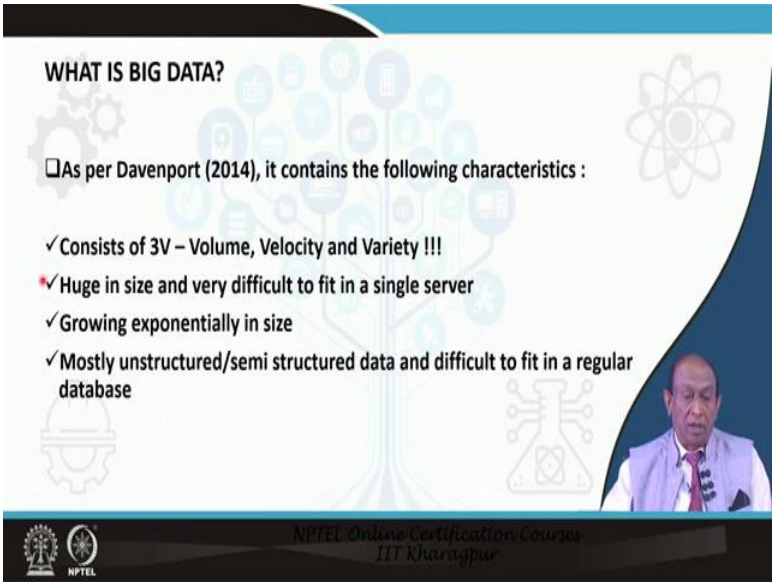
Prescriptive analytics finds optimal solutions to problems. So, basically, prescriptive analytics in supply chain derives decision recommendations based on descriptive and predictive analytics models and as well as mathematical optimization techniques. So, there lies somewhat difference between descriptive and predictive analytics with prescriptive analytics.

Prescriptive analytics is an area where there is extensive application of statistical and operations research models to find optimal solutions and the basis of prescriptive analytics, basically depends on these techniques to be applied after we visualize the data and filter out the data through descriptive analytics, and also getting some insight from predictive analytics. So prescriptive analytics is somewhat at a higher level, basically dealing with optimization techniques.

(Refer Slide Time: 16:50)

It answers the question of what should be happening. So descriptive analytics basically talks about what has happened. Predictive analytics is basically going to tell you what is going to happen and prescriptive analytics will tell you basically what should be happening. Arguably the bulk of academic research in software or in any other practice, particularly in supply chain analytics, focuses on prescriptive analytics. Lot of work is currently being undertaken in the area of prescriptive analytics in the context of supply networks.

(Refer Slide Time: 17:36)

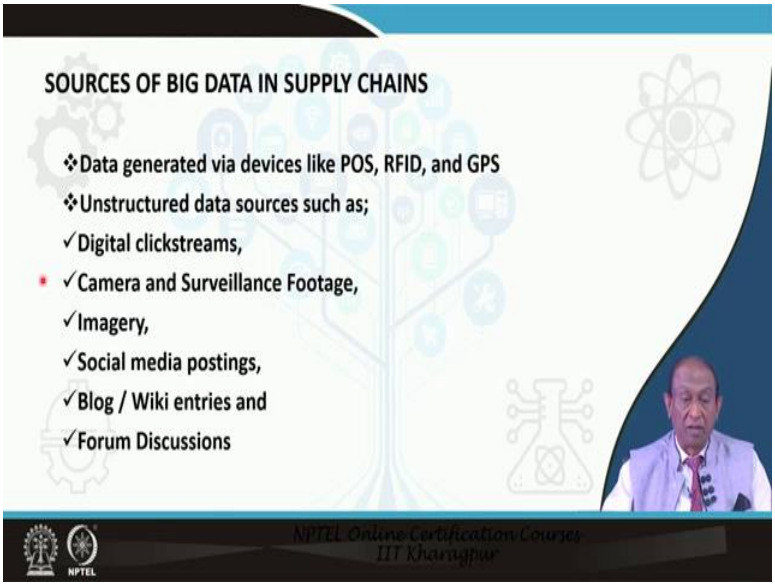


Now, we would like to deal somewhat, little bit on what is big data? Now, as per Thomas Devonport when we talk about big data, it contains the following characteristics. It consists of three V's – Volume, variety and velocity. Volume, because the data is huge in size and very-

very difficult to fit in a single server and is a continuous data, streams of data flowing. So the data is growing exponentially in size. Mostly the data is unstructured or at midst semi structured data and difficult to fit in a regular database. So, this is about volume and velocity.

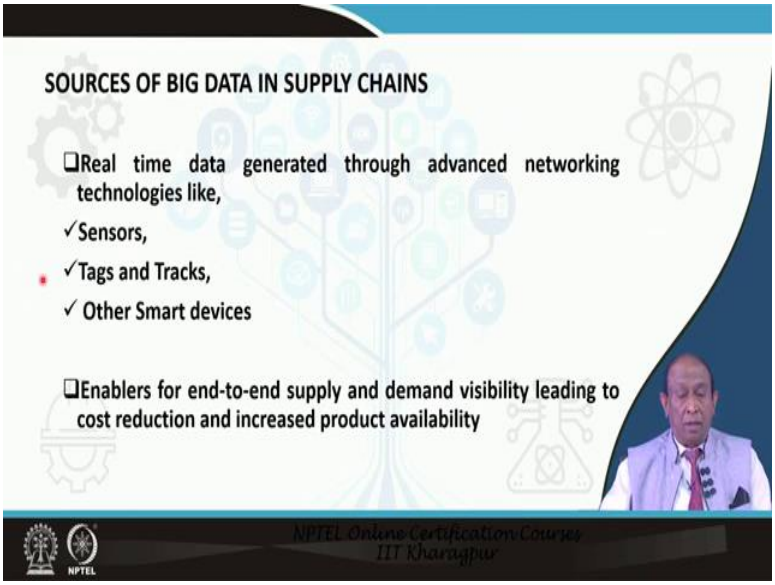
It is constantly you know, we are gathering data and variety comes in terms of different structure. So, in big data environment, data is continuously flowing to fit into a static database or say data mart or data warehouse whatever you might say. And the most important aspect with respect to big data is the lack of structure and not the size. The point is that we need to analyze this data and convert this data into insights, innovation and business value. There lies the challenge of big data in the context of supply chain analytics.

(Refer Slide Time: 19:50)



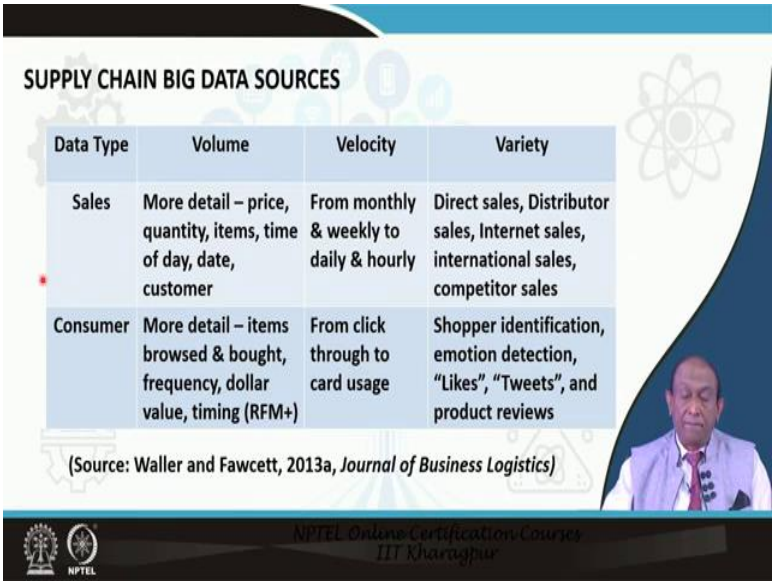
Now, we might ask that what are the sources of this big data in supply chains. If we look at the data that are generated via devices, like say, data generated at the point of sales, point of sale data, RFID, GPS data and all this data are unstructured data, unstructured data sources. For example, digital clickstreams, camera and surveillance footage, imagery, social media postings, blog and wiki entries as well as forum discussions.

(Refer Slide Time: 20:42)



Other sources of big data in supply chains basically, we can mention real time data that are generated through advanced networking technologies, like sensors, tags and tracks and other smart devices. All these are basically enablers for end to end supply and demand visibility that leads to cost reduction and increased product availability.

(Refer Slide Time: 21:22)



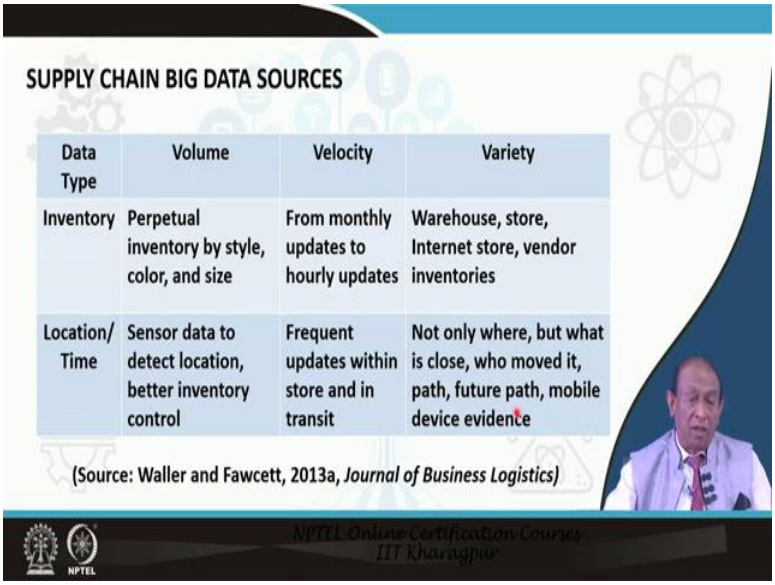
So, let us look at supply chain big data sources if the data type is of the nature sales, sales data. Now, we said that mainly there are three characteristics related to big data volume, velocity and variety. Now, big data with respect to sales is normally generated two point of sales transactions and others what I had mentioned.

Now, when you look at the volume of data, we get more detailed information related to price, quantity, what are the different items that have been sold? At what time of the day, and which date, which customer bought it, all this data, all this information is accumulated in a sales data type in big data.

Now, I will to talk about velocity. In the past, we used to only get monthly data or weekly sales data. But today, with the help of these big data, we can get from monthly and weekly to daily and hourly even on a minute basis. We can get all this information related to sales. And if we are talking about variety, direct sales, distributor sales, internet sales, international sales, competitor sales, all these different types of data are accumulated. They can be analyzed to obtain insights.

If we are talking about consumer data type, we get more detail corresponding to items browsed by the consumer. What are the items that have bought by the consumer? At what frequency the customer is buying? What is the dollar value? At what time? All this information we can obtain when we talk about volume. With respect to velocity the scope is from click through to card usage. And when we talk about variety, we can basically mention about shopper identification, emotion detection, likes, tweets and product reviews, all this.

(Refer Slide Time: 24:19)

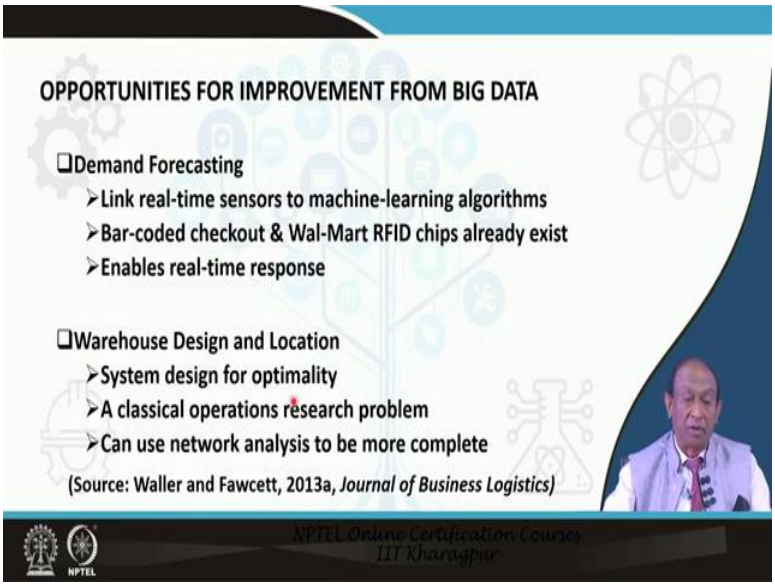


Let us back to inventory data. When we look at the volume of data, we can have access to perpetual inventory data on a continuous basis, perpetual inventory by style, color, size of the product. And here also from monthly updates to hourly updates. Variety, we can have access

to warehouse inventory data, store's inventory, internet stores data, vendor inventories, all these with respect to location and time type of information.

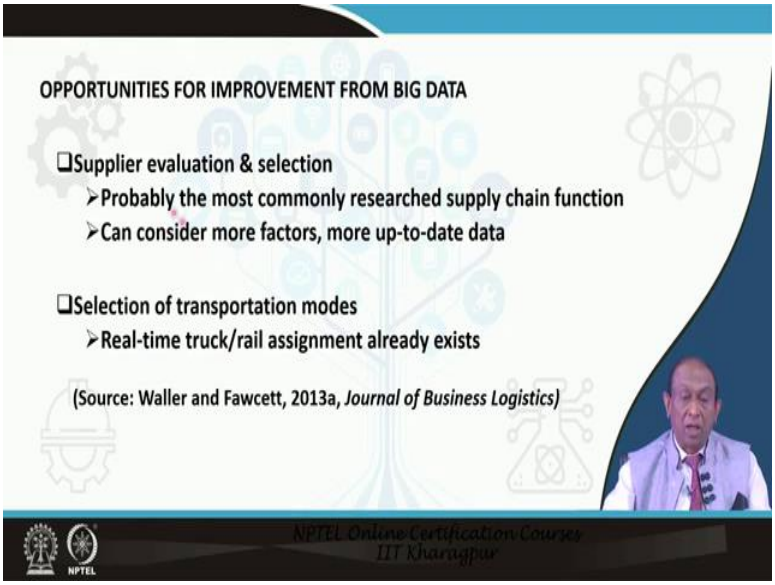
We have the sensor data to detect location, better inventory control, velocity, frequent updates within store and in transit and variety. Not only where but what his close, who moved the data, through which part the data has been moved. What is the future path? Even all mobile device evidence can be captured.

(Refer Slide Time: 25:37)



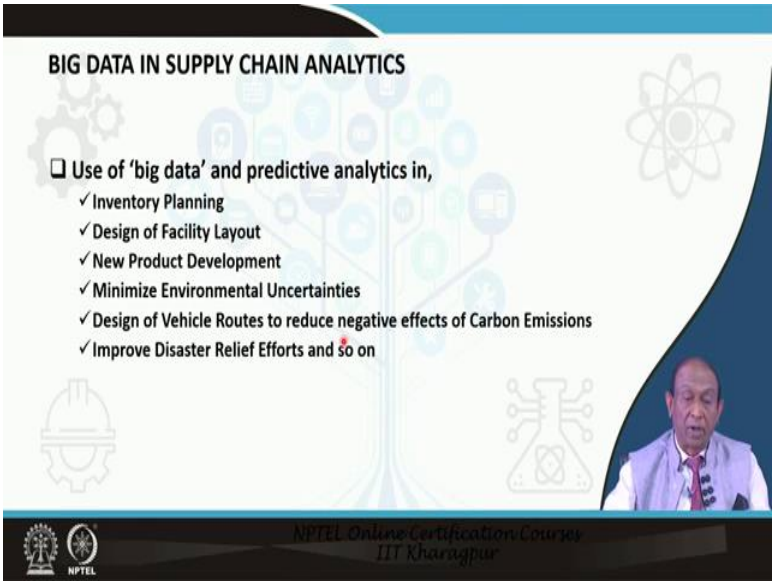
Opportunities for improvement from Big Data lies in the area of demand forecasting where the real time sensor based data is linked to machine learning algorithms. We have barcode at checkout and Wal-Mart RFID chips has already exist that kind of facilitate and it enables real time response. We have warehouse design and location data. We can improve all this through Big Data.

(Refer Slide Time: 26:11)



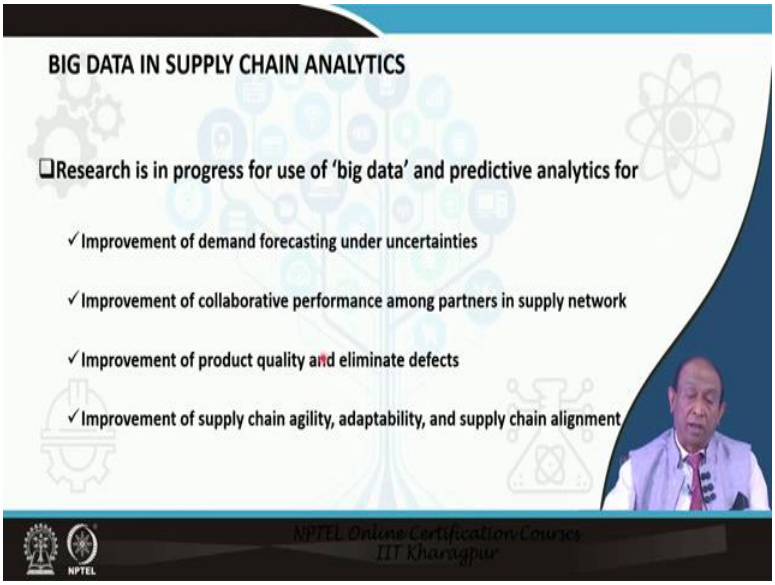
Opportunities for improvement from Big Data lies in supplier evaluation and selection. And it is probably the most commonly researched supply chain function. Selection of transportation mode is also another application area where a lot of improvement have been obtained from Big Data.

(Refer Slide Time: 26:31)



Big Data in the context of supply chain analytics has been used extensively for inventory planning, design of facility layout, for new product development, to minimize environmental uncertainties, design of vehicle routes to reduce negative effects of carbon emissions, improve disaster relief efforts and so on.

(Refer Slide Time: 27:02)



And today academic research or even research in the industry is there in progress for use of big data and predictive analytics for improvement of demand forecasting under uncertainties mainly in a read react situation. Improvement of collaborative performance among partners in supply network, improvement of product quality and eliminate defects.

And big data is also used in improvement of supply chain agility. We have talked about what is agile supply chain? Because agile supply chains guard against disruption in supply. Also, those kind of supply chains are also responsive towards the customer needs. Improvement of adaptability and supply chain alignment particularly big data is currently used in the alignment of the strategies of the different entities.

They are or even functional strategies, they are all now becoming consistent with each other because in any supply chain we mentioned that the objective is basically to improve the overall supply chain profitability, to maximize the value generated supply chain value or what is also called supply chain surplus. In this context, all the functions within an organization that is basically in intra-organization.

And also the different organizations or the entities in the chain must have consistent strategies so that the overall supply chain profitability can be maximized, this also known as supply chain fit. And that can also be achieved by analyzing Big Data, that where somebody's strategy or somebody's key performance indicators is not aligned with the rest of the chain.

(Refer Slide Time: 29:21)

Now, the last thing that we need to know in this particular session is that we are talking about supply chain analytics, we have just understood or got some exposure of what we mean by supply chain analytics but why supply chain is not extensively used in every organization? Yes, it is being used, but not to the extent to which it should have been used.

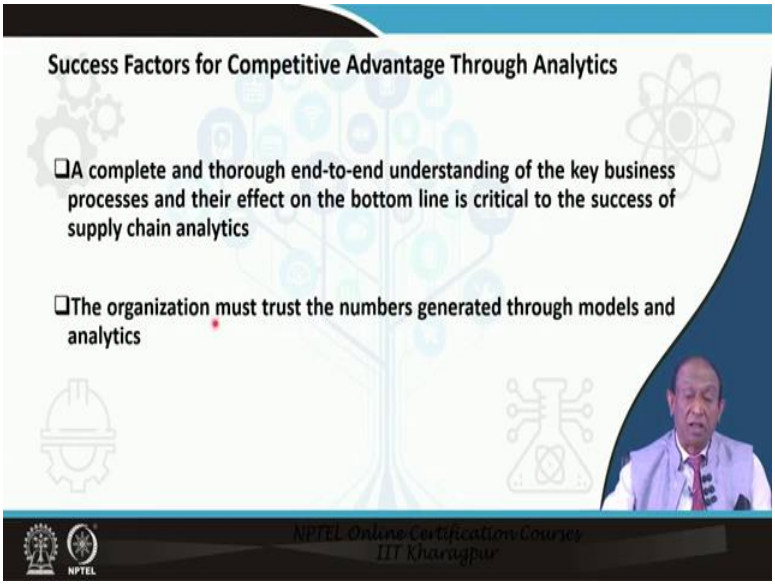
So, there are certain success factors for gaining competitive advantages through analytics. Five or six of them needs mentioned. First of all, in any organization, if they have to apply supply chain analytics in a very successful manner, the top management's support in word and deed to create an analytics culture is absolutely essential.

The top mandate is very necessary to establish an analytics culture in any organization. Analytics professionals must be able to develop and implement simple models, so as to explain the insights and techniques in terms that anyone in the organization can understand. There is no point in developing complex model, which people do not understand.

Because you can only obtain buy-in by developing simple models, the results of which can be explained to anybody in the organization in a manner, which is understandable by him. Sometimes he may be curious to know that through what technique or what is the basis of arriving at these results?

Simple models will help analytics professionals to explain to them that how they have obtained such insights and that is very much important for success of supply chain analytics

(Refer Slide Time: 31:26)



Then, a complete and thorough end to end understanding of the key business processes and their effect on the bottom line is critical to the success of supply chain analytics. And moreover, the organization should have trust on these numbers generated through analytical models and techniques.

(Refer Slide Time: 31:53)

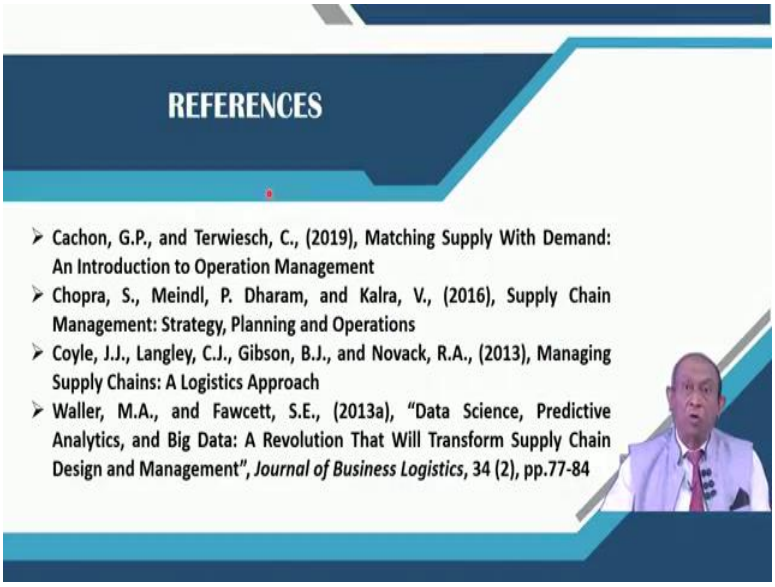
And organizations they require the right kind of infrastructure and mechanisms that will help analytical professionals or all professionals who are engaged in this area to develop domain knowledge. Analytics professionals should gain adequate exposure and knowledge to intricacies of business functions such as supply management, which is also known as

purchasing, distribution, marketing and sales, for successful application of supply chain analytics and gaining competitive advantage.

(Refer Slide Time: 32:36)

Companies, first of all, must try to reduce the time it takes to identify a supply chain problem or opportunity, perform the appropriate analysis and transform the insights into action through a shorter insight cycle time that encompasses every aspect of Supply Chain Management.

(Refer Slide Time: 33:04)



Thank you for today and we will meet next time.