

Predictive inventory management: Keeping your supply chain in balance



Contents

- 2 Introduction
- 2 Keeping shelves full, but not too full
 - Cost containment
 - Risk is everybody’s business
 - You can’t sell what you don’t have
- 4 How predictive analytics aid inventory management
- 5 Inventory and demand forecasting
 - Assortment planning and market basket analysis
- 9 The inner workings of predictive analytics
- 11 Conclusion

Introduction

A lean, efficient supply chain is an important goal for virtually any business involved in manufacturing, distribution or retail. In recent decades, innovations such as just-in-time manufacturing, bar codes and RFID tags, to name just a few, have revolutionized inventory tracking and the entire process of inventory management. Along with these innovations has come a dramatic increase in the quantity of information about inventory. The result is that today, one of the most basic and necessary capabilities of an effective inventory management system is that of coping with the sheer volume and diversity of data involved.

This white paper outlines some of the major factors affecting inventory and supply chain management, and covers practices and capabilities that distinguish the most successful approaches to this complex process. It highlights some of the factors you should consider as you evaluate the maturity of your own supply chain and inventory management processes. It also identifies incremental improvements that can enable you to cost-effectively upgrade your inventory management system, one step at a time.

Keeping shelves full, but not too full

Inventory management is one of the most important operational activities that determine the success or failure of any business. Whether it’s a neighborhood bakery keeping enough doughnuts on hand for a construction crew working nearby or a multinational retailer ordering cargo containers full of merchandise from an overseas supplier, the basic issues are much the same. Maintaining optimal levels of inventory is a challenging process, and one that requires constant vigilance. The right level of inventory—enough, but not too much—can produce happy customers, brisk sales and an optimal capital cost structure. The wrong level of inventory can lead to logistical chaos, lost sales and lower profits.

Cost containment

Any organization involved in the production, distribution or sale of a product holds inventory in various forms (raw materials, work-in-process goods, and finished goods), awaiting processing, packaging, use or sale, as seen in Figure 1. Each type of inventory represents working capital that is tied up and unavailable for other purposes until that inventory leaves the company as purchased goods.

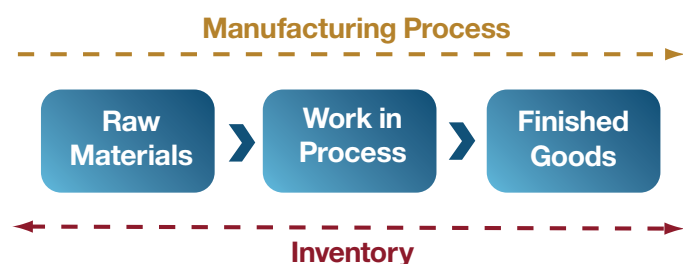


Figure 1: Inventory is held in different forms throughout the manufacturing process.

Inventory typically represents a large portion of the total investment in a business. For retailers, wholesalers and distributors, inventory is usually the largest single asset on the balance sheet and the cost of that inventory is the single largest expense item on the income statement. At any given time, large retailers can have billions of dollars tied up in inventory. For manufacturers, inventory carrying costs often comprise a substantial part of the cost of production, and those costs drive major decisions regarding production and distribution.

It is important to note that the total cost of inventory extends far beyond the cost of goods sold. It also includes carrying costs, or the cost of managing and maintaining inventory. Components of inventory carrying costs can include financing charges or the opportunity cost of the inventory investment, as well as insurance, taxes, material handling expenses and warehouse overhead. Inventory control and cycle counting expenses, along with inventory shrinkage, damage and obsolescence are also factors. Studies of inventory carrying costs have estimated that these costs often represent 25 - 30 percent of the value of inventory on hand for a typical company.¹ And for an average *Fortune* 1000 company, a modest 5 percent decrease in inventory cost translates into a \$20 million increase in profits.²

Risk is everybody's business

In addition to cost, risk is an increasingly important factor in inventory management and supply chain decision-making. In a survey of supply chain executives conducted by the IBM Institute for Business Value, 60 percent of the executives surveyed identified risk as a significant or very significant challenge.³ The leaner the supply chain, the greater the risk of a disruption. And as supply chains have become more globalized and interdependent, risks ranging from an unexpected rise in fuel costs to natural disasters or even political upheaval can have major implications for inventory management.

Reliance on too few suppliers poses a risk, as does the distance from those suppliers. More recently, environmental sustainability has become a supply chain risk factor. “Green” business practices, or the lack of them, can seriously affect relationships with customers. A supplier with a poor record on any number of environmental or labor issues can taint the image of a brand—sometimes overnight—through an unflattering news report or through social media, and inventory is ultimately affected.

You can't sell what you don't have

Managing inventory is a balancing act. Having adequate inventory on hand—but not getting caught with obsolete or out-of-season items—involves skillfully balancing a number of competing requirements and staying alert to changing external factors.

In a retail context, where consumer tastes and preferences are constantly shifting, maintaining a wide assortment of stock is critical. Obtaining lower prices from suppliers by making volume purchases is desirable, but not if it means

ending up with slow-moving inventory that must eventually be sold at a discount or returned. Increasing the rate of turnover and keeping stock levels low is important, but not if it means sacrificing customer service or incurring excessive shipping costs by expediting orders when stocks run *too* low.

In a manufacturing context, a shortage of essential parts or materials could lead to the shutdown of a production line, with ripple effects hitting customers, other suppliers, employees and business partners. An excess of inventory can be just as disruptive, causing, for example, storage problems for factories designed for lean, just-in-time manufacturing systems.

How does an organization predict the optimum level of inventory necessary to meet internal needs or customer demand while keeping the level of reserve inventory or “safety stock” to a minimum? Predictive analytics offers the solution.

How predictive analytics aid inventory management

Implementing predictive analytics in an inventory management process can lead to significant improvements in cost structure, no matter where the inventory resides within the supply chain, as seen in Figure 2. Predictive inventory management includes applications such as demand forecasting and assortment planning. Regardless of the industry, it can help to ensure that inventory levels are optimized for all participants along the entire supply chain as products go from raw materials to work in process to finished goods.

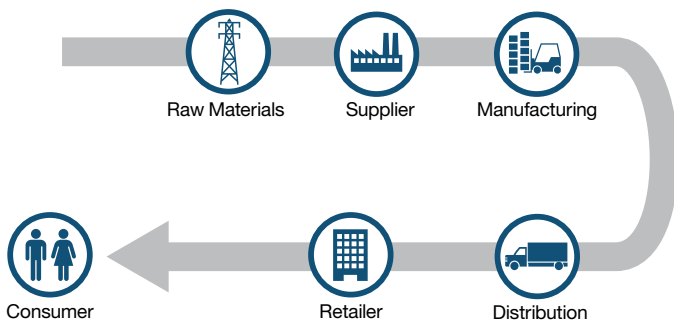


Figure 2: Predictive analytics can aid inventory management along the entire supply chain.

Inventory managers and analysts can use predictive analytics to create models that score inventory levels by SKU to identify which products are likely to be stocked out. Adding business rules and domain expertise to the scoring process helps ensure that both internal experiential information and external factors are taken into consideration. That information can then be fed into operational KPIs and displayed on dashboards to present supply and demand figures and inventory trends with clear, easy-to-understand graphics, providing actionable insight.

With predictive analytics, organizations involved in manufacturing, distribution or retail can:

- Reduce total inventory costs by optimizing inventory levels to better align with demand
- Increase cash flow by reducing working capital invested in inventory
- Improve customer service by providing better availability of both fast-moving and slower-moving merchandise
- Increase the rate of inventory turnover
- Enhance productivity by assuring adequate supplies of essential parts and materials in manufacturing facilities
- Predict the appropriate amount of inventory necessary to meet demand at each facility, while reducing safety stock levels
- Predict how much and when to make-to-order and make-to-stock
- Improve overall profit margins by limiting discounting or scrapping of redundant stock

Inventory and demand forecasting

Forecasting inventory can be a daunting challenge because of the enormous volume of inventory information available. And if multiple systems are involved, it can take substantial manual effort to get one system to work with another. Many organizations carry an extremely wide range of inventory from a wide range of suppliers. That variety is often reflected in the volume and diversity of information used to track its physical movement through the business, for example, from cargo container to delivery truck to loading dock to store shelf to point of sale.

Many of the issues that apply to forecasting mass merchant inventory also apply to both short-term and longer term inventory, including relatively small numbers of complex, highly customized items such as automobiles. Even a single automobile represents a significant amount of capital for a car dealership. But if a car lacks a specific, popular feature or is in a color that appeals to only a narrow group of customers, the dealership might have to sell the vehicle at a significant discount, hurting profits.

Another example might be a chain of hardware stores with multiple outlets in multiple regions. Hardware retailers typically carry a great variety of items in different categories ranging from plumbing, electrical and gardening supplies, to paints, cleaning products and much more. The inventory needed in different stores can vary widely according to factors such as regional climate, demographics and even the age of the housing stock in the specific neighborhood where the store is located.

Ideally, a large hardware retailer would have the ability to dynamically evaluate the demand for all the SKUs in its inventory across hundreds of store locations, in order to increase the accuracy and scalability of its assortment planning process. Inventory planning to anticipate customer demand is highly complex, involving millions of data points and the ability to share consolidated information throughout the entire supply chain.

The major challenge is filtering and analyzing all this inventory data store by store, a task which has historically been left up to local merchandise managers who make allocation decisions based on industry reports, personal experience or gut instinct, with uneven results. But with thousands of SKUs in diverse product categories, this type of guesswork can't account for all the variables involved or drive prudent stocking decisions that help maintain maximum profitability.

A predictive analytics solution, however, can take the guesswork out of inventory forecasting. It can automate category management and generate regular forecasts—as many as thousands of forecasts per month, if needed. These solutions can enable analysts to accurately predict sales and make informed decisions about what products to stock—or remove from the shelves—at every store in the company network.

Predictive analytics solutions from IBM combine user-defined planning rules with the forecasting accuracy that only statistical modeling can provide. Ultimately, inventory management can be fully automated, generating regular forecasts that compare past sales history with sales projections. To track future demand, these solutions can automatically assign a value to each SKU, which correlates seasonal trends and other factors during the forecasting process.

Data can be drawn from multiple sources including internal transactional information, external third-party data, for example, benchmarking data, even weather reports or other relevant information. The data can be structured, unstructured or in text format, such as notes from delivery drivers or customer service representatives. Modern analytic applications are designed to manage these very large data sets regardless of data source and type and they allow users to manipulate and analyze the data with relative ease, and with minimal assistance from IT support staff.

With an automated solution, the company can gain better control over scaling and managing the system, with the ability to add new rules on the fly and continuously evaluate historical patterns and future trends. In addition, with data mining and predictive modeling capabilities the company can identify these trends and predict the performance of product bundles or groups of items that are typically purchased together.

For the hypothetical hardware retailer, a predictive analytics solution can:

- Increase accuracy in inventory placement throughout the supply chain
- Decrease inventory holding costs by accurately predicting the sales of thousands of different items in stores nationwide
- Optimize product mix to fit the specific needs of each store
- Significantly reduce time for assortment planning thanks to automated inventory controls

Most importantly, with the product mix optimized for the needs of each location, the chain's customers can be more confident of finding the items they need. The result is greater customer loyalty and more repeat business.

Assortment planning and market basket analysis

Organizations use a variety of different practices to optimize their assortment planning. One successful practice used by some leading companies is “vendor managed inventory” (VMI). This process enables suppliers to schedule the delivery of goods to sales outlets, saving the retailer the effort of actively monitoring the flow of various items in inventory and making the re-order calculations. The supplier can respond rapidly to information from point of sale (POS) systems and other data sources, automatically ordering replenishments based on sales variations in stores and according to preset business rules. VMI solutions can access a variety of electronic data records from different source systems. The replenishment scheduling systems will compare forecasts with actual sales and increase or decrease inventory replenishments accordingly.

Although innovations and solutions such as VMI enable organizations to view *historical* sales, they have minimal to no capabilities for predicting future sales. Predictive analytics, however, can be used to identify patterns and trends in sales for a single product or set of complementary products.

With the aid of predictive analytics, the assortment of goods exhibited to the customer can be planned more effectively, so that top selling goods are identified and sufficient stock made available to meet demand, while a lower priority is placed on slower moving items. Product characteristics such as size, color, style and model as well as external factors such as seasonality, weather, time of day and a myriad of other factors can all be included in the analysis.

Customers who buy one product may typically purchase another product at the same time for any number of reasons—grass seed and fertilizer, for example. With predictive analytics, once purchasing patterns are identified, an increase in the sales of the first product can trigger an automated decision to increase the inventory of both the first product and its complementary product, helping to maximize total sales volume and customer satisfaction.

This process, called “market basket analysis,” uses algorithms to analyze huge amounts of POS transactional data in order to identify and quantify customer buying patterns, preferences and behaviors. These patterns can drive decisions on how to plan assortments and develop combined offers of multiple products within and across categories, to help drive higher sales and profits. They can be implemented across an entire retail chain or sales channel. If the data is analyzed at the store level, specific offers can be formulated and rolled out at a local level. Business-to-business industries too are increasingly deploying market basket analysis to better manage sales and inventory in all their channels. (See an example in the sidebar on the Brammer Group.)

As seasons change and new products are introduced, predictive analytics can also help determine how to move existing inventory off the shelves with the least negative effect on profitability. The analysis can identify which goods to discount and when, and how large of a discount to offer in order to accelerate sales. Ultimately, organizations will know where best to locate their products on the shelves and how many are needed at a given time.

Predictive analytics enables inventory managers at any point along the supply chain to substantially automate much of the inventory management process. Such a system enhances the decision-making capabilities of managers and frees them from the routine aspects of the inventory management process. It allows them to focus on areas where human experience and insight are most needed.

IBM SPSS Market Basket Analysis

IBM SPSS® software for market basket analysis uses algorithms to analyze huge quantities of point-of-sale (POS) transactional data, revealing associations or patterns that indicate which products are typically purchased together. Market basket analysis helps retailers understand customer buying patterns, preferences and behavior and enables them to create profitable, targeted promotions that deliver the maximum return on marketing spend.

These IBM SPSS solutions are highly scalable. They can analyze the whole range of customer data, relate that to previous purchases and build predictive models that can be applied along with business rules and other analyses for any group of customers and potential offers.

IBM SPSS market basket analysis can be delivered to business users in the form of dashboards, reports, alerts and analysis provided by IBM Cognos Business Intelligence. The combination of IBM Cognos Business Intelligence and IBM SPSS technology provides a complete view of historical performance together with a predictive view of the future. This gives marketing and merchandising managers the insight they need to stock products and create relevant promotions that will consistently improve product sales and margins.

Predictive analytics deliver lower costs, better service at Brammer Group

Brammer Group is a leading European distributor of technical components for the maintenance, repair and overhaul (MRO) of production line equipment. The company maintains an inventory of millions of parts to supply thousands of customers in diverse industries such as automotive, pharmaceuticals, chemicals, food and beverage, utilities and aerospace.

Brammer offers its customers a single source supply for many of the world's leading industrial brands. It is known for its excellent levels of product availability, with an emergency replacement service that dispatches essential parts 24 hours a day, 7 days a week, 365 days a year. Brammer invests considerable capital in maintaining its enormous inventory, and the company realized that identifying and predicting sales patterns could produce significant cost-savings through better inventory control.

Brammer turned to IBM and selected the IBM SPSS Modeler data mining workbench to implement a demand forecasting and stock planning system based on predictive analytics and best practices.

By analyzing the history of previous and current usage, Brammer was able to create profiles of the MRO inventory that customers require. Brammer used this information to predict future requirements and determine the inventory level needed to meet ongoing demand. The new system revealed areas where Brammer could reduce stock, and contributed to a 22 percent reduction in inventory levels, resulting in cost savings of £31.1 million in one year. In addition, customer service and customer satisfaction improved. Brammer is now able to supply infrequently ordered products to its customers just as fast as more regularly ordered stocks.

Additional benefits included:

- Inventory turnover improved from 3.2 to 3.7 times in less than one year
- Standardization of data for all territories served by the company
- Closer relationships with key suppliers and increased spend with those suppliers, leading to further cost savings and greater marketing support from suppliers

Read the [Brammer case study](#).

The inner workings of predictive analytics

Predictive analytics solutions can be used in a three-step process for gathering and using information:

- **Align:** Collect and gain access to inventory information from individual facilities, for example, retail stores, warehouses or factories; POS information from customers or CRM and ERP systems. Enhance this information with customer and employee attitudinal information regarding sales and inventory.
- **Anticipate:** Organize the data, conduct analysis and interpret the results to gain understanding, to identify the key drivers behind sales, and to reliably anticipate customer and supplier needs and preferences.
- **Act:** Use the insights gained to enhance decision-making throughout the organization by incorporating them into organizational processes and decision-making mechanisms. Optimize decision-making by leveraging business rules and predictive analytics to improve the availability of those inventory items and groups of items that have the greatest sales potential.

Controlling outcomes with predictive analytics

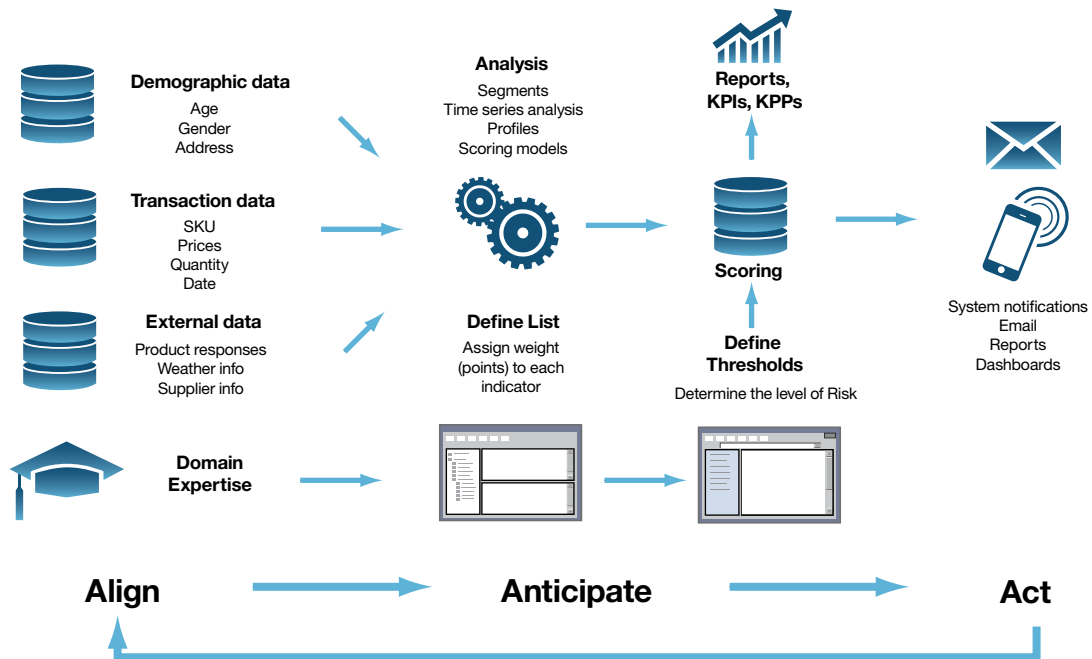


Figure 3: A three-step process for gathering and using inventory information.

Given the importance of inventory management, virtually every area of the business can benefit from using the best techniques and technology available. Yet, because it typically affects so many processes and so many areas of the enterprise, discrete improvements can be made according to the greatest need. IBM has defined a series of incremental steps that any business can take to improve inventory management. These steps are organized in the form of an inventory management maturity model. This model guides the business in upgrading various processes with a minimum of disruption, and in a sequence that builds capability upon capability in a logical progression, suited to the specific industry and specific business conditions.

The Predictive Inventory Maturity Model has five individual steps, each of which delivers its own set of benefits.

- **Develop inventory strategy and metrics.** Identify the most significant factors affecting the cost and effectiveness of your current inventory strategy. How do you define inventory management success? Where are the most promising opportunities for cost savings?
- **Collect and augment information.** Assemble input from different sources and standardize the data in order to allow for apples-to-apples comparison of supplier performance, sales performance, and other factors. Where does existing information currently reside? Is more information needed?
- **Analyze information and predict outcomes.** Perform analysis on the information collected, conduct what-if operating scenarios and predict likely outcomes. Who will conduct the analysis? How often will it be conducted?
- **Share and integrate insights.** Distribute the findings of your analysis throughout the organization, seeking input and validation. Integrate those validated insights into policies and business rules. Who needs to view the output? How can you ensure that the insights are accessible at the appropriate time to the appropriate people?
- **Automate and optimize inventory process to include insights.** Identify those elements of the inventory control process that could benefit from automation and implement an automated process. How can insights be embedded into your processes? How will you ensure that insights are provided to those who need it and that process improvement occurs regularly?

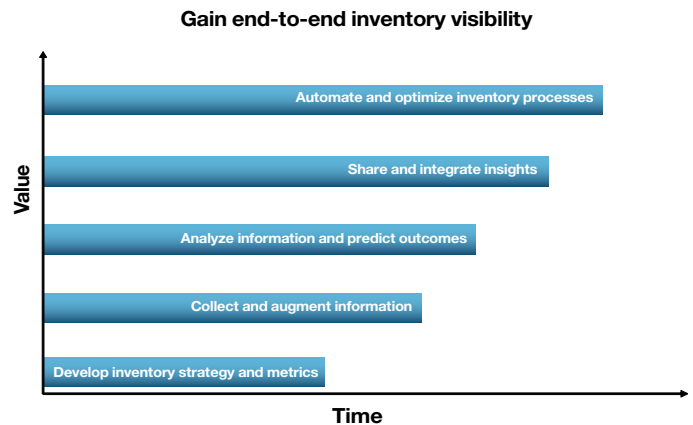


Figure 4: The five-step maturity model for improving inventory management.

Conclusion

Successful management of inventory levels is one of the key factors in the financial success of every manufacturer, wholesaler or retailer. As the primary component of working capital for most of these businesses, inventory affects the flow of money through the business as much as it does the flow of materials and merchandise through the company's operations.

Predictive inventory management helps ensure that the business can meet the ever changing needs of a diverse customer base while minimizing costs and end-of-life discounting, and maximizing profitability. An optimum level of inventory, which enables the business to free up working capital, can give a business the flexibility to take advantage of capital-intensive opportunities when they present themselves.

IBM SPSS solutions for predictive inventory management can help companies determine the correct inventory levels for products and materials at virtually all stages along the

supply chain. These solutions can help organizations balance the trade-offs between carrying costs and customer service levels—and between production volume and capital reserves. By analyzing data from enterprise resource planning (ERP) systems and customer relationship management (CRM) systems, plus logistics information from factory floors, distribution centers and retailers, organizations can gain the insight they need to make better, smarter decisions and compete more successfully.

To further enhance business performance and outcomes, IBM SPSS solutions can easily integrate with IBM Maximo® asset management software, IBM Cognos® Business Intelligence—including dashboards—and IBM financial performance management solutions.

As with all business processes, the search for improvement in inventory management never ends. But predictive analytics has been shown to help forward-looking businesses gain an edge that can keep them one step ahead of the competition.

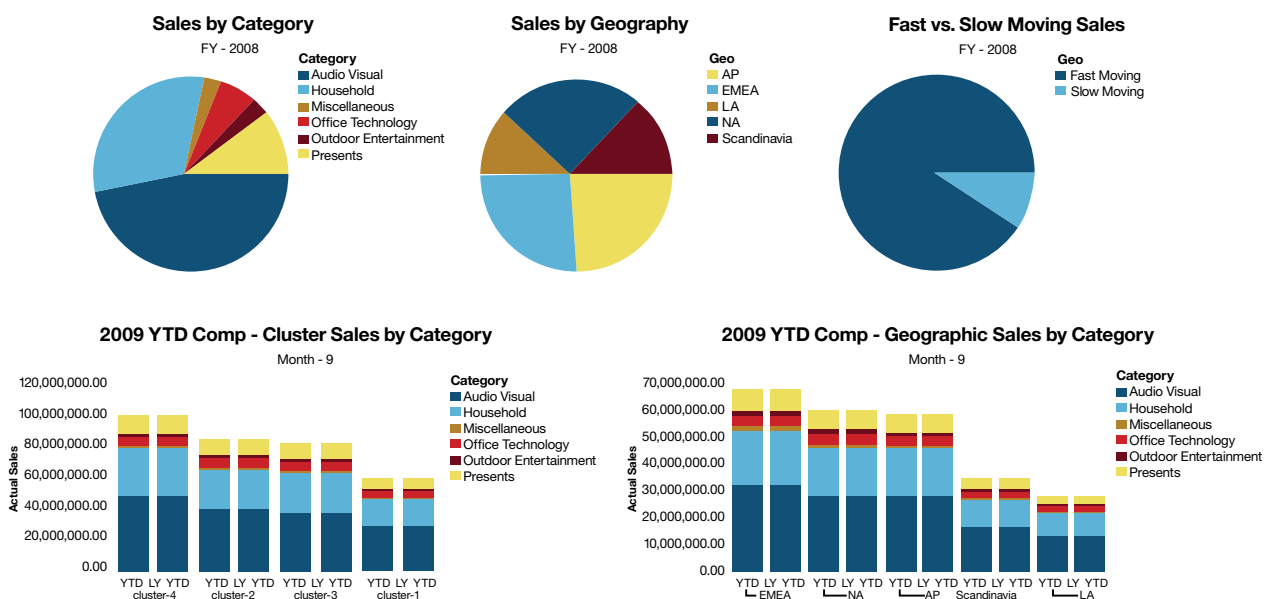


Figure 5: An example of information displayed in an IBM Cognos dashboard.

About IBM Business Analytics

IBM Business Analytics software delivers data-driven insights that help organizations work smarter and outperform their peers. This comprehensive portfolio includes solutions for business intelligence, predictive analytics and decision management, performance management, and risk management.

Business Analytics solutions enable companies to identify and visualize trends and patterns in areas, such as customer analytics, that can have a profound effect on business performance. They can compare scenarios, anticipate potential threats and opportunities, better plan, budget and forecast resources, balance risks against expected returns and work to meet regulatory requirements. By making analytics widely available, organizations can align tactical and strategic decision-making to achieve business goals. For further information please visit ibm.com/business-analytics.

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