

Tech in Business: Research Project Report

on

Visualizations in IoT

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1. Introduction

This paper is research on the implementation of IoT in different domains of our industry being manufacturing, finance, agriculture, healthcare, transportation, and retail. For this case study, every author took up one industry from the industries mentioned and thoroughly studied one organization in the same.

The Internet of Things (IoT) has been rapidly advancing in recent years, and the need for efficient, secure, and reliable networks to connect all types of devices is increasing. As such, many companies have been investing heavily in IoT switch technology. This paper examines the features and benefits of as well as the potential drawbacks the IoT technology has brought in organizations.

Additionally, we extended our research into how the companies utilize visualizations to derive insights from their IoT data. Through this paper, we aim at providing a comparison of organizational changes brought by introducing these visualizations along with IoT technology and what scope it brings for the companies studied.

1.1. What is IoT?

The Internet of Things, or IoT, refers to the collective network of linked objects and the technology that enables communication between devices and the cloud, as well as between devices. We currently have billions of devices connected to the internet because of the development of low-cost computer chips and high-bandwidth telecommunication.

This implies that everyday gadgets like vacuum cleaners, cars, and robots might employ sensors to gather data and respond dynamically to consumers.

The Internet of Things connects "things" to the web. Since the 1990s, computer engineers have started incorporating sensors and CPUs into common items. However, because the chips were large and heavy, progress was initially slow. RFID tags are small computer chips that were initially used to track valuable equipment. These processors evolved throughout time to become smaller, quicker, and smarter as computer devices shrunk in size. Currently, it is far less expensive to incorporate processing power into tiny items. For instance, vibrations in large-scale constructions like dams, bridges, and skyscrapers can be picked up by motion sensors. These gadgets may spot irregularities and disruptions in the structures that might cause disastrous failures.

A whole industry has emerged with an emphasis on outfitting our homes, companies, and offices with IoT devices. These intelligent objects can automatically send and receive data from the Internet. The Internet of Things pertains to all these hidden computing devices and the technology supporting them.

1.2. IoT Development in USA

Worldwide IoT connected device count from 2019 to 2021, with projections until 2030:

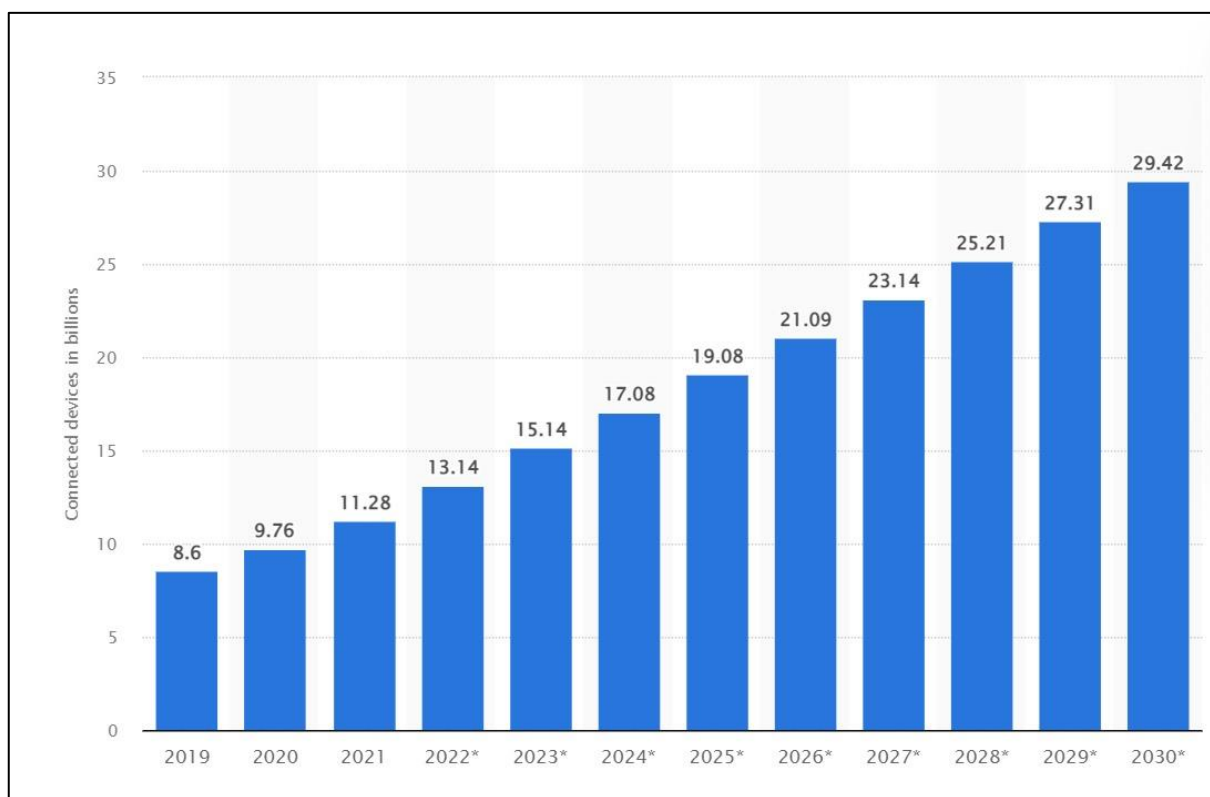
From 9.7 billion IoT devices in 2020 to more than 29 billion IoT devices in 2030, the number of IoT devices is expected to triple. China will have almost 5 billion customer IoT systems by 2030, making it the country with the most of them.

Individual consumers and other business verticals both employ IoT devices, with the commercial market expected to account for over 60% of all IoT-connected devices by 2020. Over the following ten years, it is expected that this share will remain at this level.

Major industry sectors and usage scenarios:

Electricity, gas, steam, and air conditioning, water supply and waste management, retail and wholesale, transportation and storage, and government are major industry sectors with more than 100 million linked IoT devices currently. By 2030, there will be more than eight billion IoT devices in use across all industry verticals.

Household network and multimedia devices like mobile phones, where the number of IoT devices is expected to increase to more than 17 billion by 2030, represent the most significant use case for IoT devices in the retail market. By 2030, linked (driverless) automobiles, Information systems, object tracking & surveillance, and smart grid will all have more than one billion IoT devices in use.



2. Technology Impact of IoT

2.1. Visualizations in IoT

All the gadgets that are connected to the internet are known as smart devices. Use of these smart devices generates a heap of data every single moment. This is called big data. Without a meaningful purpose this data is useless as it is unprocessed raw data. Collecting, Segregating, analyzing, and processing data is mandatory to derive meaningful insights from it. It is important to present this data in a user-friendly manner. Data visualization is now a crucial component of the Internet of Things due to the exponentially increasing volume of data and

the requirement to evaluate and derive relevant insights from it. Data visualization offers a rapid and efficient approach to convey information to spot patterns and trends as well as discrepancies and flaws in the dataset. It enables organizations to make choices quickly and easily, track progress visually, gain actionable insights, and assess the factors influencing consumer and company behavior. With the noise from the data removed and the important information highlighted, a successful visualization tells a story. Data visualization methods and technologies make it possible to effectively carve the data. The information gathered from different types of IoT systems transmitted over time is shown using various widgets on an IoT dashboard in the form of line graphs, geographic maps, bar charts, pie charts, gauges, heat maps, etc. Visualization of data derived from IoT devices ease functioning for the users and the organization indeed.

3. Organizational Analysis

3.1. IoT in Retail: Amazon Go

The older system, let us imagine we are in the year 2000, I basically cannot imagine as I was a toddler back then, but why not! You want to buy something from the Convenience store, like a deli sandwich, coffee, and a few groceries. You will simply go to the store, take a cart from the outside, spend your time searching for those items, put it in the cart, and after finishing it, you stand in a queue outside the cashier counter to check it out. It would probably take you an hour to get those things done. Now, 22 years later, you can get the same things in like 15 to 20 minutes.

3.1.1. What made this difference?

The technology IoT in Retail, and that's what we are going to talk about. The way business is done today, IoT in Retail has been a game changing factor for it. The major concern that retail companies (like any other company) have nowadays is, how can they become more profitable and efficient within their stores. So, with the help of IoT, these retail companies evaluate people's purchasing behaviour, adjust their inventories, and in turn save on storage space, save money, and build relationships with customers.

3.1.2. But using what technologies do the retailers make it possible?

IoT uses technologies like RFID, CCTV's, sensors, barcodes, and GPS, and helps monitor and manage physical assets in an organisation. With the aid of IoT, every device or asset of an organisation can be interconnected with other assets

Again, how are those technologies applied in retail?

These technologies are used in various aspects of retail like Facility management, Supply chain, Predictive equipment maintenance, Personalised offers, and Automated checkouts.

3.1.3. Can you give an example of a company leveraging IoT in Retail?

Amazon, for instance, has been trying out this new phase of checkouts since 2018 in their Amazon Go shops. If I go to shopping, I am easily demotivated by seeing long lines at the cashier, but the greatest advantage of IoT is that it does not have any cashier counters, or any

assistants helping you out. Everything happens with the help of devices connected with each other through the IoT technology. We open the Amazon app, get the in-store code, and scan the code when we walk into the Amazon Go store. We take whatever we want from the store, and items are automatically added to the cart, where we could also put the items back. After finalising, we just walk out of the store, no lines, no checkout. And that is what a ‘Just walk out technology’ means. Let me show you a practical video of my ‘Amazon Go’ experience, to get a more clear idea. It’s the first Amazon Go store that opened to the employees in 2016, and for the public in 2018. *Link:* [My Amazon Go experience!.mp4](#)

3.1.4. How did Amazon achieve this, what did it take?

I think Amazon’s trait in all its business ventures is its willingness to change. For Amazon, Innovation and change drive success work hand in hand. Amazon has innovated leanly by,

- Putting customers first and foremost
- Incremental changes
- Learning from feedback and analytics
- Incremental innovation using

3.1.5. How interested are people worldwide to use these technologies?

A graph below shows how the “just walk out” experience fascinates the shoppers. According to the statistics, majority of respondents opted for a cashier-less experience, 61% were at least somewhat interested in the idea of unmanned stores, and 7 out of 10 were interested in using a scan-and-go app.



3.2. IoT in Agriculture: Cargill

IOT in agriculture made the increase in the agricultural productivity. World’s rapid growth in the nutrition needs is one of the primary challenge facing in the current century. Productivity, efficiency and profitability are the main aspects in the agriculture. So to achieve these there is a need of IOT.

The most powerful tool that has transformed the agriculture is a drone. An American food corporation that's helping the world food system work is Cargill. So basically this is one of the innovative technology making the operations safer. Cargill's Unmanned Aerial Systems (UAS) organization is a group dedicated to using and leading drone technology in a wide range of ways. It is focusing on using drones — instead of people. To enter into a hazardous area for the safety inspection, an employee's life is set to high risk. So, Cargill instead of putting employee into danger introduced drones for the inspection at harmful environments. Drones are helping in giving the detailed inspection details.

Cargill made investment in a drone technology development company which is providing the drones to avoid the entry to dangerous places and reduce downtime. We can predict what our crops need and a computer will stitch together the images and produce a detailed map of the required inspection. More sustainable palm oil production is possible with the help of drones. Since Cargill has the commitment to produce palm oil in a sustainable and economical way. To help deforestation, Cargill introduced drones and ground-base sensors in its palm oil plantations. The thermal cameras in the drones monitor the first sign of trouble. Drones are revolutionizing the business operations.

Here, there Transitional change management took place where there is replacement of what already exists with something different so here drones are replacing the human which is leading to job loss of an employee but in turn it is also providing the employment because a human as a pilot is required to operate the drone. Cargill introduced pilot training programs for their employees so that they can operate the drones easily. So here the Forces of change are innovation and risk reduction.

3.3. IoT in Finance: Capital One

Credit cards, automobile loans, banking, and savings accounts are all areas of expertise for the American bank holding corporation Capital One Financial Corporation. It is among the biggest banks in the country and has earned recognition as a tech organization.

Mr. Fairbank founded Capital One Financial Corporation and currently serves as its chairman, chief executive officer, and president. Mr. Fairbank has developed Capital One from a start-up to one of the top ten banks and 100 largest corporations in the United States, according to Fortune Magazine, via innovation and entrepreneurial leadership. Since the company's foundation, Mr. Fairbank, who has substantial expertise in the financial services industry, has led the company's business skills in the areas of technology, risk management, brand, customer experience, talent development, and diversity.

By bringing innovation, ease of use, and humanity to banking, Capital One is on a quest to assist consumers in succeeding. The company was established on the idea that information and technology, starting with credit cards, will change the banking sector. The company holds the view that teamwork and mutual respect provide the best results and that perspective is the fuel that drives creativity. They are developing real-time, intelligent client experiences across the entire organization. The success that consumers experience and the advocacy they display are how the company gauges its efforts.

Capital One is a leading digital bank in the country who constantly introduces new tech products for banking. To gain market share, Capital One employed a few creative strategies.

Giving cardholders the option to customize their cards or incorporate the logos of their college or sports team made them feel proud, which led to increased spending.

One such recent idea of the firm was to introduce IoT to the banking sector. Capital One came up with an idea to collaborate with Alexa, Amazon's Voice service device. Like other banks Capital One had traditional internet banking, mobile application, and wallet app.

Previously customers were using Capital One through websites or apps. The CEO Mr. Fairbank and CIO Rob Alexander are enthusiastic and encouraging tech lovers. Both have a vision to blend the current technology into the finance sector and their organization. In changing technological trends, Capital One engineers found a potential innovation in syncing the app-based services with voice control feature present in Amazon Alexa. The organization thought of voice interface-based service for customers that would make their banking experience easier. Voice interface helps customers to track their spendings, view their expense charts and operate their banking activities verbally. This feature is also a great help for handicapped people.

In the summer of 2015, a team of developers from Capital One saw an opportunity to create an Amazon Echo skill that would allow users to access their bank records. In a hackathon, teams gathered around, went through a series of options, and started developing the skill. They created their own server-side account linking system for the beta version. Then, in October 2015, the team presented the Beta version at the AWS re: Invent conference. Engineers were extremely motivated and laser-focused on creating the first Alexa skill that would allow users to connect with their bank accounts after the skill's Beta version was successfully tested.

Account syncing with the skill was a simple job, but the development team faced challenges as they were the first in the industry to implement this kind of skill. First, they tried to link sensitive information with Alexa, something no business with an Alexa skill had done before. They had also never created a smart user interface before. Additionally, as they were developing the skill, the Alexa Skills Kit was still developing and evolving, so they had to be adaptable in ability to make quick changes to the code. Organization's primary priorities are always data protection and providing clients with a clear, effortless service.

To tackle these issues the development team of Capital One teamed up with experts at Amazon. To incorporate a security layer that assures information integrity while still delivering an easy, hands-free interface, the technical team at Amazon worked through potential options within the Alexa infrastructure. They implemented a security measure that includes within uttered "personal key" in addition to using OAuth to safely join accounts. Alexa prompts customers to provide a "personal key," a 4-digit personal identification code, as they set up the Capital One skill and pair their accounts via OAuth.

Capital One was the first business to provide its consumers with an Alexa-based interface for managing their bank accounts in March 2016. Customers were able to access all their Capital One accounts, including credit cards, bank accounts, house, and vehicle loans, in real time by using the Capital One skill (app) for Alexa.

The implementation of Alexa Skill brought a change into the banking operations and customer services of Capital One. It helped the bank to learn and analyze the data collected from the customers. With constant updates of operating patterns from the customer the bank can identify needs and risks to provide consumers with assistance whenever necessary. Alexa skill helps to recognize and visualize the digital banking habits of the customers--.

3.4. IoT in Manufacturing: Cisco

Talking about another well-known organization, Cisco is one of the leading global providers of networking and IT solutions. Founded in 1984, Cisco has grown to become one of the world's largest and most influential technology companies. Their products and services enable businesses, organizations, and individuals to connect to the world's most advanced networks and to take advantage of the latest advancements in computer networking. Products and services range from routers and switches to security systems, cloud computing, collaboration, and unified communications. They are committed to providing customers with the highest quality products and services available and to providing innovative solutions that meet their needs.

Cisco's portfolio of IoT switches includes both wired and wireless options for connecting various types of devices. All their switches offer advanced features such as Layer 2/3 switching capabilities, Quality of Service (QoS) for optimizing traffic flow, and advanced security features like 802.1X authentication and MACsec encryption. Additionally, most switches also come with built-in support for Power over Ethernet (PoE), allowing them to be used to power connected devices without the need for additional cables or power supplies.

Before 2001, with three business units devoted to serving the company's three main customer segments—service providers, enterprises, and businesses—organizational Cisco's structure was decentralized. The organizational structure was out-of-date, with a segmented approach to work and an environment where mid-level and lower-level managers, rather than the senior management team, make most of the choices.

Due to this organizational change, Cisco employees were frequently required to abandon operational projects of the Cisco Catalyst 83xx series of switches to finish other deployments. Switches ended up being more expensive than those from other manufacturers due to their elevated level of functionality and quality components.

This cost duplication of work across each of the three customer-facing business divisions, giving rise to issues in sales of their switches and obliged Cisco to fire 18% of its staff and review its organizational structure. Cisco's Vice President of IT NDCS John Manville decided that an organizational change was needed to drive the team to provide the additional scalability and agility for the business to achieve the kind of growth and technology evolution that Cisco IT was expecting.

That company then decided to bring about a more centralized network, one based on silos to one based on a lifecycle model with six stages: prepare, plan, design, implement, operate, and optimize. This new framework clarified each stage of a project, allowing team members to focus on their specific areas of expertise. The numbers published by Cisco showed that employees had more time to dedicate to mentoring, training new hires, and outages dropped from 1,000 to 300 hours each quarter. The number of incidents that had a negative impact on clients decreased from 150 per quarter to 70 per quarter, these numbers provided by the company proves that the change in the functionality of the organizations has led to a positive impact.

The organizational change that the management has taken has definitely brought Cisco's most commercially successful switches, Cisco Catalyst 38xx series of enterprise-class, stackable switches included increased scalability, improved performance and enhanced security.

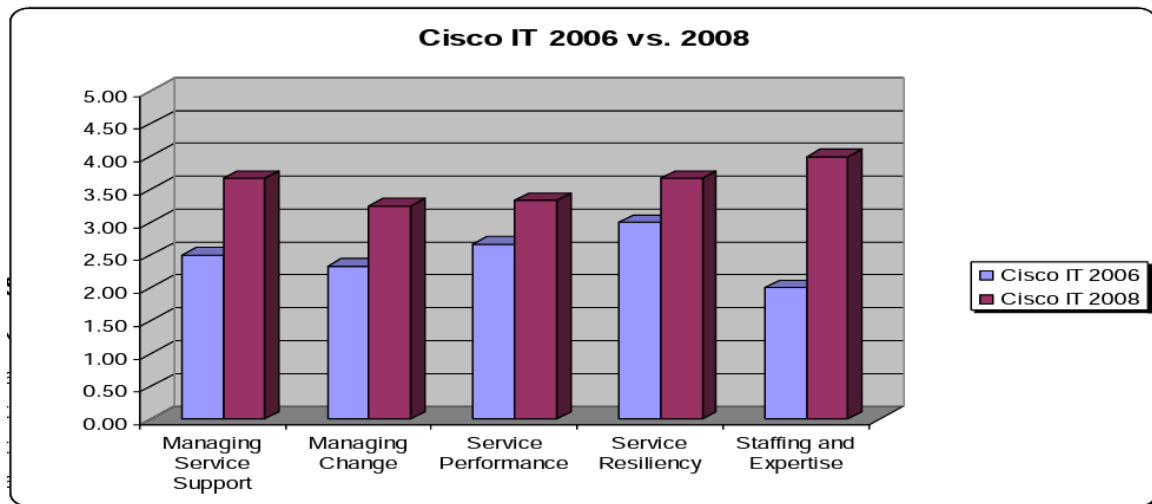


Figure 1: Shows the difference before and after implementing change

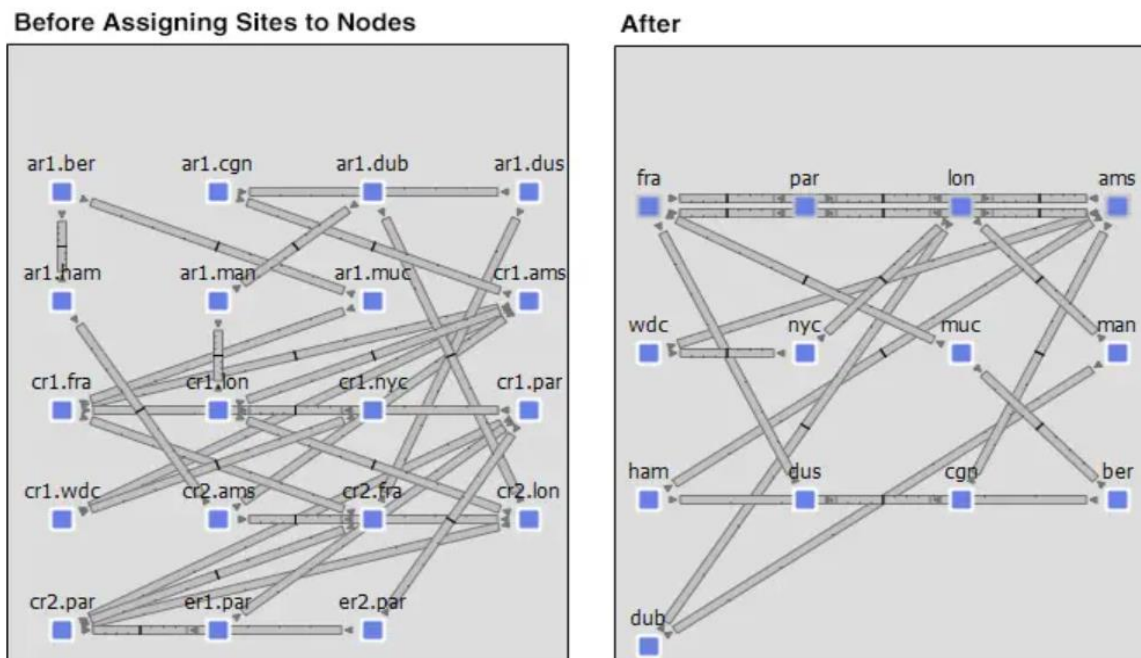


Figure 2: Shows the difference in the switching network after organizational change

3.5. IoT in Healthcare: Medtronic

Medtronic is an American medical device company founded in 1949. The company's operational headquarters is in Minneapolis, Minnesota. It is the largest medical device company in the world and is at the forefront of medical technology. It has a workforce of over 90,000 and is operating in 150 countries. Medtronic's four major segments are cardiac and vascular, minimally invasive therapies, restorative therapies, and diabetes. Medtronic reported revenue of \$31.7 billion in 2021.

Medtronic offered many medicals devices which could measure a patient's physiological parameters at home such as blood pressure, heart rate, blood glucose, oxygen level of the blood

etc. However, there was no system in place to communicate these parameters to a healthcare professional. Interactions with doctors were limited to visits and telephone calls. There was no way doctors or hospitals could continuously monitor patients' health and make recommendations accordingly.

Internet of Things has made remote monitoring in the healthcare industry possible. IOT devices such as sensors, actuators, monitors, camera systems etc. can collect physiological information from the patient. Vital Sync is Medtronic's virtual patient monitoring platform which enables reporting, alarm management, and EMR (electronic medical record) connectivity. The Vital Sync physiological patch, also wireless, is a lightweight device applied to a patient's sternum to continuously collect physiological data — heart rate, respiration rate, single-lead ECG and body position. This data is automatically transmitted to the Vital Sync system where the healthcare professionals can view the information remotely.

Algorithms are used to analyze the data in order to generate alerts on web enabled devices. For example, an IoT sensor that detects a patient's unusually low heart rate may generate an alert so that healthcare professionals can intervene. The data collected from the sensor will be analyzed and visualized in the software. Remote monitoring enables doctors to track patient's health more effectively.

Medtronic is a highly customer centric company. They adopted a completely new technology-IOT which is a transformational change in the company, to make patients lives easier. Remote patient monitoring eliminates the need for patients to visit their providers or gather their own health information. It is helpful for patients who have recently gone through surgery or have a chronic illness. Though remote patient monitoring was already gaining traction before Covid, the global pandemic has highlighted the importance of remote care.

3.6. IoT in Transportation

In recent years, the application of IoT in the transportation sector has accelerated. According to Allied Market Research, the IoT market for transportation is anticipated to reach \$328 billion in value by 2023. IoT devices are used in the transportation industry for a variety of purposes, including ticketing, security, surveillance, and telematics systems, to provide effective and secure transit in urban areas. The Internet of Things (IoT) in the transportation industry uses a large network of embedded sensors, actuators, smart objects, and other intelligent gadgets. This network gathers information about the actual situation and sends it via specialized software to turn it into helpful information.

Logistics links the supply chains to the users through transportation. It serves as a vital link between consumers and products. It is comprised of variables like accessibility, logistics, and movement. By providing advantages like vehicle monitoring, safer route optimization, distance coverage, and others, IoT aids in the integration of the complete management process. The heart of any firm benefits from an intelligent transport management system, as do the traveling public, the motor industry, futureproofing of infrastructure, and so forth. IoT can also automate several transportation-related activities, including parking, identifying available automobiles, navigating, aided driving, and even controlling self-driving cars.

For this case study, we look into why and how Wabtec introduced IoT and visualizations in its products and business processes.

3.6.1. Brief Information on Wabtec

In 1999, the Westinghouse Air Brake Company (WABCO) and MotivePower Industries Corporation merged to become Wabtec Corporation, which is short for Westinghouse Air Brake Technologies Corporation. Pittsburgh, Pennsylvania, serves as its headquarters. Wabtec produces components for locomotives, freight cars, and passenger transit vehicles and constructs new locomotives with a maximum power output of 6,000 horsepower (4 MW). On February 25, 2019, the corporation bought GE Transportation.

3.6.2. Background for inventing new system at Wabtec

In the 1990s, a considerable portion of accidents were related to human error at the time, as shown in several years' worth of official records from the FRA, and most rail lines in the US relied on crew members to adhere to all safety regulations. Around that time, among its "Most Wanted List of Transportation Safety Improvements," the US National Transportation Safety Board (NTSB) included PTC (then known as positive train separation). The collision between a Metrolink passenger train and a Union Pacific freight train on September 12, 2008, in California, which resulted in 25 fatalities and more than 135 injuries, prompted the drafting of a new bill. The US Congress debated a new law in September 2008 that established a deadline of 15 December 2015 for the adoption of PTC technology over most of the US rail network. On October 16, 2008, President George W. Bush approved the 315-page Rail Safety Improvement Act of 2008.

Following this political development, Wabtec deployed a PTC system called I-ETMS (Interoperable Electronic Train Management System). Wabtec's I-ETMS is a safety-critical overlay system that allows for the enforcement of movement authorities, speed restrictions, work zones, and switch location to assist reduce the likelihood of train accidents. To improve the safety of railway operations, I-ETMS integrates new technologies with the current train control and operational systems. The crew still has control over the train, thanks to I-ETMS. The display panel gives the train crew a wealth of operational information while the system monitors and guarantees that the crew complies with all operating orders. The onboard computer continuously determines warning and braking curves based on all pertinent train and track information, including speed, location, movement authority, speed restrictions, work zones, and consist restrictions. It does this with the help of an onboard geographic track database and GPS system.

3.6.3. Change Facilitators: The Great Recession and Industry 4.0

Cheap credit and loose lending rules, which created a housing bubble, were the root causes of the financial crisis of 2008. The banks were left with trillions of dollars' worth of worthless investments in subprime mortgages after the bubble crashed. Following the Great Recession, many people lost their homes, savings, and jobs. The stock market in the United States crashed, wiping off roughly \$8 trillion in value between late 2007 and 2009. In October 2009, the unemployment rate reached a high of 10%. As home values fell and retirement accounts vanished, Americans lost \$9.8 trillion in wealth. According to Moody's Analytics, the Great Recession resulted in a loss of more than \$2 trillion in global economic growth, or a decline of about 4 percent, between the pre-recession high in the second quarter of 2008 and the low reached in the first quarter of 2009.

Around 2011, a new stage of the Industrial Revolution known as "Industry 4.0" placed a strong emphasis on connection, automation, machine learning, and real-time data. Industry 4.0 involves reinventing how your entire organization runs and expands, not just investing in new

technology and tools to increase industrial efficiency. Industry 4.0 transformed how businesses operate. Manufacturers started incorporating cutting-edge technology into their operations and manufacturing facilities, such as the Internet of Things (IoT), cloud computing and analytics, AI, and machine learning. The requirement for connectivity and access to real-time information across processes, partners, products, and people is a challenge that businesses and organizations at that time as well as today must all overcome, even though each one is unique.

The executives at Wabtec had recognized this need and potential of the emerging technologies and set plans into action for brainstorming ideas for incorporating the same. One such opportunity presented itself when General Electric (GE) CEO Mr. John Flannery announced on November 13, 2017, that they would sell its Transportation business within the next two years as it pursues a more focused strategy. The company's stock had fallen by 40% that year following the aftermath of the great recession.

Raymond T. Betler, Wabtec's president, and CEO recognized this opportunity and pursued GE for a potential merger. Wabtec Corporation concluded its merger with GE Transportation, a former GE business subsidiary, in February 2019. By combining Wabtec's wide range of freight, transit, and electronics products with GE Transportation's best-in-class products, services, and digital solutions in the locomotive, mining, marine, stationary power, and drilling industries, this merger made Wabtec a Fortune 500 global transportation and logistics leader. Through this merger, Wabtec also acquired rights to GE's EdgeLinc platform and thus, IoT was incorporated into Wabtec products through EdgeLinc.

3.6.4. New System: EdgeLinc

EdgeLinc is an Industrial IoT platform solution that ensures edge-to-cloud connectivity in transportation. It is a comprehensive edge device lifecycle management platform that offers device administration and streaming analytics, asset performance, and operating efficiency. By utilizing data and insights, EdgeLINC enables you to get the most out of your investments in industrial IoT systems and to significantly increase asset performance and operational effectiveness. Following are some of the features and upgrades that EdgeLinc brought into the locomotive products at Wabtec:

Connectivity

- Manages, monitors, and connects devices in challenging situations. large range of sensors and I/O supported networks
- Offers interfaces for wireless IP communication through cellular and Wi-Fi networks
- Provides two customer-configurable cellular data modem sites and supports GSM, CDMA, and LTE modems

Device Lifecycle Management

- Controls device registration, authentication, and encrypted connectivity to external systems.
- Offers remote over-the-air device configuration and firmware updates for GE and third-party devices
- Supports flexible deployment across GE, customer, and third-party edge devices and applications.
- Has a browser-based user interface for active notifications and history

Rules Engine and Streaming Analytics

- Offers a comprehensive business rules engine that works both on and off-board and supports graphical rules editor
- Delivers pre-defined rulesets that enable locomotive telemetry, fuel monitoring, train handling alerts, etc.
- Executes both on-board and off-board streaming

3.6.5. Benefits and Changes that were brought about by EdgeLinc:

1. The Internet of things makes operations transparent by providing real-time visibility.
2. Issues like truck weight management, delays in traveling, energy and resource management, performance monitoring, location tracking, and safety management can be handled well.
3. A specially designed smart app that measures the load on trucks throughout their shipment and sends the information to the owners on their smartphones. If the load on a truck is reduced or increased beyond the limit, then the owners immediately get notified. They can ensure that their goods are transported legally and safely to the destination.
4. Barcode scanning, GPS tracking, mobile fuel logs, sensors, camera, etc., are used locomotive telemetry. These provide information about engine health, fuel consumption, and inefficiencies.
5. Some sensors are used to track the temperature of the products, shock, and vibration levels, etc., to ensure that the goods are in safe condition.
6. Monitor the wear and tear of vehicles and analyze vehicle health. Using this information, business owners can reduce maintenance costs, saving thousands of dollars. Any breakdown issues of the vehicles can be detected in advance, preventing major damages.

4. Conclusion

Massive and complicated data sets are produced because of the dramatic rise in output brought about by the development of IoT. The incorporation of human judgment into the data analysis process makes it possible for visual analytics to learn from these data sets and gain insightful knowledge. Every IoT data point is important in this process for the extraction of information and practical patterns.

When data is presented visually, human cognitive and perceptual faculties easily detect patterns. To handle the large and streaming amounts of IoT data without sacrificing efficiency and response time, data visualization approaches must overcome several obstacles.

This paper provides a study of visualization methods, tools, and techniques for the IoT. In this study we went through one organization of a respective industry and learnt how IoT implementation brought about change in the business processes.

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