Internet of Things (IoT) – Its Impact on Manufacturing Process

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ABSTRACT
Manufacturers are moving to leverage IoT technologies and data analytics to survive and stay competitive. The Internet of Things (IoT) is transforming manufacturing by making the plants more efficient, productive and smarter. In the light of this, present study addresses the understanding of the concept IoT and smart manufacturing. To order to survive, be competitive in the market place and gain competitive advantage the manufacturers are initiating to leverage IoT technologies and data analytics. With globalisation, Global competitive pressures are challenging industrial and manufacturing companies to manage workforce skills gaps, drive out inefficiencies from their systems, and uncover business opportunities. The world is hurtling into an era of deep data inter-connectivity and companies are able to double their previous production amount, after installing new technologies. International Data Corporation (IDC) forecasts the global IoT market will grow from $1.3 trillion in 2013 to $3.04 trillion in 2020 whereas Cisco predicts the global IoT market will be $14.4T by 2022. This secondary research is undertaken to understand how internet of things can be used in manufacturing. Some analysts are forecasting that there will be as many as 25 billion internet-connected things by 2020, and with more and more companies investing and making an impact in smart technology. Hence the paper focuses on Internet of things, its importance and impact on manufacturing process.

KEY WORDS: Internet of Things, Smart manufacturing, Importance, Impact on manufacturing process

INTRODUCTION
Manufacturing worldwide is on the cusp of a revolution. New information technologies are suddenly offering not only to make the management of manufacturing more effective but also the work itself smarter. Technologies based on the Internet of Things have the potential to radically improve visibility in manufacturing to the point where each unit of production can be “seen” at each step in the production process. Batch-level visibility is being replaced by unit-level visibility. This is the dawn of smart manufacturing. The reality is that the IoT allows for virtually endless opportunities and connections to take place, many of which we can't even think of or fully understand the impact of today.

The "Internet of things" (IoT) is a concept that not only has the potential to impact how we live but also how we work. Broadband Internet is becoming more widely available, the cost of connecting is decreasing, more devices are being created with Wi-Fi capabilities and sensors built into them, technology costs are going down, and smartphone penetration is sky-rocketing. All of these things are creating a "perfect storm" for the IoT.

The Internet of Things
It is basically connecting any device with an on and off switch to the Internet (and/or to each other). This includes everything from cellphones, coffee makers, washing machines, headphones, lamps, wearable devices and almost anything else you can think of. This also applies to components of machines. The analyst firm
Gartner says that by 2020 there will be over 26 billion connected devices. That's a lot of connections (some even estimate this number to be much higher, over 100 billion). The IoT is a giant network of connected "things" (which also includes people). The relationship will be between people-people, people-things, and things-things.

There is no unique definition available for Internet of Things that is acceptable by the world community of users. The Internet of Things can also be considered as a global network which allows the communication between human-to-human, human-to-things and things-to-things, which is anything in the world by providing unique identity to each and every object.

The “Internet of Things” refers to the coding and networking of everyday objects and things to render them individually machine-readable and traceable on the Internet.

**History**

The Internet of Things is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology. The first Internet appliance was a Coke machine at Carnegie Mellon University in the early 1980s. Though the buzzword “Internet of Things” evolution was set out a way back in 1980’s with coffee vending machine, the original term is coined by Kevin Auston, the Executive Director of Auto-ID Labs in MIT in 1999. The concept of IoT first became very popular through the Auto-ID centre in 2003 and in related market analysts publications. Right from the beginning the Internet of Things evolution started, there were many things or objects connected to the internet for the different applications through diverse technologies depending on the type of object for the comfort ability of Human.

**Smart Manufacturing**

As global market and industry dynamics push manufacturers to rethink their manufacturing operations, effective factory management is essential. Smart manufacturing requires IoT-driven data analytics to improve asset utilization and greater efficiency. Combining new and old data with analytics-driven insight will give manufacturing workers the degree of flexibility and decision-making capability they need to deal with increasing market complexity and demand variability.

Smart manufacturing is about creating an environment where all available information—from within the plant floor and from along the supply chain—is captured in real-time, made visible and turned into actionable insights. Smart manufacturing comprises all aspects of business, blurring the boundaries among plant operations, supply chain, product design and demand management. Enabling virtual tracking of capital assets, processes, resources and products, smart manufacturing gives enterprises full visibility which in turn supports streamlining business processes and optimizing supply and demand.

In essence, smart manufacturing is a decision-making environment. Very importantly, smart manufacturing includes proactive and autonomic analytics capabilities, making smart manufacturing an intelligent and self-healing environment. With smart manufacturing organizations can predictively meet business needs through intelligent and automated actions driven by previously inaccessible insights from the physical world. Smart manufacturing transforms businesses into proactive, autonomic organizations that predict and fix potentially disruptive issues, evolve operations and delight customers, all while increasing the bottom line.

Smart manufacturing, is essentially a platform that integrates several technologies, such as connectivity technologies (the network that enables things to connect to the Internet), the cloud (the computing and storage environment where assets can communicate) and Big Data analytics (the intelligence of the system that is able to analyze data and provide insights on the fly). The idea is to use connectivity technologies (e.g., industrial networks, wifi, M2M, etc.) to link factory automation assets (e.g., production equipment, robots, RFID, etc.) to end-user apps (e.g., MES, PLM, ERP, etc.), as well as mobile devices for more active and precise business decision-making.
RESEARCH METHODOLOGY
Secondary data sources that is from websites, books are journals is taken for the study.

OBJECTIVES
1. To understand the concept of Internet of things and smart manufacturing.
2. To study the application of IoT in manufacturing process.
3. To analyse the impact of IoT on manufacturing process.

REVIEW OF LITERATURE
From the MPI Group’s Internet of Things Study which is based on interviews with 350 manufacturers completed during August and September 2015 it was found the following:

- Despite the high level of interest and planning, only 10% of manufacturers have implemented an IoT strategy today.
- 63% of manufacturers have either implemented or are planning to integrate IoT technologies into their products.
- 58% of manufacturers say that improving product quality is the most important objective they are pursuing by incorporating smart devices or embedding intelligence.
- 44% of manufacturers say that their biggest obstacle in leveraging the IoT is their company’s limited knowledge of how the IoT can improve operations and products.
- 71% of manufacturers say that IoT will have a significant impact (24%) or some impact (47%) on their business over the next five years, yet 24% have no companywide understanding of IoT. While the majority of manufacturers see the value of IoT, there’s a significant knowledge gap in how to best plan for and capitalize on these technologies.
- 76% of manufacturers will increase their use of smart devices or embedded intelligence into manufacturing processes in the next two years. 66% will increase their use of non-production IoT applications. Manufacturers consider shipping, warehousing, document management to be the best opportunities to improve operational accuracy and performance.
- Enabling existing products with IoT technologies (28%) is the best opportunity according to manufacturers. Providing IoT technologies for other manufacturer’s products (10%) and devices for other manufacturers (9%) are the top three most attractive opportunities to manufacturers today.
- Improving customer satisfaction (76%), enabling greater productivity (75%), and contributing to higher product quality (72%) are the top improvements manufacturers anticipate will most impact profitability.
- Additional areas where IoT strategies are expected to make solid contributions include speed and on-time delivery (59%), machine reliability and uptime (59%), product and service innovation (54%). The study also found manufacturers are focusing on improving cost controls and reductions (53%), safety (41%) and attaining sustainability goals (16%).
- Just 10% of manufacturers have networks capable of machine-to-machine communications today. 41% predict some upgrades to their network will be required, and 32% say significant upgrades are needed to attain machine-to-machine integration. 18%, or nearly one in five, say their systems will need to be overhauled.
- The majority of manufacturers are planning to embed smart devices in their products with increasing revenue from new products and market share (both 39%) being the most pervasive objective. Additional objectives include accessing data from products or services in the field (34%), increase profit margins per product (34%), improve branding and market awareness (27%) and access new markets/sectors (26%).
- 58% of manufacturers say that improving product quality is the most important objective they are pursuing by incorporating smart devices or embedding intelligence. Increasing operational performance
and speed (57%), decreasing manufacturing costs (57%), improving manufacturing equipment maintenance and uptime (47%) and improving information for business analytics (42%) are the top five objectives manufacturers are pursuing with IoT technology adoption.

- Identifying opportunities/benefits of IoT (44%) and having network capabilities that can scale to handle IoT (38%) are the two biggest challenges facing manufacturers today. Additional challenges include budget and resources to develop or expand IoT initiatives (37%), incorporating smart devices or embedded intelligence (37%), adapting existing technologies (36%).

SCM World’s field survey in 2015 on smart manufacturing and the Internet of Things finds that while one in five today admit their factory operations are offline completely, this will drop to near zero in five years. About 40% of survey respondents believe that smart manufacturing along with its foundational technology—the Internet of Things—is ready and that it’s the right time to invest. Only 3% dismiss smart manufacturing and the Internet of Things as pure buzzwords. Most of the respondents expected performance outcomes were expected with smart manufacturing, and found some very high hopes. Gains in quality, uptime, inventory efficiency and more are expected to be well into double-digit percentages.

Cisco predicts the global Internet of Things market will be $14.4 trillion by 2022, with the majority invested in improving customer experiences. Additional areas of investment including reducing the time-to-market ($3T), improving supply chain and logistics ($2.7T), cost reduction strategies ($2.5T) and increasing employee productivity ($2.5T). The cited infographic also found that 50% of IoT activity today is in manufacturing, transformation, smart cities and consumer markets. Industry-specific use cases will generate $9.5T (66%) including smart grid, connected personal vehicles. Cross-industry use cases will generate $4.9T (34%) including future of work initiatives (telecommuting and collaboration technologies), and travel avoidance. (Source: Embracing the Internet of Everything To Capture Your Share of $14.4 Trillion, white paper published by Cisco.)

BI Intelligence also predicts the number of devices connected via IoT technology will grow at a 35% CAGR from 2014 to 2019. Source: Business Insider, The Internet of Everything, 2015 Slide Presentation.

Cisco predicts Smart Factories will contribute $1.95T of the total value at stake by 2022. Source: Embracing the Internet of Everything To Capture Your Share of $14.4 Trillion, white paper published by Cisco.

The number of connected devices is projected to grow from 22.9B in 2016 to 50.1B by 2020, attaining a 21.62% CAGR in four years. Source: World Economic Forum, Is this the future of the Internet of Things?, November 27, 2015.

![FIGURE1: GROWTH IN THE INTERNET OF THINGS](image_url)
The IoT market revenue will grow from $1.928B in 2013 to $7.065B in 2020. IDC predicts that the installed base of IoT units will grow at a Compound Annual Growth Rate (CAGR) of 17.5% from 2013 to 2020, reaching 28.1 billion units in the forecast period. Source: Worldwide and Regional Internet of Things (IoT) 2014–2020 Forecast: A Virtuous Circle of Proven Value and Demand Internet of Things.

KPMG’s 2015 Global Innovation Survey show the following study:

- Global tech leaders predict cloud computing (11%), mobile platforms and apps (9%), Internet of Things (IoT)/M2M (9%) and data and analytics (9%) will be the most disruptive technologies over the next three years. U.S. tech leaders predict biotech/digital health/healthcare IT (15%), data and analytics (14%) and cloud computing (14%) will be the three most disruptive technologies over the next three years. Chinese tech leaders predict artificial intelligence/cognitive computing (15%) will be the most disruptive technology impacting the global business-to-consumer (B2C) marketplace.

- The three most disruptive technologies predicted to drive business transformation in enterprises over the next three years in the U.S. include cloud computing (13%), data and analytics (13%), and cyber security (10%). Japanese tech leaders predict artificial intelligence/cognitive computing will have the greatest effect (23%), and 14% of Chinese tech leaders predict the Internet of Things/M2M (14%) will have the greatest impact on business transformation in their country. The following table compares global tech leader’s predictions of which technologies will disrupt enterprises the most and drive business transformation over the next three years.

- Improving business efficiencies/higher productivity, and faster innovation cycles (both 20%) are top benefits tech leaders globally are pursuing with IoT strategies. The point was made on the webinar that in Asia, consumers are driving greater adoption of IoT-based devices to a richer contextual customer experience. Greatest challenges globally to adopting IoT is technology complexity (22%), lack of experience in the new technology or business model (16%), and both displacement of the existing tech roadmap and security (both 13%).

**EXAMPLES OF COMPANIES**

A number of leading global manufacturers—including the likes of Bosch, Cisco, FCA (Fiat Chrysler Automobiles), GE, General Mills, Harley-Davidson and Siemens—are early adopters of smart manufacturing in their plants. Interesting examples include:

**Siemens.** At Siemens’ electronics manufacturing plant in Amberg, Germany, machines and computers handle 75% of the value chain autonomously, with some 1,000 automation controllers in operation from one end of the production line to the other. Parts being produced communicate with machines by means of a product code, which tells the machines their production requirements and which steps need to be taken next. All processes are optimized for IT control, resulting in a minimal failure rate. Employees are essentially supervising production and technology assets, including handling unexpected incidents.

**General Electric.** At one of GE’s Durathon battery plants, 10,000+ sensors measure temperature, humidity, air pressure and machine operating data in real time. This not only gives the opportunity to monitor production and adjust processes in real time, but also to trace battery performance back to specific batches of powder and at every step along the process.

**Harley-Davidson.** Much of the turnaround that Harley-Davidson achieved in rebuilding its major production facility in York, Pa., is due to a dramatic increase in visibility. Every asset on the plant floor is connected and every step in production is tracked and incorporated in a real-time performance management system.

**Cisco.** To better orchestrate its global network of outsourced production plants, Cisco developed a “virtual” manufacturing execution system platform (VMES), which provides real-time visibility of production operations. The system leverages technologies such as cloud, Big Data analytics and the Internet of things to connect and gather real-time information from production machines, enabling predictive quality capabilities in a fully outsourced manufacturing environment.
IMPORTANCE OF INTERNET OF THINGS AND ITS IMPACT ON MANUFACTURING PROCESS

The following are the applications and its impact on the manufacturing process by connecting the factory floor, machinery, equipment and production lines.

i. Helps in driving operational productivity and profitability and also helps to optimize performance and efficiencies across your industrial devices, production lines, and factory as a whole

ii. By using cloud technologies to monitor and optimize equipment performance, without disrupting factory operation

iii. Gain operational visibility: Operate at peak efficiency by drawing insights from data generated by connected equipment.

iv. To improve efficiencies, optimize processes, and decrease ingredient waste. Ex: Hershey is expanding their Microsoft IoT Solution, from intelligent sensors on the factory line to packaging, transportation, and customer behavior.

v. To better serve its customers and maintain its more than 13,000 commercial aircraft engines around the world Ex: Rolls-Royce applied the predictive analytics capabilities to access data that helped them reduce fuel consumption, minimize maintenance costs, and improve the customer experience.

vi. To help improve the scalability and global tooling solutions it delivers to its customers, Sandvik optimized its manufacturing process and created a predictive maintenance schedule.

vii. Combining predictive analytics and preventive maintenance, Rockwell Automation created an IoT solution to monitor valuable capital assets—including mining, transport, refining, and sales operations equipment—and better provide its customers with real-time insights at every point of the supply chain, helping predict problems before they occur.

viii. Jabil, one of the leading design and manufacturing solution providers in the world, used IoT for machine learning and predictive analytics that connect its factory floor to the cloud to reduce unplanned maintenance costs and downtime, and gain better agility to meet its customers’ demands.

ix. To help ensure the power stays on when customers need it most, Cummins Power Generation used IoT solution to help create a cloud-based, remote monitoring that provides new insight into data to predict and avert problems.

x. Because managing power supplies is a priority, ABT Power Management selected Azure IoT Suite to provide insights and predictive maintenance for more than 6,000 managed assets, helping avoid operations coming to a standstill due to faulty industrial forklift or truck power supplies

xi. To improve operational efficiency for its partners in the field, MARS DRINKS built an Azure IoT Suite-based solution that uses predictive analytics and collects real-time data from vending machines to reduce the frequency of downtime and out-of-stock products

xii. To improve efficiencies, optimize processes, and decrease ingredient waste, Hershey is expanding their Microsoft IoT Solution—including Cortana Intelligence—from intelligent sensors on the factory line to packaging, transportation, and customer behaviour

CONCLUSION

IoT has been gradually bringing a sea of technological changes in our daily lives, which in turn helps to making our life simpler and more comfortable, though various technologies and applications. The Internet of Things has a catchy ring to it, but for many the possibilities are almost too far-reaching to imagine. For manufacturers the likely impact of IoT in smart manufacturing looks very big indeed. In future manufacturers will rely on connected products to provide product as a service. They will explore the viability of micrologistics networks to make better business decisions through investments in operational intelligence and enable the promise of accelerated delivery for select products and customers.
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