Big Data Analytics with IoT in Traditional manufacturing industry: The emerging era

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Abstract

Big Data and the Internet of Things (IoT) have been implemented as solution technologies in Information Technology (IT) industries for some time now, but the integration of these technologies to attain higher precision, pattern predictions and reduced hazards with regard to manufacturing industries, is still in its early stages. Along with these setups a remote/mobile access to conclusions has always been a tempting feature for industries.

The technological advancements with the proliferation of data over the internet and varying devices with continuous surging recordings play a vital role in the growth of industries in today's scenario. Academic research in this rapidly spurting field and teleology of this evolving phenomenon of 'Big Data Analytics in Traditional Manufacturing Industry' may exhibit insights with significant implications for practicing industrialists as well as academicians.

The manufacturing and industrial entities observe bewilderments and limitations when it comes to real time access to analyzed conclusions regarding discretely placed actuators and sensors collecting data continuously throughout the industrial premises. A heuristic for this obscurity is proposed in the paper highlighting the implementation of popular and niche technologies that are Internet of Things (IoT) and Big Data Analytics in an integrated manner.

This paper is an effort to explore the current state of, 'Big Data Analytics with IoT in traditional manufacturing industry', and propound a methodology to accentuate its utilization in the industry for good. Through a review of relevant academic literature, the paper attempts to posit a valid solution and discuss its contributions.

Keywords: Big Data; Internet of Things; Information and Communication Technology; Big Data Analysis; Information Technology; Teleology;

1. INTRODUCTION

The Information and Communication Technology (ICT) advancements and profuse internet based developments compel the manufacturing industry to change its methods of functioning in order to benefit the most. This leads industrialists and practitioners to delve for smart surroundings and deduced conclusions along with a remote access for a cherry on top.

Smart surroundings in regard to manufacturing industries is an immensely advantageous feature which provisions- a) Highly accurate and timely noted data values, b) Reduced human intervention implying lesser of risks in adverse conditions and c) On time alerts for immediate actions to be taken. Big Data analysis on the other hand poses its own benefits of high speed conclusion deduction and pattern prediction. Internet of Things is said to be the beginning of industrial evolution 4.0 leading the world to a new era, similarly, Big Data Analysis has been termed the most value creation technology in today's scenario for its features of extracting value from vast sets of data at a high speed.

The current scenarios of manufacturing industries with adverse working conditions regarding temperature and/or pressure or tough situations, still deploying human support at such locations have lead to excoriations and polemics in public, and sufferings from- inaccuracy of gathered data; untimely recordings; risk of human life and increased number of manpower requirement. Albeit the ambits the industry is curbed by the data if even congregated may be distorted and is treated in an apathetic manner.

The integration of IoT with Big Data Analysis and a remote access to deductions methodology is discussed as a workable solution to the above problems for industries. The suggested solution possesses the potential to not only eradicate the insolvencies of the mentioned issues to an extent but to provide an expedient and conspicuous growth in regard to the organization functioning. The implementation of these technologies in a coalesced fashion is yet to be completely explored and scourged for its benefits.

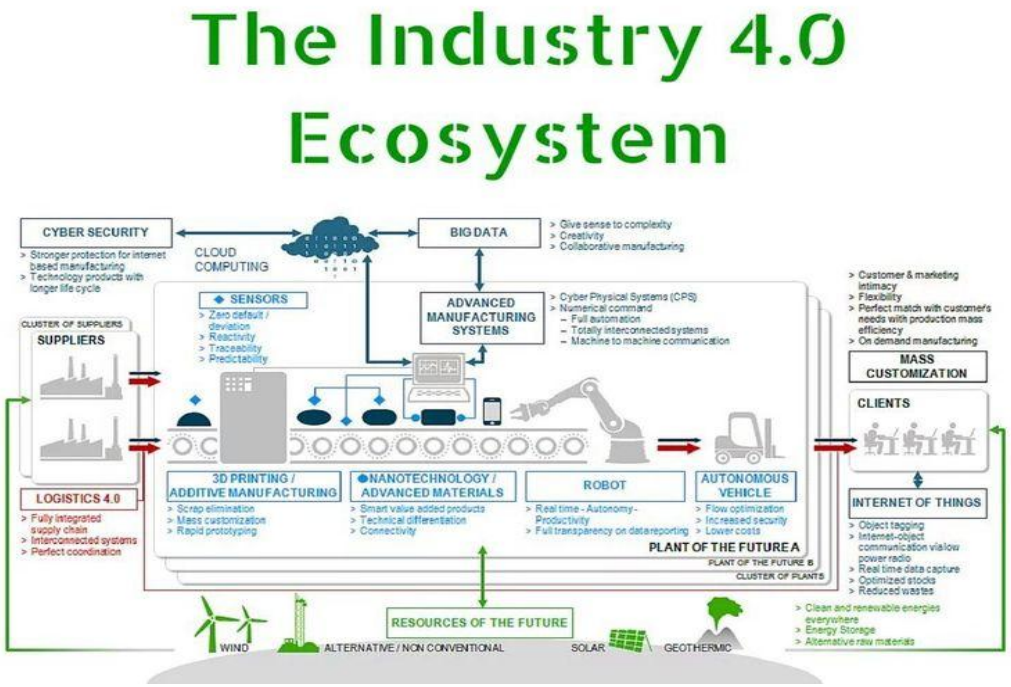

Figure 1: Industry Evolution 4.0

2. PROBLEM STATEMENT

2.1 Background

The technological concepts of both IoT and Big Data have been well researched upon and implemented in various fields on separate notes. These have been hyped about and have proved to pose strength of such levels as well. The popularity of these technologies used in a segregated manner is hard to miss and enough work and investments in the two have been contributed by industries in expectance of high ROIs. According to a Tata Consultancy Survey, manufacturers utilizing IoT solutions in 2014 saw an average 28.5% increase in revenues between 2013 and 2014 (Greenough, 2016). Hence influencing further investments by organizations in smart and clean manufacturing and analysis which lead BI Intelligence's Business Insider to estimate in their report that global manufacturers will invest $70 billion on IoT solutions with Analytics in 2020. As a contemporary, regarding Big Data, as of 2017, 94% of Big Data Analytics users perform analytics on large volumes of data which was not possible before; 88% analyze data in greater detail; while 82% can now retain more of their data.

2.2 Current Standings

The implementation of IoT and Big Data Analytics in an integrated manner to attain business solutions and increased monetized insights still observes paucity due to haywire and continuous change in the technology world. Adapting to the pace of change is difficult with such magnitude to concern with. Although tempting advantages and ease of work posed by the integration has encouraged organizations to move forth with it. Companies are shifting towards more sophisticated and smart working allured by the rewarding ROI exhibited by hidden value and patterns in huge data sets.

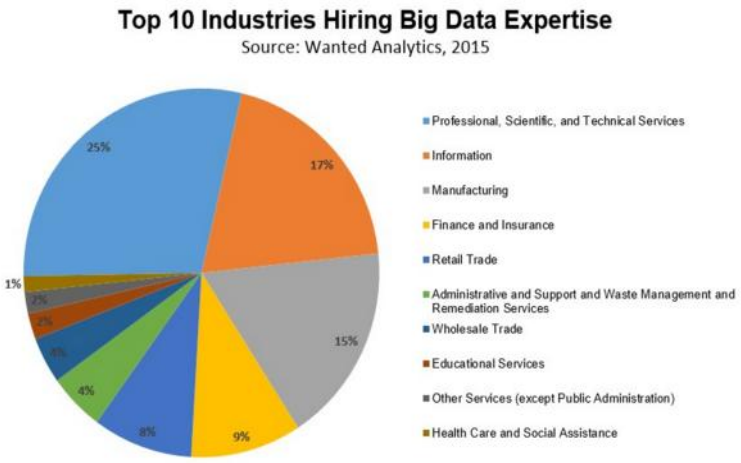

Figure 2: Big Data Hiring

Not implemented enough but the concept of using the two technologies in a parallel manner to gain benefits of new altitudes has been well researched upon by numerous academicians and business intelligence researchers. The phenomenon 'Big Data Analytics with IoT in traditional manufacturing industry' has been noticed on a large scale and dwelled upon by a number of entities. Hence the current scenario being a perfect interim to speculate and implement an integrated expedient solution.

3. THE PROPOSED SOLUTION

3.1 Proposed Method

On exploration and analysis on the combined implementation of IoT and Big Data Analytics we were able to propound a workable idea for the manufacturing industries to gain from the use of these technologies in a parallel manner. Academic research and conclusions were examined and studied during the research of this phenomenon of 'Big Data Analytics with IoT in traditional manufacturing industry'.

The posit methodology suggests the development and maintenance of a networked connection of sensors and actuators attached to smart objects ("Things") in the actual industry premises, which contributes to the deployment of device to device communication via the implementation of standards like RFID, Zigbee and Wi-Fi, exhibiting the principles of IoT and provisioning a sense of automation in the industry functioning. The IoT data congregated to an IoT server at a remote cloud service to be maintained by a third party.

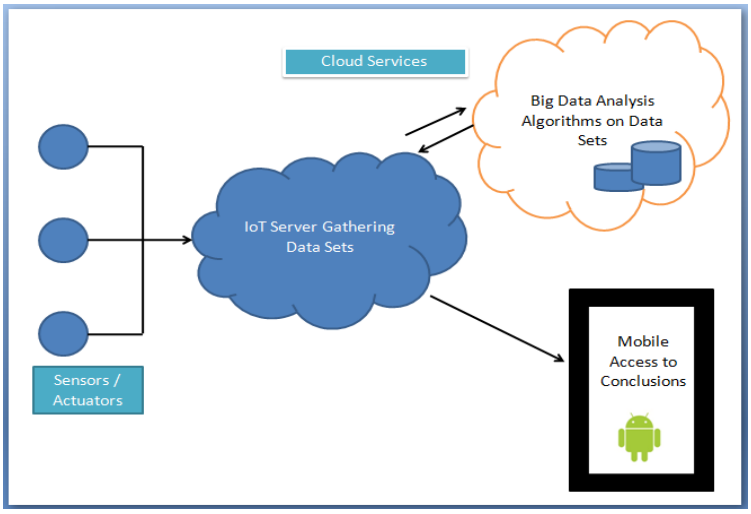

Figure 3.1: Methodology Architecture

The considerable back end analyzing system to be working on the concepts of Big Data Analysis, again on a cloud service, are to deduce conclusions and perceive patterns from the huge data sets provided by the IoT garnered data via the use of Hadoop platform toolset and MapReduce Engine based on relevant models and algorithms. Data recordings of various parameters with regard to time depending on the industry field can be analyzed using various algorithms in order to gain required conclusions.

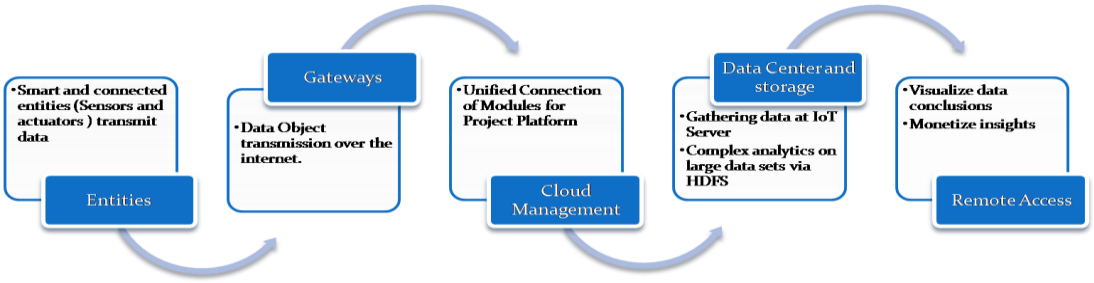

Figure 3.2 System Process Flow

In contrast to general analysis and pattern based search, the data in regard to the industry, using big data and advanced analytics may also be employed to perform predictive analysis. These predictions of behavior of the industry functioning lead to gain speculations about events that may take place. This in turn fuels event based decision making and immediate actions provisioning the benefits of avoiding mishaps and preventing damages, which have been observed to be prone in manufacturing industries substantially. To fully utilize the deduced conclusions of the analysis based on various algorithms and models, it is imperative that the deductions be available and presented to the respective entities on time. This is where the remote mobile access to the conclusions plays its role. The analyzed results or predictions made are again restored at the IoT server, which communicates with mobile devices to transfer data. This data is to be represented with infographics on the mobile device for better understanding and in turn immediate action. Graphical interpretations of the analysis allow better insights towards the industry ecosystem functioning.

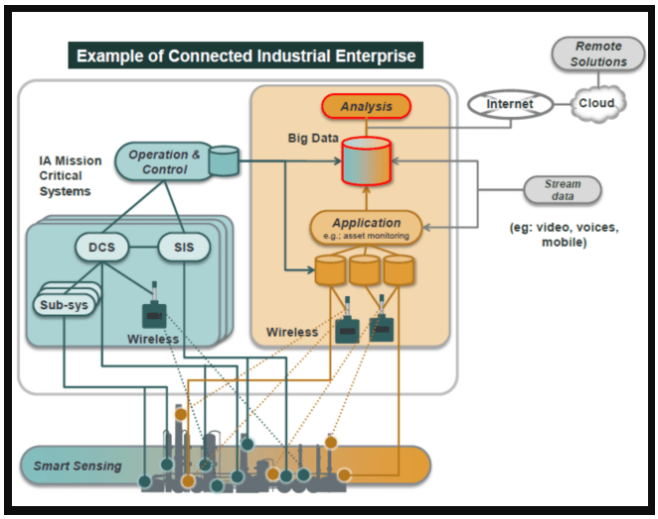

Figure 3.3 Example of Working System

3.2 Use Cases

3.2.1 Big Data

Big Data Analysis has been in existence long before the IoT burst out and established into the scene to perform analytics: information is defined as big data when it demonstrates the 4 V's : Volume, Velocity, Variety and Veracity (Kushmaro, 2017). A big data use case provides a focus for analytics, providing parameters for the types of data that can be of value and determining how to model that data using big data analytics tools (4 Big Data Use Cases in the Manufacturing Industry). Big Data and advanced analytics use cases, some presented by McKinsey & Company are highlighted in the following text.

- **Improved Manufacturing Process**

The McKinsey & company offer a use case in pharmaceutical manufacturing implementing the Big Data concepts (James Manyika, 2011). The company tracked cells with more than 200 variables for vaccines and blood components; they used big data tools to target processes and were able to save between $5 and $10 million.

- **Better Quality Assurance**

Intel Corporation a well established microchip manufacturing organization implemented big data for predictive analysis to reduce quality assurance test numbers which were 19000 per chip; this saved them $3 million for each line of Intel core processors.

- **Managed Supply Chain**

Big Data Analytics to overlay potential delays on maps, analyzing weather forecasts and traffic situations allowed a company to perform predictive analysis to calculate to probabilities of delays in the supply of raw materials.

- **Custom Product Design**

Cited by Tata Consultancy Services (TCS) a $2 Billion used Big Data Analysis tools to analyze and predict the repetitive behaviour of salient customers to understand and lean the manufacturing towards more customer satisfaction.

3.2.2 Internet of Things

The concept of IoT aims to turn a wide range of "Things" into smart objects to be equipped with sensors or chips to be connected on the internet and perform a device to device communication over the internet in order to attain a level of automation. It is just a game of collecting and sending of data over a large network. The complexity and breadth in manufacturing industry are shown in IoT use cases of manufacturing.

- **Manufacturing Operations**

Over 57% of all IoT Manufacturing investments are in typical Manufacturing Operations Management (MOM) including intelligent manufacturing, monitoring, performance optimization and end-to-end operational visibility.

- **Production Asset Management and Maintenance**

The second largest IoT use case including asset monitoring and tracking in terms of performance, quality, bottlenecks and potential damages.

- **Field Service**

The Field Service organizations of manufacturers are clearly differentiators in this new hyper-connected digitized and IoT-enabled ecosystem. According to IDC IoT spending may go up to $183 billion (The Internet of Things in manufacturing: benefits, use cases and trends).
A method to bring the two discrete practices together to render an ecosystem, where the analytical tools are employed on real time data to attain various value based insights, is discussed in further sections of the paper.

4. PROPOSED ALGORITHM

4.1 Workflow

- Industry premises placed actuators and sensors collect data sets transmitted to the IoT server on a cloud service.
- IoT server interacts with the Big Data system providing data sets to be analysed, transmitted over the internet.
- The Big Data File System along with MapReduce Engine run algorithms and models of analysis over the humongous sets of gathered data to attain conclusions.
- Deductions made by the analysis are again restored at the IoT server system.
- These conclusions are provisioned to be remotely accessed over the internet via mobile devices for a detailed and Infographic representation.
- Respective personnel and entities can view and act according to the speculations recorded and examined upon.

5. RESULTS

Reflected Effects

The following text highlights and discusses the benefits as well as issues posed by the propounded methodology to integrate IoT and Big Data in traditional manufacturing industry.

5.1 Merits

- **Efficiency** - The overall working process of the organization is affected and leads to production and functioning in an efficient manner.
- **Automation** - The primary motive of the principles of Internet of Things is to create smart surroundings which results into automation of workspaces and hence better work results.
- **Timely** - Data gathered does not lose its value by a wait as long as its lifecycle but is timely analyzed and worked upon through big data analysis.
- **Accuracy** - A reduced human intervention for data collection in industries leads to highly accurate and unhindered data sets.
- **Low Risks** - Less risk to human life in industries dealing with adverse conditions in regard to temperature or pressure.
- **Hazard Avoidance** - The predictive analysis of parameters allows immediate action on alerts hence avoiding any mishaps.
- **Competitive Benefits** - Including customer centricity, relevance of action and a holistic behavior for the organization.

5.2 Challenges

- **Security** - With increase in network and device complications and more of data in the open environment maintenance of cyber security as such a magnitude will pose a challenge for even the largest of companies.
- **Data Storage and Quality** - The production of data in huge amounts and at a high rate becomes an issue in storage as well as quality in regard to duplicity, inconsistency and missing data.
- **Relevant Analysis** - Only the availability of data and tools in not enough for proper analysis. The relevant models and algorithms to narrow the search to get what is needed come as a challenge.
- **Expertise Paucity** - A lack of experts and practitioners with the knowledge of both technologies working together is another challenge posed to organizations. The technologies being in adolescent phases and still developing strengthen the issue to more extents.
- **Development Pace** - The speed of development of the industry as a whole with such magnitude is not very encouraging, hence increases the difficulty for some to change.
- **Inertia** - Huge companies with wide setups in traditional methods face difficulties in changing standards at such a magnitude.

6. CONCLUSIONS

The research on the phenomenon 'Big Data Analytics with IoT in traditional manufacturing industry' is not limited to this paper but is a vast issue to delve upon. This paper is an attempt to highlight the current position of implementation of integrated technologies in manufacturing industries, and further to suggest a relevant methodology to couple two major technologies to setup a gainful ecosystem for industries to endeavor.

Regarding the solution proposed and the technologies implemented a huge scope of future work in the direction is open to be explored. Integration with further more technologies and concepts surely will unravel vast number of directional issues for further research and actual implementation as well.

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