

# LARGE SCALE MANUFACTURING IN NORTH AMERICA: HOW MACHINE LEARNING AND ANALYTICS IMPROVE EFFICIENCY

Alberto Valentino Gonzalez<sup>1</sup>

<sup>1</sup>*Pennsylvania State University, Pennsylvania, USA*

[alberto.val@mexicomail.com](mailto:alberto.val@mexicomail.com)

## Abstract

Nowadays, we are unquestionably in the era of info. Big Data Analytics isn't a point of view for all levels of the company. This is of specific fascination with the production pastime, together with the higher capital severeness of theirs, time constraints, and also offered the substantial quantity of info today captured. Nevertheless, there is a paucity in last literature on BDA in developing a far better understanding of the capabilities of the strategic ramifications to get importance from BDA. In that vein, the primary objective of this specific paper is generally to produce a novel layout that summarizes the main capabilities of BDA in the context of the manufacturing process. This is performed by relying on the end result of an analysis of the continuing exploration, together with a numerous case study in a visible phosphates derivatives company, to note the capabilities of BDA in the manufacturing process, in addition to outline suggestions to advance exploration of the market. The end result will help companies realize the main information analytics capabilities, as well as the possible implications for their production activity, and support them wanting to create much better BDA enabler infrastructure.

## Keywords

Manufacturing, Sustainable, America

## JEL Classification

M31, M44

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## Introduction

The prevailing development of electric technologies and enhancing computing power, along with the manufacturing Internet of Things, have generated a cutting-edge model of networked, information-based technologies, data analytics, and predictive modeling. This specific brand new item is driving unparalleled integrated computing capabilities to offer manufacturers with much better wherewithal to get worth from a steadily substantial amount of info and get a highly effective competitive advantage [two].

According to a research article published in the earlier 2022 by Sazu et al (2022c), contests, and originality, big data has permeated every element of everyday life, and turns into a paramount pioneer for production down the road [five]. According to Akter Jahan, et al. [2022], Big Data incorporates datasets whose size exceeds the ability of widespread data source software programs to shoot, store, manage, and also assess [nine]. In general, the ability realizes Big Data to cope with info with four qualities: Volume, Variety, Velocity, and Veracity [fourteen]. Big Data is generally associated with the thought of Analytics, which details the ability to get information from info by using statistics, optimizations, simulations, econometrics, mathematics, or perhaps other techniques to assist decision-making processes. Particularly for manufacturing processes, Big Data Analytics is greater. In reality, the unnecessary use of process operation, management computers, in addition to information methods, can make the existing manufacturing process operation databases substantial and also large [sixteen]. The overwhelming demand of manufacturing supervisors for the actual time, powerful, correct, as well as self adaptive manufacturing management, has brought brand new issues to the conventional methods [nineteen]. It becomes very pressured to create production intelligence from genuine time information to provide precise prediction of product quality, production and processing time. This is achieved by revolutionary successful strategies, inside shorter computation moments, to control the frequent true time manufacturing methods, and also to identify even defects, faults, and other irregular circumstances, alongside supporting correct and timely decision making [two].

Notwithstanding the passion, in addition to the development of interest in Big Data Analytics, little is considered the primary key abilities of theirs for creating methods. Surely, companies prepared to stay with Big Data in their production procedures are fighting to better understand the idea of it after that gets the organization worth from BDA. Moreover, hardly any scholars highlight which BDA stays in the first phase of its, and you will also find but concealed paths to savor on BDA in manufacturing methods [five]. To bridge the present information gap in the literature, the current paper aims to depend on earlier studies on BDA in manufacturing procedures, combined with a comprehensive numerous case study in an international company using Big Data Analytics to improve its creation process to complete the subsequent study objectives:

1. Clear up the thought of BDA in the concept of manufacturing processes,
  2. Review, classify and summarize most relevant articles providing with BDA in manufacturing methods, using a conceptual framework for classifying the literature,
  3. Point out upcoming exploration manners to enhance the abilities of BDA in the manufacturing process,
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4. Analyze in depth the findings linked to a numerous case study in a prominent small business to provide recommendations to advance BDA implementation in the manufacturing process.

The majority of this paper is put as follows. Spot 2 provides an integrative characterization of Big Data Analytics. The analysis range combined with the method perused to conduct the analysis are then launched in Section 3, followed by Section 4 and also Section 5, which exist and also greatly conversation about the results, along with results of the literature review and also the numerous case studies. Section 6 points out the implications for investigation, training, and initiatives of the investigation. Finally, the summary discovers the paper, limitations, and suggestions for future research agenda in Section 6.

## **Methodological tactics as well as investigation scope**

Papers addressing BDA in the context of producing process begin to look at theirs in the literature, Haque et al. (2022 Jahan and), et al.). Nevertheless, these papers did not discuss in depth BDA capabilities for manufacturing processes. Furthermore, research articles offering BDA in manufacturing technique related issues do not provide an overall comprehension of its abilities from several facets, in addition to dimensions, and limit themselves to one component. This means BDA in the context of manufacturing treatment is still changing, and you will also find nevertheless research to look at in this particular area. Therefore, an intelligible understanding of the subject, the features of its and class remain totally surrounded.

## **Comprehensive Review of literature on BDA in Manufacturing Process**

With a perspective to gain insight and offer a lot more comprehensible understanding of the capabilities of BDA on manufacturing procedures, a set up comment, in addition to grouping literature by utilizing bibliometric society, is carried out [twenty one]. This specific program is perused due to its transparency and reproducibility, while getting a major comprehension with the analysis of extant literature and the comparison of important labor [twenty three]. Additionally, Sazu, et al. (2022b) argued this specific method allows you to stipulate existing evidence near a technology or treatment, for instance, to summarize the benefits along with drawbacks of explicit map programs. To that conclusion, this specific analysis uses the literature review strategy recommended by Rowley & Slack. The newest papers similarly followed the same technique in detaching insights from previous BDA analysis documents, Sazu, et al, (2022e Wang and), et al.). This specific analysis tactic includes, furthermore on the stage of material collection, three info analysis steps: descriptive analysis, bibliometric evaluation, in addition to neighborhood evaluation.

## **Strategy of data collection**

As the author is instantly productive in the digitalization of the NAPC manufacturing process of the NAPC, the case study sticks on the method of an interested research project to collect and examine info. For curious or perhaps action analysis, the researcher and the company's staff are employed in concert to fix or perhaps fix a particular issue in the company, as well as to assist the body of knowledge. Therefore, the method of info collection was based on direct and on-site observation, combined with

interviews of many key members of the job. Throughout the visits, the author started with observation, assortment of substances which can be purchased, in addition to semi structured interviews, along with a conducted journey around the various entities implementing BDA job. The main interviewer was one of numerous primary engineers actively active in the job.

## Manufacturing Process Challenges

Table 4 provides the distribution of documents by the issues of the manufacturing process resolved by BDA. Above a lot of, it is obvious that many papers managed many manufacturing exercise issues solved by BDA [nine]. Afterwards, most papers are about QPC. This is followed by Quality in addition to Process Control: A couple of years later, companies that are competent to keep track of their operations, together with the busy rising amount of information to forecast their quality fault, as well as proactively manage their procedures using knowledgeable analytics, are gon na have advance of their competitors. In performing this, He & Wang mentioned a novice driver development of Statistical Process Control dealing with complex and multivariable with which MSPM methods could fail or perhaps lead to misleading outcomes [twenty five].

Power and also Environment Efficiency: Due to the overwhelming strain of constrained organic power, which increases considerable eco-friendly issues, manufacturing methods are placing energy saving in addition to emission reduction, as two important difficulties need to be solved by BDA. For instance, revolutionary analytical units might be placed on to improve the components believed to have the biggest impact on green outcomes. Zhang, et al. proved the use by proposing an enormous info driven analytical framework determined by two technologies, i.e., main details acquisition and also vitality major data mining, are used-to reduce electrical power use in addition to emission for energy-intensive manufacturing industries. Safety and Risk Analysis: Due to the advance and sophistication of existing manufacturing processes, chance and protection examination has become much more challenging and precious time consuming [thirteen]. Undoubtedly, Safety and Risk Analysis in the manufacturing process will acquire by proper application of BDA. As stated by Hammer, the application of complicated analytics combined with rendering simply acting on the specified insights lead to sound security needs and thus protect the physical protection of the workers, owners, and also the earth. Zerrouki and Smadi demonstrated the use of Bayesian Networks inside HAZOP evaluation. In precisely the same vein, Khakzad and Reniers place on Advanced Analytics to chance based approach, in addition to decision making with chemical plant life, to utilize the principles of inherently safer design and land use preparing. Furthermore, Sazu et al. (2022d) used Advanced Analytics to determine the security instrumented strategies to prevent unsafe events, and then to alleviate their aftermath to surroundings, gear, and employees. Sazu, et al. (2022f) underlined, furthermore to HAZOP based analytics, the evaluation of abnormal working conditions and options on emergency treatment of substantial accidents.

## Critical analysis and research trends

The results of the literature review of ours stressed the manner in which producing processes would utilize BDA characteristics, matter to get worth from info sets huge as BDA through a 3 level framework. Consequently, BDA functions have been confirmed to require managers and process engineers to obtain drastically more information than earlier, to what concerns numerous challenges in their manufacturing activity. Nevertheless, a set of fashion is realized from the literature review conducted. In reality, these trends investigate gaps that're still not totally managed, and consequently they need concentration that's considerably [twenty].

### Research advancement one: BDA enabler architecture

In the manufacturing process, info is streamed from several heterogeneous and dispersed strategies. Therefore, the implementation of data mining and BDA requires a smart architecture based on info management, in addition to storage techniques, governance and risk management, to deal with large quantities of info out of several sources. Indeed, volume, variety, velocity and also the other seven V's which characterize huge details imply that using BDA requirements high end sources, for instance storage space, in addition to processing modules. Based on the literature review of ours, authors focus on this specific problem via two leading techniques. First of all, many proposed frameworks proposed the establishment of internal particulars warehousing, allowing keeping and also commanding collected info. These remedies allow companies to complete command with their information, and also offer much more protection, although it requires huge purchase bills in terminology of implementation, engineering and maintenance. Then, other works proposed the use of therapies based on outsourcing information as Cloud Manufacturing. This particular solution reduces costs, but poses a huge threat to information security. Although there is an increasing trend towards the implementation of BDA enabler architecture, this is currently an under-explored location due to the countless issues that happen as info safety, along with secrecy, crisis and risk management, implementation costs... etc.

Consequently, prescriptive analytics is expected to be much more widespread and pervasive among a huge array of practitioners. In spite of this, the literature review of ours shows clearly that prescriptive analytics within the production process stays in a novice phase compared to descriptive, inquisitive or perhaps possibly predictive analytics [eighteen]. Along with numerous initiatives, Kumar, et al.), the chance of prescriptive analytics is very much from being neatly exploited. Consequently, extra examination is required towards the road of merging the end result of predictive analytics with big data and advanced algorithms to advance the future generation of manufacturing treatment based on analytics strategies. This could lead to not only explanations of risks and possible issues while working with production process difficulties, but also suggest actionable levers, effectively providing precise, reliable, real time option assistance to process superiors.

## Insights and learnings from many case studies

The goal of the case studies will be to more analyze the interdependencies of core BDA capabilities in a real-life context of the manufacturing process, and also uncover emerging themes.

## Description of the situation when studies

We talk about three duties of BDA implementation at different vegetation subsidiaries to NAPC. The activities are a component of a larger undertaking of the electric transformation of the companies of the business, wherein the best management clearly shows its dedication. We selected these cases, since they are thoroughly recorded, involved BDA characteristics, they came up with implications for our research trends, and they are judged as tasks which are good [fifteen].

### Case one: Implementing BDA in a fertilizers plant

In April 2018, a fertilizers plant was selected as a pilot place for BDA implementation. For that, the management solves the issue of info security, in addition to security. Nevertheless, the issue of implementation charges arises. Maintenance designers through the implementation strategy [twelve]. The initial necessity is the implementation of a genuine time process, with all the building of a Data Hub in which a few sources of energy of info from different phases of the generation pastime throughout various departments are integrated. The target is to incorporate these data with historical information for far better progression monitoring [seventeen]. In performing that, many IT capabilities endowed the company's production process. For instance, Hadoop Data Lake, which ties also into HDFS, was acquired to determine DWM faculty. In reality, the Hadoop Data Lake constitutes a great infrastructure for real time information management, besides numerous faculties such as information collecting, historicizing, recovering, analyzing, presenting, along with imagining [eight]. Many difficulties motivated the use of Hadoop Data Lake, namely: The OPC server is deployed in Windows machine, which presents security risk. Due to not enough Lora process, the context info of smart receptors is not exploited, and the storage capacity of DSC historic info is restricted to one season. The utilization of Hadoop Data Lake enables to bring together a terrific assortment of info from different platforms attached to the manufacturing process, this type of as:

- PI system: utilized as self service monitoring capability of info plant by Process Engineer,
- OPM Treatment: used as something of performance monitoring,
- MyOPS platform: formerly deployed as an essential instrument for the HSE methods & the upkeep reliability processes,
- Oracle EAM: discusses the schedule along with extensive asset maintenance requirements of asset extensive organizations,
- LIMS: allows to effectively manage the flow of related information and samples to improve lab efficiency via standardizing workflows, tests and procedures, while providing precise configurations of the process.
- Connect and AlMaarifa: two platforms, by utilizing the idea of Internet of people, recover an information garden where people are interlinked, as well as their expertise.

Apart from the Data Hub, an Intelligent Monitoring System was implemented in two dimensions: an excellent campaign of info informatisation using online sensors for progression and purple variables, Complex Event Processing utilizing specific algorithms. The target tracked along with procedure streams of information regarding occurred functions by integrating many energy sources with the target to identify circumstances or maybe patterns which constitute a certain meaning for the unit, such as opportunities or threats, and also to answer to them.

### **BDA enabler architecture**

Of the situation when someone implemented a Data Hub based on inner tracking down; driving advantages which are good in terms of the massive storage space ability recommended by Hadoop Data Lake. Surely, the substantial ability of data warehousing allowed keeping treatment parameters record for many seasons available in the DCS, after which modeling a lot more properly fashion in addition to tendencies based upon complicated analytics. Although this particular solution is not widespread in literature due to the necessary investment and steep technical complexity, it has proved advantageous, particularly to resolve the problem of privacy in addition to information security [seven].

Recommendation one: The implementation of internal locating to storage and processing of big data can solve the issue of info security, in addition to security. Nevertheless, the issue of implementation charges arises. One more choice for BDA enabler architecture implementation depends on outsourcing info provided by cloud manufacturing, as explored in case 2 and scenario 3. This is the most popular choice in literature, as it allows authorization to get into various functionalities while storing and processing info [ten]. Recommendation two: External sourcing along with cloud computing can provide different possibilities for info control in the price of secrecy. As shown in case 2, the significance of roles in addition to duty applicable to information management techniques is paramount to mitigate the risk of secrecy in addition to information security [eleven]. Recommendation three: The significance of roles plus duties inherent in info control by "data governance guidelines" could possibly reduce the risk of information security.

### **Real time information mining approaches**

Wise monitoring is a more developed technique of engineering management that fuses true time sensing with task certain info processing, like complex event processing, predictive analytics, and collaborative resources for info interpretation in addition to decision making.

## **Integrated Human Data intelligence**

The implementation of IoP together with expertise share Os's offering, and are believed to assure a novice involvement of humans in BDA implementation. These platforms are a real instrument for enhancing the expertise of operators who are now much more familiar with brand new solutions [twenty three]. Recommendation seven: Broad correspondence utilizing IoP combined with original participation of all personnel ensures the integration of individuals in BDA. The key element to work with the upshots from BDA will be two outfit supervisors, along with operators with great master expertise, as depicted in case 2 and situation 3 [twenty five]. Consequently, it is crucial that companies provide analytical education classes in places like regular details, data mining, and business intelligence on process operators, who believe an important support part in the completely new info abundant labor context. Recommendation eight: Hiring qualified employees alongside superior education sessions on info science can motivate the tie of human details intelligence connection

## **Prescriptive analytics within the production process**

A beginning spot of changing towards the novice driver type of prescriptive analytics is predictive BDA methods along with algorithms. As described in case 3, fuzzy logic and neural network were utilized. Exactly similar conclusion is yanked - Positive Many Meanings - from the extant literature, Sazu, et al. (2022a). Recommendation nine: Generic BDA methods, along with algorithms that use artificial intelligence, in addition to machine learning, can be a foundation for creating prescriptive techniques. It is essential to computerize the compilation of info around the manufacturing operation. To get this done, sensors, in addition to sensible items, need to be generalized to enhance the ability of the process to exchange data and actions with the cyberspace. Recommendation ten: Generalization of automation and sensor driven information is of outmost importance in the future generation of prescriptive analytics.

## **Discussion and Implications**

Working with BDA in an industrial context allows many possibilities for the manufacturing process. Nevertheless, hardly any businesses that entirely advantages due to this confirmed opportunity, especially for their manufacturing procedures [twenty one]. In truth, despite the countless benefits of BDA in manufacturing fields, process in a holistic and data-driven way [twenty five]. Sharp proof that groups collectively main information functions and classifies them according to every context and use scenario. On the other hand, the extant investigation work discussing the transformative potential of BDA actually provides different features of the use of BDA in manufacturing context, rather than producing process. works focuses mostly on the practical side, and also various other technical styles for the use of big data, and in most cases cope with one capability simultaneously. Nevertheless, almost all these researches do not discuss theoretical capabilities without proposing several models or perhaps referential, which represents the different BDA insights along with abilities [three].

The present study aimed to present an introduction of the different scenarios offered by utilizing BDA techniques, and also offer a repository for researchers, in addition to companies, thinking about the massive chance of BDA. To do and therefore, we proceeded on three unique axes:



- Firstly, we have done an organized literature review on BDA in the context of manufacturing procedures, where we selected and considered 60 8 files from the main medical related data bases. A critical analysis of literature was developed based on a bibliometric, as well as difficulties analysis to classify selected files dependent on BDA aspects, trends and categories.
- Secondly, we recommend an overall framework of BDA capabilities in the manufacturing process, as well as they clearly show a summary of manufacturing process difficulties, bid info analytics faculties, capabilities, and bid data analytics values. This particular architecture was suggested based on the analysis of relevant succeeds suggested in literature [four].
- Finally, we carry out numerous case studies on a prominent internet business that has currently implemented BDA in their production activity. The number of case studies was not arbitrary. In fact, we do case studies on companies which use BDA to deal with the different identified and investigate trends in the critical evaluation of ours [twenty three]. The objective of these case studies is to evaluate the obtained results from using BDA in these firms, with results, affirmations, in addition to predictions contained in literature. We aimed also to assess the cases and also to provide new lines of review advancement [six].

It is noteworthy that the papers of ours would be the first, including an organized literature review with many case studies, to provide a holistic introduction to implementing BDA in the manufacturing process.

## Theoretical Implications

The present documents yield many exciting insights into the theoretical implications of using BDA in the manufacturing process, and also contribute to the methodological literature of its. So, this specific analysis provides a broader understanding of BDA implications within the generation activity by conceptualizing various concepts about BDA in the manufacturing process in a holistic and data-driven way [twenty five]. In reality, the systematic literature review can help academic researchers contend with new empirical exploration in this specific place to completely clean up BDA concepts in the context of manufacturing processes, which stays in the initial issue.

## Practical Implications

The present documents yield many exciting insights for practical implications of using BDA in manufacturing development, and offer many essential outcomes provided by performing and looking at a selection of significant situation analysis. By mingling the findings of the systematic literature review and also subsequently examined case studies, this specific paper has attempted to provide researchers, supervisors and supervisors substantial info on the formula, in addition to implementation of BDA enabler infrastructure in the manufacturing process environment:

- This study offers a detailed introduction to a few good case studies, which could help manufacturing companies shift into an agile and entirely digitalized smart manufacturing unit, while utilizing BDA like an important pillar of marketplace 4.0 for manufacturing process.

- In addition, this specific analysis may help producing companies apply totally IT enabled BDA architecture to boost the performance effectiveness of theirs, improve production quality, improve maintenance management, encourage employee engagement along with empowerment, and improve security tradition and delivery in the long term [one].

The case research finished is in excellent concordance with identified BDA analysis trends. The analysis of these case studies allowed to experiment with the main recommendations while using BDA based on each design. In addition, the circumstance studies analysis allowed us to conclude that to successfully apply BDA in manufacturing context, we ought to depend on a few essential transformation levers, like for example progression along with the usage, as well as operations automation of electric remedies and knowledgeable analytics methods. This particular finding represents a huge contribution, as it provides crucial recommendations to consider while building entirely BDA capabilities. Furthermore, companies working in situations like that of the situation when companies might acquire from the outcomes of the cases scientific research to design their infrastructure, which will allow the use of BDA for their production activity.

## **Conclusion along with eventually works**

To use data for practice intelligence improves in the present era of Big Data, in the highway towards functional excellence. Meanwhile, processes along with manufacturing equipment have undergone an enormous evolution over the last couple of years, which has led to rapid technological developments in many parts of the market. Appropriately, scientists have argued that most businesses recognize the significance of their information for analyzing the manufacturing process of theirs, and also have advocated the use of enhanced analytics and business intelligence is a top priority in the future. The present post has provided a clear understanding of how these firms can work with Big Data Analytics to boost their production process as a technique to enhance digital transformation for internet business value. Consequently, the study begins with the identification of most agreed capabilities of BDA in the production activity, with the effects related to an organized literature review to produce a framework of BDA capabilities in the manufacturing operation. Subsequently, the study will use a multiple case study to allow this framework to provide a useful means for supervisors to disclose the potency of BDA around the inter-disciplinary capacities determined in the analysis.

The study of ours, like every other, has limits that should be recognized. To start with, there is the selection of the posts to be reviewed. The limitations imposed all over the search process may well actually leave many top quality posts on BDA behind in the production operation. An additional limitation of this study will be the use of qualitative analysis to handle the multi case study. The case studies are actually qualitative, making it difficult to draw unbiased conclusions about the capabilities of BDA in the production operation. Research on the next areas could be carried out in the future. First of all, an analysis of the impact of BDA features on manufacturing performance through a quantitative analysis strategy based on primary investigation results. More in-depth empirical studies need to be carried out to verify the information. Additionally, BDA- aloud infrastructure in service businesses, like SMEs, and specific contexts, should be investigated. Nevertheless, research on BDA in the production method and the associated theoretical analysis just started. As an outcome, there's a fantastic deal of work being done pushed by relevant technologies and software requirements if the BDA is successfully incorporated in the production process.

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