

Using Machine Learning and Analytics for Efficient Manufacturing Process: A Case Study of South American Economies

Damaris Edel Chiara, Universidad de San Carlos de Guatemala, Guatemala

Alberto Valentino Gonzalez, Monterrey Institute of Technology and Higher Education, Mexico

Antonellia Celeste Maria, Universidad de Antioquia, Colombia

Corresponding author email: alberto.val@mexicomail.com

Abstract- Nowadays, we're unquestionably in the era of information. Big Data Analytics is not a point of view for those level of the business. This's of particular interest in the manufacturing activity with the high capital intensity of theirs, time constraints and provided the massive amount of information now captured. Nevertheless, there's a paucity in previous literature on BDA developing much better understanding of the abilities of the strategic ramifications to acquire value from BDA. In that vein, the main goal of this particular paper is usually to create a novel design which summarizes the primary abilities of BDA in the context of production procedure. This's completed by relying on the results of an evaluation of the continuing exploration in addition to a many case study in a prominent phosphates derivatives manufacturer to mention the abilities of BDA in manufacturing process as well as outline recommendations to advance exploration in the industry. The results are going to help businesses to recognize the major data analytics abilities and the potential implications of its for the manufacturing process of theirs and support them seeking to develop better BDA enabler infrastructure.

Keywords: Big Data Analytics; Manufacturing process; Big Data Analytics capabilities; business intelligence; literature review; several case study

1. Introduction

The prevalent growth of electronic technologies and improving computing power in addition to development of the manufacturing Internet of Things have resulted in an innovative generation of networked, data analytics, information-based technologies, and predictive modeling. This particular new model is delivering unparalleled integrated computing abilities to provide makers with better wherewithal to acquire value from a progressively massive quantity of information and obtain an effective competitive advantage [2].

Based on the research article published in the earlier 2022 by Sazu et al (2022c), competition, and innovation, big data has permeated every aspect of daily life, and turns into a paramount pioneer for production in the future [5]. Based on Akter Jahan, et al. [2022], Big Data consists of datasets whose size exceeds the capability of common database software tools to shoot, manage, store, and assess [9]. Generally, Big Data is recognized by the capability to deal with information with 4 qualities: Volume, Velocity, Variety, and Veracity [14]. Big Data is usually connected with the idea of Analytics which describes the capability to get info from information by using statistics, optimizations, simulations,

econometrics, mathematics, or maybe several other methods to help decision making processes.

Especially for manufacturing processes, the task of Big Data Analytics is greater. In fact, the unnecessary use of procedure operation, management computers as well as info systems can make the existing manufacturing procedure operation databases massive as well as huge [16].

Next, the enormous demand of manufacturing managers for the real time, dynamic, accurate and self-adaptive production management has brought brand new problems to the standard methods [19]. It gets extremely forced to produce manufacturing intelligence out of real time data to offer exact prediction of product quality, processing time and production. This's accomplished by innovative highly effective methods, within shorter computation moment in order to manage the constant real time manufacturing systems and to recognize faults, defects and even other abnormal circumstances alongside supporting accurate as well as timely decision making [2].

Notwithstanding the passion as well as development of attention in Big Data Analytics, little is thought about the key capabilities of theirs for producing procedures. Certainly, businesses ready to follow Big Data in the manufacturing processes of theirs are fighting to better comprehend the concept of its after

which acquire the company worth from BDA. Moreover, very few scholars highlight which BDA remains in the early stage of its and you will find but hidden directions to enjoy on BDA in manufacturing procedures [5]. To bridge the current knowledge gap in the literature, the existing paper aims at being dependent on earlier studies on BDA in manufacturing processes together with a thorough many case study in a worldwide business utilizing Big Data Analytics to enhance its production process to accomplish the next investigation objectives:

1. Clear up the idea of BDA in the idea of manufacturing processes,
2. Review, classify as well as summarize almost all pertinent articles offering with BDA in manufacturing procedures making use of a conceptual framework for classifying the literature,

3. Point out upcoming investigation fashion to improve the skills of BDA in the manufacturing process,

4. Analyze in-depth the findings associated with a many case study in a prominent business to offer recommendations to advance BDA implementation in manufacturing procedure.

The rest of this particular paper is placed as follows. Area two offers an integrative characterization of the idea of Big Data Analytics. The study range together with the technique perused to conduct the analysis are then released in Section three, followed by Section four and Section five, that present and profoundly talk about the findings as well as outcomes of the literature review and the many case study. Section six points out the implications for research, train, along with efforts of the research. Lastly, the newspaper is realized by the summary, suggestions and limitations for future research agenda in Section six.

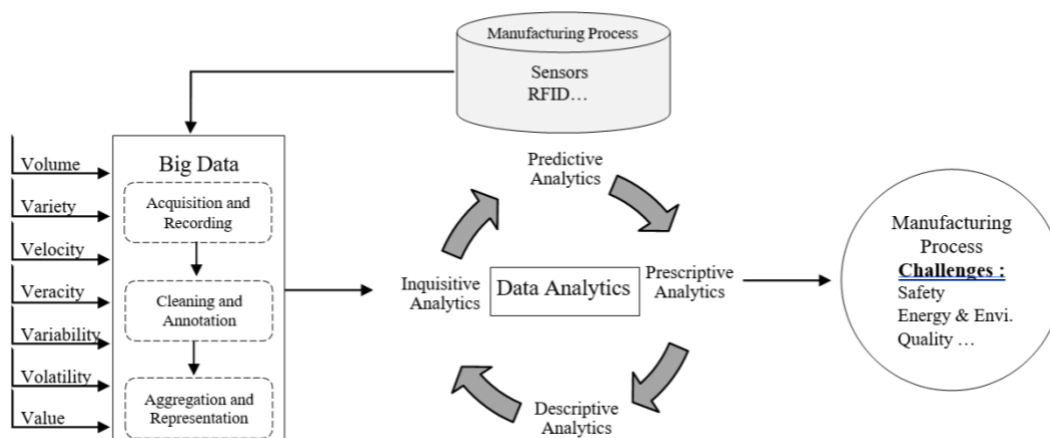


Fig 1: Design of the research hypothesis

2. Methodological approaches and research scope

Papers addressing BDA in the context of manufacturing procedure start making the appearance of theirs in the literature, Haque et al. (2022) and Jahan, et al.). Nevertheless, these papers didn't discussed in depth BDA features for manufacturing processes. Additionally, studies articles offering with BDA in manufacturing system associated problems don't supply a general understanding of the capabilities of its from numerous facets as well as limit and dimensions themselves to a single element. This implies that BDA in the context of manufacturing

procedure continues to be changing and you will find still studies to examine in this specific region, thus, an intelligible comprehension of the topic, the facets of its as well as category is still to be completely surrounded.

2.1. Comprehensive Review of literature on BDA in Manufacturing Process

With a point of view to gain insight and give much more comprehensible understanding on the abilities of

BDA on production process, a set up comment as well as category of literature by using bibliometric community is conducted [21]. This particular strategy is perused owing to the rationality of its, reproducibility and transparency while gaining a significant understanding with the evaluation of the comparison and extant literature of influential work [23]. Moreover, Sazu, et al. (2022b) argued that this particular technique helps you to stipulate present proof near a treatment or a technology, for example to summarize the proof of the advantages as well as drawbacks of an explicit map method. To that conclusion, this particular analysis uses the literature review methodology suggested by Rowley & Slack. The latest papers similarly followed identical strategy in removing insights from earlier BDA research documents, Sazu, et al. (2022e) and Wang, et al.). This particular evaluation strategy includes, additionally to the phase of material collection, 3 information analysis steps: descriptive analysis, bibliometric analysis as well as community evaluation.

2.2. Strategy of Data collection

As the writer is immediately active in the task of digitalization of manufacturing process of the NAPC, the case study stick to the technique of an interested research project to gather as well as analyze information. In interested or even action analysis, the researcher as well as the company 's staff members work in concert to solve or even to correct a certain problem in the business, also to help the body of knowledge. Thus, the technique of information collection has based on on-site and direct observation together with interviews of a selection of the primary key members of the task. Throughout the appointments, the writer began with observation, assortment of materials that are available as well as semi organized interviews plus a conducted trip around the different entities implementing BDA task. The primary interviewer was one of many main engineers directly active in the task.

3. Manufacturing Process Challenges

Table four offers the distribution of documents by the difficulties of production procedure resolved by BDA. Above many, it's apparent that several papers managed several production activity problem resolved by BDA [9]. Afterwards, the vast bulk of the documents are around QPC. This's followed by Quality as well as Process Control: Several years down the line, organizations which are able to monitor the operations of theirs with the fast-paced growing quantity of data to forecast the quality fault of theirs and proactively

manage the processes of theirs by means of experienced analytics are going to be in advance of the competitors of theirs. In doing this, He & Wang discussed a brand new development of Statistical Process Control dealing with multivariable and complex with which MSPM techniques might fail or even lead to misleading results [25].

Energy as well as Environment Efficiency: Bowed to the overwhelming stress of limited natural energy increasing significant green problems, manufacturing procedures are putting energy saving as well as emission reduction as 2 vital difficulties have to be resolved by BDA. For example, innovative analytical device could be put on to enhance the elements which are thought to have the largest effect on environmental results. Zhang, et al. proved the point by proposing a huge information driven analytical framework dependent on 2 technology, i.e., power major details acquisition as well as vitality big data mining, are used to decrease the power use as well as emission for energyintensive manufacturing industries.

Protection and Risk Analysis: Owing to the sophistication and the advance of the present production processes, possibility and security examination is now much more demanding and time consuming [13]. Undoubtedly, Safety and Risk Analysis in manufacturing procedure will gain by appropriate application of BDA. As mentioned by Hammer, application of complex Analytics together with rendering just acting on the specified insights cause create solid security requirements and therefore defend the actual physical security of the employees, owners as well as the planet. Smadi and Zerrouki demonstrated the usage of Bayesian Networks within HAZOP analysis. In exactly the same vein, Reniers and Khakzad put on Advanced Analytics to risk based style as well as decision making in chemical plant life to employ the concepts of inherently safer style as well as land-use preparation. Additionally, Sazu et al. (2022d) used Advanced Analytics in order to identify the security instrumented methods to stop the occurrence of dangerous events and to relieve the aftermath of theirs to employees, gear, and surroundings.

Sazu, et al. (2022f) underlined, additionally to HAZOP based analytics, the examination of irregular working conditions as well as choices on emergency treatment of significant accidents.

4. Critical research and analysis trends

The findings of the literature review of ours stressed out the way manufacturing procedure would use BDA

features, matter to acquire value from information sets enormous as BDA by way of a three layer framework. Consequently, BDA features have confirmed necessary to make managers and process engineers obtain drastically a bit more info than previously, to what concerns various challenges in the manufacturing process of theirs. Nevertheless, a pair of fashion will be recognized out of the literature review conducted. In truth, these trends constitute investigate gaps that're still not completely dealt with and therefore they require focus that is much [20].

4.1. Research development one: BDA-enabler architecture

In manufacturing process, information are streamed from numerous, heterogeneous and dispersed solutions. Thus, the implementation of data mining and BDA takes a wise architecture based on information management as well as storage methods, governance and risk management to cope with big amount of information from numerous sources. Indeed, variety, volume, velocity and the other 7 V's which characterize large data imply that using BDA needs high performance resources for example storage space as well as processing modules. According to the literature review of ours, authors emphasizes this particular issue via 2 major approaches. For starters, several proposed frameworks proposed the establishment of inner details warehousing which allows to keep as well as control collected information. These solutions enable businesses to have total control over the data of theirs and provide more security though it takes enormous investment costs in terminology of implementation, maintenance and engineering. Next, various other works proposed the usage of treatments based on outsourcing data like Cloud Manufacturing. This specific remedy reduces costs but poses a tremendous threat on data security. Though there's an increasing trend towards the implementation of BDA enabler architecture, this's presently an underexplored area because of the many problems that occurs like information protection as well as secrecy, risk and crisis management, implementation costs... etc.

Thus, prescriptive analytics is anticipated to get a great deal more prevalent and pervasive among a big array of practitioners.

In spite of this, the literature review of ours shows obviously that prescriptive analytics inside the manufacturing procedure remains in a beginning stage than descriptive, inquisitive or maybe perhaps predictive analytics [18]. With all the exception of several initiatives, Kumar, et al.), the possibility of

prescriptive analytics in much from being nicely exploited. Thus, additional analysis is needed towards the path of merging the results of predictive analytics with advanced algorithms and big data to advance the coming generation of manufacturing procedure based on analytics methods. This can lead not only to explain risks as well as potential problems while dealing with the production process difficulties, but additionally recommend actionable levers, effectively providing accurate, dependable, real time choice support to procedure supervisors.

5. Learnings and insights from multiple case studies

The objective of the case studies would be to additional examine the interdependencies of core BDA features in a reallife context of production procedure and uncover emerging themes.

5.1. Description of the situation when studies

We discuss 3 tasks of BDA implementation at various vegetation subsidiaries to NAPC. The tasks are a part of a bigger task of the electronic transformation of the businesses of the company where the best management show obviously the commitment of its. We selected these instances since they're extensively recorded, they involved BDA features, they came up with implications for the research trends of ours and they're judged as projects that are successful [15].

5.1.1. Case one: Implementing BDA in a fertilizers plant

In April 2018, a fertilizers plant in selected to become a pilot location of the task of BDA implementation. For that, the management recruited a very competent staff members of it designers as well as information scientists to take help to process and maintenance designers throughout the implementation plan [12]. The very first requirement is the implementation of a real time system with the construction of a Data Hub where several energy sources of information from various phases of the production activity throughout different departments are integrated. The target is combining these data with historical info for much better process monitoring [17]. In performing that, a selection of IT abilities endowed the manufacturing procedure of the business. For example, Hadoop Data Lake, which ties also into HDFS, was acquired to be able to ascertain DWM faculty. In fact, the Hadoop Data Lake constitutes a good infrastructure for real time data management besides many faculties like data gathering, presenting, analyzing, recovering, historicizing, and visualizing [8]. Many difficulties

motivated the usage of Hadoop Data Lake, namely: The OPC server is deployed in windows machine, which present security risk, Because of not enough Lora system, the context information of sensible sensors aren't exploited, as well as the storage capacity of DSC historic information is restricted to a single year. The utilization of Hadoop Data-Lake allows to bring together a great assortment of information from various platforms connected to the manufacturing process this kind of as:

- PI system: used as self service monitoring ability of information Plant by Process Engineer,
- OPM Treatment: utilized as something of performance monitoring,
- MyOPS platform: previously deployed as a necessary instrument for the HSE procedures & the maintenance reliability processes,
- Oracle EAM: tackles the routine and comprehensive asset maintenance needs of asset comprehensive organizations,
- LIMS: allows to successfully controlling the flow of samples and related information to enhance laboratory effectiveness via standardizing workflows, procedures and tests, while giving exact settings of the procedure.
- Connect and AlMaarifa: 2 platforms, by using the concept of Internet of folks, make up an info space where individuals are interlinked and the knowledge of theirs as well as knowledge are discussed.

Aside from the Data Hub, an Intelligent Monitoring System was implemented dependent on 2 dimensions; a great campaign of information informatization utilizing internet sensors for progression and green variables, Complex Event Processing utilizing certain algorithms. The target was tracking as well as process streams of data concerning occurred events by integrating several sources with the target to detect circumstances or maybe patterns that comprise a specific meaning for the device, like threats or opportunities, and to respond to them.

5.2 Real time data mining approaches

Smart monitoring is a well established method of engineering control which fuses real time sensing with project specific information processing such as for instance complicated event processing, predictive analytics, and collaborative tools for information interpretation as well as decision-making..

5.3 Integrated Human Data intelligence

The implementation of IoP along side expertise share os's providing one is thought to guarantee a beginning involvement of human in BDA implementation. These platforms is a genuine tool for improving the expertise

5.4 BDA enabler architecture

Of the situation when one, a Data Hub depending on inner tracking down was implemented; delivering benefits that are great in term of the huge storage capability suggested by Hadoop Data Lake. Certainly, the massive capability of Data warehousing allowed retaining procedure parameters history for several season offered in the DCS, after which modeling much more correctly trends as well as tendencies based on complex analytics. Even though this solution isn't widespread in the literature because of the required investment and the steep technical complexity, it's proved to be advantageous especially to solve the issue of privacy as well as data security [7].

Recommendation one: The implementation of inner sourcing to the processing and the storage of big data are able to resolve the problem of information security as well as privacy. Nevertheless, the problem of implementation prices arises.

Yet another option for BDA enabler architecture implementation is relying on outsourcing information offered by cloud manufacturing as explored in case two and situation three. This's the most widely used option in the literature as it enables for getting permission to access different functionalities while storing as well as processing information [10].

Recommendation two: External sourcing including cloud computing is able to provide various opportunities for information management at the cost of secrecy.

As shown in case two, the meaning of roles as well as responsibility relevant to data management method is of outmost importance to be able to mitigate the danger of secrecy as well as data security [11].

Recommendation three: The meaning of roles plus responsibilities inherent in information management via "Data governance guidelines" might lessen the danger of data security.

of operators who currently much more familiarized with new solutions [23].

Recommendation seven: Broad correspondence using IoP together with first involvement of all personnel guarantee the integration of people in BDA The key to use the upshots from BDA would be to outfit supervisors as well as operators with good master expertise as depicted in case two and situation three [25]. Thus, it's essential that businesses offer analytical education classes in areas like standard data, data mining and business intelligence on the procedure operators who'll believe a crucial support part in the brand new information rich labor context.

Recommendation eight: Hiring skilled workers alongside superior training sessions on information science is able to encourage the tie of human data intelligence connection

5.5 Prescriptive analytics inside the production process

A starting place of changing to the brand new model of prescriptive analytics is predictive BDA techniques as well as algorithms. As described in case three, neural network and fuzzy logic were utilized. Precisely the same conclusion is pulled out of the extant literature, Sazu, et al.(2022a).

Recommendation nine: Generic BDA techniques as well as algorithms using artificial intelligence as well as machine learning is able to function as a foundation while building prescriptive approaches.

It's fully necessary to computerize the compilation of information all around the manufacturing operation. To do this, sensors as well as smart products have to be generalized to improve the capability of the task to exchange actions and data with the cyberspace.

Recommendation ten: Generalization of automation and sensor driven info is of outmost in the coming generation of prescriptive analytics.

6. Discussion and Implications

Utilizing BDA in an industrial context enables providing many possibilities for production procedure. Nevertheless, very few companies that completely benefits because of this proven potential particularly for the manufacturing processes of theirs [21]. In reality, in spite of the many advantages of BDA in manufacturing fields, the deployment of its yet extremely limited since there's no clear documentation which groups together major info features and classifies them based on each context and to each use situation. On the opposite hand, the extant investigation work talking about the transformative potential of BDA is really offering with various facets of the usage of BDA in manufacturing context instead of manufacturing procedure. Some other works focuses largely on the practical side and proposes a

technical style for the usage of big data and usually deal with one capability at the same time. Nevertheless, nearly all of these researches don't talk about the theoretical features without proposing some model or maybe referential which represents the various BDA insights as well as abilities [3].

The current study aimed to provide an overview of the various possibilities provided by using BDA methods and provide a repository for researchers as well as businesses considering the huge opportunity of BDA. To do and so, we proceeded on 3 distinct axes:

- Firstly, we've perform an organized literature review on BDA in the context of manufacturing process in which we selected as well as considered sixty eight documents from the mains medical data bases. A critical evaluation of literature was created based upon a bibliometric and problems analysis to classify selected documents based on BDA aspects, categories and trends.
- Secondly, we suggest a general framework of BDA features in production procedure, and they show a summary of manufacturing process difficulties, bid information analytics faculties as well as abilities as well as bid data analytics values. This architecture was proposed depending on the evaluation of pertinent succeeds proposed in literature [4].
- Finally, we conduct a many case studies on a prominent business which has currently implemented BDA in the manufacturing process of theirs. The selection of the case studies wasn't arbitrary. Actually, we do case studies on firms that use BDA to cope with the various identified investigate trends in the critical analysis of ours [23]. The goal of these case studies is comparing the obtained outcomes from applying BDA in these businesses with results, affirmations as well as predictions present in literature. We aimed also to evaluate the cases and offer new lines of study advancement [6].

It's noteworthy that the paper of ours is the very first which includes an organized literature review with many case study to give a holistic introduction concerning implementing BDA in manufacturing procedure.

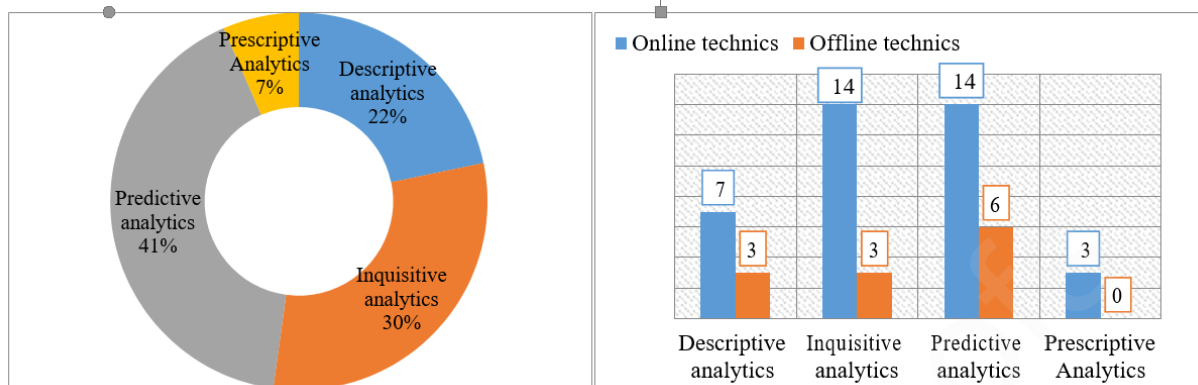


Fig 2: Comparison between various kinds of analytics used by heavy manufacturer

6.1. Theoretical Implications

The existing papers yields several interesting insights for theoretical implications of utilizing BDA in manufacturing process and contributes on the methodological literature of its. Consequently, this particular study offers a broader understanding of BDA implications inside the production activity by conceptualizing different ideas regarding BDA in manufacturing procedure in a data-driven and holistic fashion [25].

In fact, the results from the systematic literature review is able to help academic researchers to deal with new empirical exploration in this particular area clean up BDA ideas in the context of manufacturing processes, and that remains in the original point.

6.2. Practical Implications

The existing papers yields several interesting insights for practical implications of utilizing BDA in manufacturing progression and provides several important results given by doing as well as examining a number of significant case research. By mingling the findings of the systematic literature review and then examined case studies, this particular newspaper has attempted to offer to researchers as well as supervisors significant information on the formulation as well as implementation of BDA enabler infrastructure in the manufacturing process environment:

- This study provides a detailed introduction to a few effective case study that could aid manufacturing businesses to change into an agile and completely digitalized wise manufacturing device while utilizing BDA as a crucial pillar of market 4.0 for manufacturing procedure.
- In addition, this particular study might help manufacturing businesses to implement completely IT enabled BDA architecture to increase the performance

efficiency of theirs, enhance production quality, enhance maintenance management, promote employee engagement as well as empowerment, and enhance security tradition and execution in the long run [1].

The case studies completed are in great concord with identified BDA analysis trends. The evaluation of these Case studies permitted to experiment the primary recommendations while utilizing BDA based on each pattern. In an additional hands, the situation studies analysis enabled to conclude that to be able to effectively apply BDA in manufacturing context we should depend on several crucial transformation levers such as for instance progression as well as the use and operations automation of electronic solutions as well as experienced analytics strategies. This finding represents an enormous contribution since it offers essential recommendations to think about while building completely BDA capabilities. Additionally, businesses running in conditions that are similar to which of the situation when businesses could gain from the results of the cases scientific studies to structure the infrastructure of theirs which enable the usage of BDA for the manufacturing process of theirs.

7. Conclusion and later works

Making use of Data for process intelligence increases in the current era of Big Data, in the road towards operational excellence. Meanwhile, processes as well as production tools have undergone a massive evolution over the last couple of decades, which has led to rapid technological advances in a number of areas of the industry. Accordingly, researchers have argued that the majority of companies acknowledge the significance of their information for analyzing their manufacturing process and have advocated the

usage of enhanced business and analytics intelligence as a high priority in the near future. The present article has provided a clear understanding of exactly how these businesses are able to use Big Data Analytics to improve their production process as a method to boost digital transformation for business value. Thus, research starts with the identification of the majority agreed abilities of BDA in the manufacturing process with the results associated with a systematic literature review to create a framework of BDA features in the manufacturing process. Then the research is going to use a multiple case study to support this framework to supply a practical method for managers to reveal the potency of BDA along the inter-disciplinary capacities identified in the research.

Our study, like any other, has limitations, which must be acknowledged. To begin with, there's the selection of the articles to be reviewed. The restrictions imposed throughout the search process might in fact leave some top-quality articles on BDA behind in the manufacturing process. Another limitation of this

research is the use of qualitative analysis to carry out the multi case study. The case studies are in fact qualitative, making it hard to go much deeper and draw objective conclusions about the abilities of BDA in the manufacturing process.

Researches on the following areas may be performed in future. For starters, an evaluation of the effect of BDA capabilities on manufacturing performance using a quantitative analysis technique based on primary research results.

More in-depth empirical studies have to be carried out to verify the data. In addition, BDA-enabled infrastructure in specific contexts, like SMEs and service businesses, must be explored. However, research on BDA in the production process as well as the associated theoretical study has just begun, as a result there is a great deal of work being done driven by related technologies and application requirements when the BDA is effectively integrated the manufacturing process.

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