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Implementing Big Data Analytics in E-Commerce: Vendor and Customer View

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ABSTRACT Due to the information revolution, one of the biggest challenges of e-commerce is the huge data that needs to be processed and analyzed to gain benefits from it. Big Data Analytics (BDA) aims to improve the decision-making process by analyzing and understanding big data, e.g., messages, social media posts, etc. Furthermore, BDA capabilities are used in e-commerce activities as a key growth direction to increase vendors' revenues and attract customers. Based on the importance of analyzing big data and its advantages to e-commerce operations, this paper aims to study the values of implementing BDA in e-commerce to both vendors and consumers. Fifteen papers are selected to analyze the impacts of analyzing big data in e-commerce. Electronic vendors (E-vendors) use BDA to gain the competitive advantages they need to understand consumer behaviour and increase their income by improving customer loyalty. Besides, recommendation systems derived from BDA personalize the searching and shopping experience of the customers. However, there are some negative effects derived from applying BDA in e-commerce, such as shopping addiction. In addition, e-vendors have to deal with expensive BDA tools and professionals. In conclusion, even though BDA enhances consumers' and vendors' electronic shopping experience, the rapid growth of data is still challenging.

INDEX TERMS Big data analytics (BDA), E-commerce, predictive analytics, customization, increase revenues.

I. INTRODUCTION

According to the rapid increase of using internet-based technologies, e.g., digital sensors, cloud computing, etc., a massive amount of data is being generated and stored [1]. Based on the data variety, velocity, and volume, they are called Big Data [2]. Many companies take advantage of analyzing these big data to enhance their business strategy and gain benefits [3].

Moreover, the accelerating use of the internet resulted in activating Electronic Commerce (e-commerce) activities [4], [5]. E-commerce is the online process of purchasing products, services, and information or selling and exchanging them [6]. E-commerce companies have taken the benefits of analyzing big data to improve their processes, as well as maintaining and increasing their revenues [7]. Big Data Analytics (BDA) is the process of analyzing big data that provides a vision to make business decisions [8]. BDA affects e-commerce activities in many ways, such as understanding

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user behaviour and interest, identifying user satisfaction, and increasing companies' revenues [7]. For instance, mouse cursor moves could deduce the user's emotion [9].

Big data affects e-commerce activities in many ways that may open new opportunities for e-commerce improvement [10]. Based on the related researches and reviews, this study will address the different impacts of big data on the e-commerce experience for both vendors and users, i.e., customers. The current work will help researchers improve the BDA usage in e-commerce based on analyzing vendors' and customers' experience. This paper is structured as follows: Section 2 illustrates the related work. Section 3 describes the study methodology. Section 4 discusses the results, and section 5 contains the conclusion.

II. RELATED WORK

The related work in this section helps in understanding the role of big data in the e-commerce market. As e-commerce companies deal with structured data (e.g., personal information) and unstructured data (e.g., clicks, voice, images,

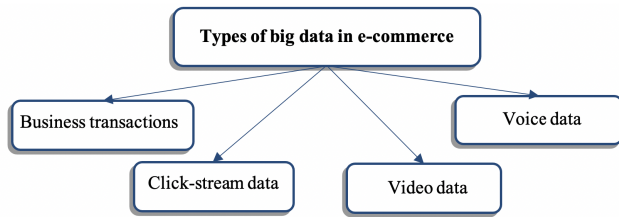


FIGURE 1. Types of big data in e-commerce [8] and [15].

tweets, etc.), they were the first in adopting BDA [8]. With BDA, e-commerce companies enhance their operations and generate new strategies to gain benefits and increase customer value. For instance, Amazon used big data to develop (i) a recommendation system that gained 35% of the sales, (ii) a dynamic pricing system, and (iii) an automated customer service [8]. Besides, Netflix implemented a BDA-based recommendation system that suggests movies based on the customer’s taste [8]. Several survey papers can be found in the state of the art that discussed the role of big data in improving e-commerce from different aspects, as in [8], [11] and [12].

In [2] and [13], researchers argued that analyzing data from social media plays a significant role in understanding customer behaviour in e-commerce platforms. In addition, several e-commerce companies use social media data to build an interactive relationship with their customers [7] and offer real-time promotions [8]. Fig. 1 illustrates four types of big data in e-commerce. E-commerce vendors can use big data to provide customized products, dynamic pricing, as well as targeting the right customer [2]. Furthermore, with the Internet of Things (IoT) capabilities, smart shopping platforms are developed to support shopping customization and recommendations [14]. Google, Amazon, eBay, Facebook and other big e-commerce companies have adopted BDA and experienced exponential growth [15].

On the other hand, researchers have analyzed some electronic purchasing factors affecting decision making to support e-vendors sales and marketing prediction. Fig. 2 specifies seven factors that may affect the purchase decision on cross-border e-commerce platforms [16]. Based on the previous factors, [16] implemented a model to predict some food products’ purchase decisions and specified the most likely goods to buy. Product images could also affect the customer purchase decision [17]. Blurred images and images in inappropriate order may take the customer intention away from purchasing that product. However, well-presented product’s pictures may increase the purchasing rate. Thus, benefiting from BDA and Machine Learning (ML) models proved a better understanding of customers’ interests [17].

Based on [18], four types of user behaviour were analyzed, which were: click, collect, add cart, and purchase. Authors in [18] found that clicks got the highest proportion since customers view items by making clicks, but they do not necessarily add them to a list or a cart. Besides, researchers classified the customers using the Recency, Frequency, Monetary (RFM) model to (i) VIP, (ii) loyal, (iii) important

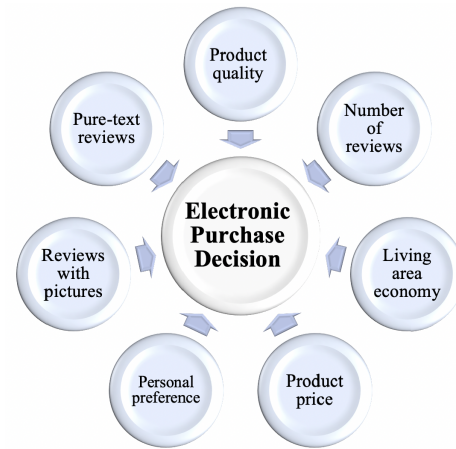


FIGURE 2. Some factors that affect the electronic purchase decision [16].

customer, and (iv) most likely to leave [18]. These classifications help e-commerce companies to interact with their customers and make their best to keep them.

From the literature review, we noticed that BDA is essential to e-commerce companies to benefit from their customers’ data. E-vendors analyze these data to increase their revenues and improve consumers’ experience. Therefore, it encouraged us to investigate the impact of BDA in e-commerce for both vendors and customers.

III. METHODOLOGY

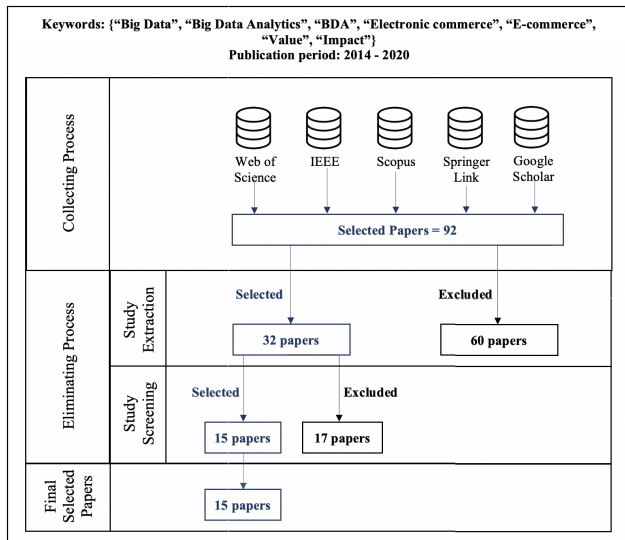
This section reports the methodology followed in this research. Table 2 illustrates the study’s research questions. Authors applied their searches in the following well-known databases for related studies:

- Web of Science.
- IEEE.
- Scopus.
- SpringerLink.
- Google scholar.

We limited the search to these databases to avoid results’ duplication. The searching keywords were: “Big Data”, “Big Data Analytics”, “BDA”, “E-commerce”, “Electronic commerce”, “value”, and “Impact”. The search string was a combination of three distinct keywords, such as (“Big Data Analytics” AND “E-commerce” AND “Impact”). All collected papers where in English. Even though companies started applying BDA in 2004, the impact of BDA greatly noticed after ten years [19]. Due to that and the high rate of studies related to big data in e-commerce, we limited the search to papers published from 2014 to 2020. The authors performed two extraction steps: 1. Study extraction, and 2. Study screening. In the study extraction process, the authors excluded 35 papers based on irrelevant titles and concluded with 32 selected papers. After that, the authors screened the abstract and conclusion of each paper. Result in excluding 17 papers that were out of the study scope. This study analyzes the impact of big data on e-commerce from the results of 15 papers. Fig. 3 presents the selection process of this study.

TABLE 1. Research questions and their rationale.

No.	Research Question	Rationale
RQ1.	What are the values of implementing BDA in e-commerce?	This question will help to identify the benefits of applying BDA in the e-commerce environment.
RQ2.	How does BDA impact e-commerce vendors?	This question illustrates the importance of applying BDA to improve e-commerce activities.
RQ3.	How does BDA in e-commerce impact customer experience?	This question aims to understand the BDA values in e-commerce that enhance the customer experience.

**FIGURE 3. Papers selection process.**

IV. RESULTS

This section will present the answers to the study's research questions based on previous studies.

A. RQ1. WHAT ARE THE VALUES OF IMPLEMENTING BDA IN E-COMMERCE?

Today, e-commerce websites record various data, such as user's search content, staying period, purchasing time, order information, customer purchase feedback, etc. [20], [21]. Thus, e-vendors analyze these data to gain benefits and improve their sales.

According to [3] and [15], companies use BDA to (i) improve their products and services and offer meaningful insights, (ii) enhance the decision-making process, and (iii) automate the business process. BDA improves many aspects of any firm, e.g., pricing, profit, sales, as well as sustaining business growth [3]. Besides, BDA supports the e-commerce business values of:

- **Customization:**
BDA supports providing customized products based on customer needs [8], [15]. Moreover, based on mobile devices' growth, analyzing mobile data helps customize advertisements based on customer location [22].
- **Dynamic pricing:**
BDA helps e-commerce companies to use a dynamic pricing strategy to attract more customers [15]. Dynamic

pricing is an approach of changing products' prices based on a specific time of the day or week, season, competitors' prices, and demand rate [8]. The previous purchases, click-streams, and cookies are analyzed to set prices dynamically, offering customized discounts [22]. Thus, two customers could purchase the same product at different prices.

- **Understanding customer behaviour and interest:**
E-commerce companies analyze customer information and activities to understand their needs, produce offers and advertisements, and improve their recommendation system [8], [15].
 - **Customer service:**
As a result of understanding the customer needs using BDA systems, the customer service improved [15]. For instance, BDA reduces the response time when serving a customer [8].
 - **Supply chain visibility:**
BDA capabilities provide e-commerce firms and customers with the supply chain information to keep them updated, e.g., product availability, order status and tracking [8], [15].
 - **Security and fraud detection:**
BDA plays an essential role in detecting fraud patterns, and abnormal actions can be controlled and managed to prevent frauds [8], [15].
 - **Predictive analytics:**
Predictive analytics include (a) product recommendation, (b) price management, i.e., dynamic pricing, and (c) predictive search [22]. Amazon uses a product recommendation system to personalize the customer experience by providing products that suit the customer taste [22]. Besides, predictive analytics aid to prevent some business problems, such as losing customers [15]. BDA search capabilities enhanced the speed of the searching process [22].
 - **Customer loyalty:**
BDA improves customer loyalty, i.e., customer willingness to purchase again [11], [23], [24]. Moreover, [25] reported that applying BDA in e-commerce has some advantages:
 - **Trend forecasting:**
Different data is analyzed from different resources, e.g., social media, to predict needs and enhance the e-shopping experience.
 - **Market demand:**
BDA supports predicting the high demands of products.
 - **Personalization:**
BDA supports recommending products based on consumers taste and behaviour.
 - **Focus on the customer:**
Enhancing customer experience and listen to their needs to limit customer loss.
 - **Increase revenues.**
- On the other hand, BDA used in the tax audit systems to improve tax compliance [26]. Besides, BDA helped in

TABLE 2. E-commerce values supported by BDA.

Ref.	Year of publication	E-commerce values										
		Predictive analytics	Increase revenues	Customization	Customer service	Supply chain visibility	Dynamic pricing	Operation quality	Customer loyalty	Enhance decision making	Security and fraud detection	Improve tax compliance
[3]	2019	✓	✓		✓	✓				✓		
[8]	2016	✓	✓	✓	✓	✓		✓				
[11]	2016	✓	✓	✓	✓	✓	✓		✓			
[15]	2017	✓	✓	✓	✓	✓	✓	✓			✓	
[20]	2018	✓	✓	✓	✓	✓	✓					
[21]	2017	✓	✓	✓	✓	✓		✓		✓		
[22]	2014	✓	✓	✓	✓	✓	✓		✓			
[23]	2020	✓	✓	✓	✓	✓	✓	✓				
[24]	2017	✓	✓	✓	✓	✓		✓		✓		
[25]	2019	✓	✓	✓	✓	✓	✓			✓		
[26]	2018											✓
[27]	2018	✓	✓	✓	✓	✓		✓				
[28]	2017	✓	✓	✓	✓	✓						
[29]	2017	✓	✓	✓	✓	✓	✓	✓			✓	
[30]	2017	✓	✓	✓			✓	✓				

innovating business models [24]. Supporting the predictive analysis to provide customization and increase vendors’ revenues might be the most noticed BDA capabilities that enhanced the e-commerce operations, as illustrated in Table 2.

B. RQ2. HOW DOES BDA IMPACT E-COMMERCE VENDORS?

After analyzing customer purchases behaviour, [20] and [27] reported that many customers prefer doing online shopping in the morning. The early purchase period may refer to the logistic strategy of delivering morning orders within the same day [20]. Fig. 4 illustrates the peak purchasing hours, according to [27]. Moreover, the shopping style of women differs from men. Women tend to shop at any time of the day, especially in the afternoons, whereas men prefer to complete their purchases in the morning [20]. Furthermore, [20] stated that more orders placed on weekdays than at weekends. Based on customers purchases analysis, e-commerce vendors can make promotion at the right time [20], [27]. Besides, e-vendors can benefit from special events, e.g., the new year event and black Friday, to activate promotions and other activities that attract customers’ attention [20].

E-vendors who applied BDA to understand their customer behaviour have enhanced their e-commerce marketing strategy and provided new services, such as customization, personalization, and recommendations [28], [29]. According to [11], [27] and [29], BDA considered a great tool for e-vendors to (i) improve market sales, (ii) understand customer behaviour, (iii) improve customer satisfaction, (iv) attract more customers, and (v) limit shopping cart rejection. BDA also impacts the decision-making process and guides e-commerce operations [21]. For instance, Amazon is using BDA to understand its consumers’ behaviour [21]. Amazon noticed that their average order processing period reduced by 3 minutes, and the processing efficiency tripled [21]. According to Amazon experience, analyzing consumers’ feedback enhanced their purchasing quality [21].

Besides, BDA capabilities increased the competition intensity between e-commerce vendors and changed the way of thinking [24].

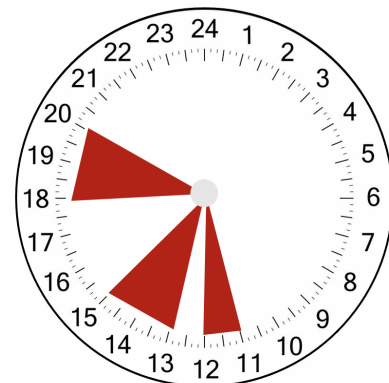


FIGURE 4. Peak hours of online shopping. Customers usually shop at the time of: (a) Between 11:00 AM to 12:00 PM, (b) Between 1:00 PM to 3:00 PM, or (c) Between 6:00 PM to 8:00 PM [27].

C. RQ3. HOW DO BDA IN E-COMMERCE IMPACTS THE CUSTOMER EXPERIENCE?

Analyzing users’ needs to provide a customized and personalized shopping experience improved the customer searching process [30], increased consumer loyalty, as well as enhanced user stickiness [24], [28]. However, besides the many advantages of BDA on improving the shopping experience, it may lead to shopping addiction [29].

On the other hand, e-vendors can enhance customer satisfaction by analyzing customers’ reviews using BDA tools [23]. For instance, product quality affects the product’s reviews; an unsatisfied customer will give a negative review that vendors have to consider to enhance their quality [23].

V. DISCUSSION

BDA considered an excellent tool for e-vendors to understand customer behaviour and improve market sales. Based on the analysis of the gathered answers to our research questions, we found that predictive analytics might be the primary BDA value in e-commerce (see Table 2). In addition, e-vendors take thoughtful decisions to increase their revenues by analyzing customers’ data to predict their behaviour. Recommendation systems widely used as a BDA capability that provide cus-

TABLE 3. Positive and negative effects of BDA in the e-commerce experience.

	Positive effect	Negative effect
Vendor	<ul style="list-style-type: none"> - Satisfy customers' needs. - Increase revenues. - Enhance marketing and advertising. - Improve supply chain control. - Increase competition rate. - Enhance customer loyalty. - Improve the decision-making process. - Detect fraud and security issues. 	<ul style="list-style-type: none"> - High cost of BDA tools and professionals. - Challenges related to data growth and analysis.
Customer	<ul style="list-style-type: none"> - Customized shopping experience. - Improved services, e.g. searching, and after-sale services. - Enhance the purchasing decision. 	<ul style="list-style-type: none"> - Shopping addiction.

tomized services and personalize consumers' need. With the various BDA capabilities, the customer service and supply chain services improved.

Moreover, the dynamic pricing strategy helped e-vendors to enhance their marketing activities and increase their income. Meanwhile, BDA aided in enhancing customer experience and loyalty. However, consumer stickiness to an e-commerce website may lead to shopping addiction, resulting in social and health issues. Table 3 summaries the major positive and negative sides that vendors and customers experienced after applying BDA in e-commerce. Even though BDA benefits e-commerce activities, it faces some broad challenges [15]:

- **Data integration:**
Due to the variety of data (structured, semi-structured, and unstructured), the integration of these data is challenging. Handling the data quality and reducing complexity is the aim of any big data-based project.
- **Data volume:**
One of the main characteristics of big data is volume. Today, BDA projects deal with numerous amounts of data that require storage, processing, and management expenses.
- **Availability of skilled people:**
Even though there are many available big data tools, there is still a need for professionals who use these tools efficiently.
- **Data privacy:**
Data contains much personal information; thus, it is necessary to keep them disclosed.
- **Data security and piracy:**
As some data could include personal information, securing them is a must.
- **Legal aspects:**
The ownership of data is one of the significant challenges.

VI. CONCLUSION

In this research, we have analyzed the BDA impacts on the e-commerce experience of vendors and customers. Authors conclude that applying BDA capabilities in e-commerce projects improves the online shopping experience and increases vendors' revenues. Additionally, understanding customers' needs and behaviour helps companies attract customers by providing personalized services and products. BDA enhanced the e-commerce experience of both the vendors and customers. However, due to the rapid growth of data, analyzing big data is still challenging. This research presented a good starting point for exploring the applications of BDA in the e-commerce area. Authors encourage researchers to study the challenges facing BDA in e-commerce, such as data accuracy and security and contribute to providing solutions and tools to overcome current challenges.

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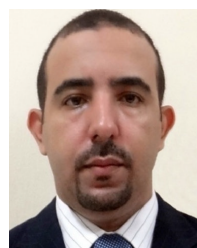
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