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THE ROLE OF BIG DATA IN CALCULATING ECONOMIC GROWTH BY SECTOR AND ITS IMPLEMENTATION IN THE ERA OF INDUSTRIAL REVOLUTION 4.0

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ABSTRACT

Introduction: Since the industrial era 4.0 Big Data has grown rapidly in terms of number and volume in Indonesia, along with the advancement of Information technology so that it supports the development of the Internet on Thing and the Internet of System**. Problem:** Big Data is around us and is growing very fast, but how is the utilization and role of Big Data in Indonesia's economic growth? This study aims to examine the role of Big Data in Economic Growth and its implementation. **The Research methode** uses descriptive quantitative analysis of BPS Big Data data from 514 Districts/Cities, 1790 KLBI and 12-year time series (2012-2023) or as many as 11,040,720 national economic sector data to calculate economic growth using the industrial sector output approach (KLBI). **Novelty:** The use of Big Data in quantitative analysis of 11,040,720 national economic sector data sourced from BPS 514 Districts/Cities. **Results and Discussion** of the role of Big Data is proven in calculating economic growth using the KLBI sector method to calculate Real GDP which is then implemented as a source of information in policy making. The policy is implemented in the form of implementing a smart city, which aims to manage and control resources more effectively and efficiently in order to maximize public services, better economic growth brings progress that ultimately improves the welfare of local communities. **Conclusion:** Big Data in calculating economic growth per industrial sector and its implementation plays a very large role and has an impact on regional progress. However, it would be better and have a multiplier effect if Big Data between agencies were collaborated,

Keywords: Big Data 1, Economic Growth 2, KLBI per sector 3, Implementation 4, Collaboration 5

INTRODUCTION

Indonesia as a developing country has entered the Digital era which is in line with the Industrial Revolution 4.0. since 2012. The fourth generation industrial revolution can be interpreted as the involvement of an intelligent system and automation in industry. This is driven by data through machine learning and AI technology which uses Big Data as information material (Forbes). There is a connection between industry players allowing computers to be connected to the Internet and communicate with each other, and ultimately produce decisions without requiring the physical presence of humans, aka a combination of the actual and virtual worlds, the Internet of Things (IoT) and the Internet of Systems (IoS) where it is supported by information sourced from millions (Megabyte Capacity) of data, billions of data (Terrabyte Capacity), even countless data (data explosion) and the complexity of data characteristics, Morabito (2014) calls it Big Data. This Big Data consists of structured data,

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semi-structured data and unstructured data. Gartner (2013) previously stated that 6.4 billion connected devices will be used worldwide in 2016 and the number will reach 20.8 billion in 2020.

Big Data is a term that applies to data that cannot be processed or analyzed using traditional tools because the volume is so large that it must use new methods and tools to get value from this Big Data (Zikopoulos, et.al,2012). In 2016, 5.5 million new devices will be connected every day to collect, analyze, and share data that is categorized as Big Data. Big data is supported by the internet and processed by applications so that it can facilitate all aspects of the economy to be fully automated. Programming language data is semi-structured data, its characteristics do not match the specifications of a relational database, but can be determined to meet the structural needs of certain applications, for example the Extensible Business Reporting Language (XBRL) which was developed to change financial data between organizations and government agencies (Morabito, 2014).

So that finally the digital economy emerged, in the form of e-commerce, wallet payments, m-banking, social media applications such as tik-tok, marketplaces, QRIS sensors, advertising supported by Google Ads, stock investment applications, mutual funds, precious metals and other commodity market investments, cashier applications, corporate financial accounting applications and national financial banking transactions which are all part of a unified system called the digital economy which aims to facilitate transactions, save time and costs and be accurate in nominal terms that bring economic progress. The progress of a country's economy is generally measured by economic growth. Economic growth is a very important indicator for knowing and evaluating the development performance of a country. The condition of economic growth in Indonesia in the 2011-2019 period can be said to be quite good with an average economic growth of 5.32% although in 2020 economic growth in Indonesia contracted by only 2.07% due to the Covid-19 pandemic limiting economic activity. However, with the existence of Information technology which includes big data transfer, it has supported economic activities to continue running so that economic growth rose again in 2021 to 3.7% and recovery to normal in early 2023 with a growth rate of 5.27% (close to the pre-pandemic level) (Agus, M, 2023). The relatively rapid recovery of economic growth after Covid-19 along with the growth rate of internet usage of 5.23% per year has greatly supported the digital economy which contains billions of Big Data. Is there a role for Big Data in economic growth? The study in this article aims to find out how Big Data can produce information on Gross Domestic Product Per Component/Business Sector Structure in Measuring Economic Growth, especially in the Industrial Era 4.0 in Indonesia (2012-2023)? So how does Big Data provide growth information per sector for policy implementation in both government and private sectors?

Economic growth will show the extent to which the government's performance in various economic sectors in producing added value for goods and services or community income in a certain period. The main factors that influence economic development and growth are human resources (HR), natural resources (SDA), capital, socio-culture and technological developments (Sadono, 2015). Patta Rapanna et al (2016) said that economic growth is a process in which income increases without linking it to the population growth rate. If economic growth improves, people's purchasing power will increase and this is an opportunity for companies to increase their sales and company profits will also increase. A country's economic growth can be measured by comparing its GDP. For national measurements, the gross domestic product (GDP) of the current year with the previous year because the measurement can only be done with quarterly or annual data. Calculating gross national income (GDP) can be done with three approaches, namely the production output method, the expenditure method, and the income method. Among the three methods of measuring GDP that are often used is the production output method or value-added approach. This is the most widely used method because it is simple and based on the calculation of the total value of gross domestic product

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(GDP) from a country's industrial sectors, namely the total value of all goods and services produced by production factors in the country for one year. This method takes into account all products produced from industry, agriculture, extractives, services and trade, both by domestic companies and foreign companies operating domestically. Real GDP is a more accurate measure of the total amount of goods and services produced at constant prices. The prices used in determining Gross Domestic Product are based on a certain base year or the previous year so that they are adjusted for inflation (Suparmoko, 2007).

Utilization of Big Data can be an option with its advantages that are real-time and can be obtained without conducting a census or survey. One of the Big Data that can be used to provide an overview of economic activity is Google Trends. Google Trends data is a search history that is classified into many categories, where the indicators above have different time frequencies, namely monthly and quarterly. The nowcasting method that can accommodate this problem is Mixed Data Sampling (MIDAS). MIDAS is able to reduce high-frequency data to low-frequency data according to its target variables (Ghysels et al., 2007). Reduction can also be done by using certain weights by considering the contribution of each period so that it is relatively better than the usual average. In the study of Kuzin et al. (2011) compared the performance of the MIDAS and MF-VAR methods in nowcasting Eurozone GDP. The results of their study showed that MIDAS tends to have better performance. The use of MIDAS as a nowcasting method has also been carried out by Claudio et al. (2020) who found that the use of MIDAS for monthly variables in predicting GDP growth.

METHOD, DATA AND ANALYSIS

The research method is quantitative from secondary data which is explained and analysis qualitatively based on the facts that occur. The author still believes in secondary data collected by BPS because in addition to being an official government institution so that the data is legal, it also comes from Big Data (primary data collected directly with a clearly classified questionnaire), the number of big data used is 514 districts/cities, 1790 KLBI (base on data 2020), and a 12-year time series or a total of 11,040,720 national economic sector data which are also calculated with a careful and standardized ratio, then processed using sophisticated computer applications to produce quality data that is worthy of publication. Analysis using increasing amounts of data (Big Data) will be better because it is closer to reality.

While nowcasting from Google is taken from Big Data which is a collection of information from various sources such as BPS, World Bank, research journals and others which may have different measurement standards so that they are less valid. The analysis was carried out from descriptive statistics from the results of calculating the index used to measure GDP and economic growth. The method used to calculate GDP is the Production Method (Output) from each business classification group (KLBI) / sector:

KLBI Ratio, 5-digit:

$$R_{jkt} = \frac{\sum V_{jkt}}{\sum (V_{jkt}\, \mathrm{R_{ijkt}})} = \frac{\sum V_{jkt}}{\sum V_{jkt} \left(\frac{Q_{ijk(t-1)}}{Q_{ijkt}} \right)}$$

Rjkt = is the ratio of the amount of commodity production in the quarter – (t-1) to t with a 5-digit KLBI value weight.
Vjkt = is the production value of the j Company in the k industry group in the to th Quarter

The economic growth rate is calculated from GDP at constant prices, intended so that economic growth is truly the growth in the volume of goods and services, not growth that still contains

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price increases/decreases (inflation). Currently the base year used by BPS-RI in calculating GDP is the base year 2010. The formula used to calculate economic growth is:

$$GDP\ yield = \frac{GDP\ t - GDP(t-1)}{GDP\ (t-1)} \times 100\%$$

Economic growth in year t can be known by comparing GDP in the current year with the previous year. If GDP has not been priced to become Real GDP, GDP is formulated as follows.

$$GDP\ t\ (riil) = GDPo\ (1+r)^t$$

Where PDB0 is the initial period GDP and r is the GDP growth rate is the difference between a period's GDP and the previous period. The data source used is Big Data that has been processed and published by BPS in 3 period divisions, namely GDP based on output in 2012-2015, 2016-2018, and 2019-2023 to simplify analysis.

RESULTS AND DISCUSSION

Quarterly Structure of Indonesian GDP 2012-2015 and Economic Growth

When observing quarterly GDP based on current prices that show the economic structure of a region, then in the period 2012-2015 the economic structure according to business fields from quarter to quarter did not change significantly. As shown by Big Data, the Manufacturing Industry Business Field provides the largest contribution in each quarter with an average contribution of 21.06 percent. Furthermore, every quarter I, II and III, the Agriculture, Forestry and Fisheries Business Field provides the second largest contribution and the Wholesale and Retail Trade, Car and Motorcycle Repair Business Field provides the third largest contribution followed by other business fields. While every quarter IV there is a slight shift in the economic structure, where the second largest contribution is achieved by the Wholesale and Retail Trade, Car and Motorcycle Repair Business Field.

Table. 1. KLBI with the Highest Contribution to GDP and Its Growth in 2012-2015

KLBI	Contribution	Growth	Causes
Manufacturing	21,06%	0,66%	• Dominated by the textile industry that surplus production and demand are influenced by religious holidays and the end of the year.
Agriculture, Plantations and Forestry	13,41%	112%	• Food crops have the highest growth due to fertilizer subsidies and pest control. • 50% supported by rapidly increasing plantation yields
Wholesaler and Retail	13,37%	67%	• Car-Motorcycle functions as a transportation that distributes output produced by the goods business field (agriculture, mining, processing industry). This causes the movement pattern of this business field to follow the goods sector (tradable) and imports of goods.

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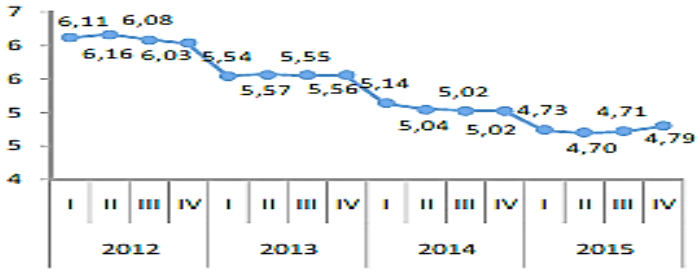
KLBI	Contribution	Growth	Causes
Mining	11,06%	2,4%	• Business Field Performance Mining and Quarrying are often influenced by government policies and supporting facilities for the production process of Mining and Quarrying commodities

Grafic. 1
Growth of Quarterly GDP (q to q), 2012-2015 (percent)



Furthermore, the very high growth of KLBI in the agriculture, plantation and trade sectors (90%) has driven a stable real GDP growth rate in 2012-2015, namely 5.4%.

Quarterly Structure of Indonesian GDP 2016-2018 and Economic Growth

Big Data The Manufacturing Industry Business Sector provides the largest contribution in each quarter to GDP and economic growth with an average contribution of 20.18 percent. In addition, the Agriculture, Forestry and Fisheries Business Sector provides an average contribution of 13.15 percent, followed by the Wholesale and Retail Trade, Car and Motorcycle Repair Business Sector which provides an average contribution of 13 percent and Construction 10.43 percent.

Table. 2. KLBI with the Highest Contribution to GDP and Its Growth in 2015-2018

KLBI	Contribution	Growth	Causes
Manufacturing Industry	**20,18%**	**3,54%**	1. Increased domestic demand for textiles and paper influenced by preparations for the 2019 election 2. Increased domestic demand from imports of food, beverages and pharmaceutical commodities.
Agriculture, Plantations and Forestry	**13,15%**	**5,33%**	1. Shifting planting seasons 2. Supply of broiler chickens 3. Increased fisheries production 4. Increased plantation production
Wholesaler and Retail	**13%**	**4,63%**	1. Increased motorcycle consumption 2 Increased retail sales
Contruction	**10,43%**	**5,69%**	1. Increased cement procurement 2. Increased revenue of state-owned construction companies 3. Increased constructionvalue index

Grafic. 2

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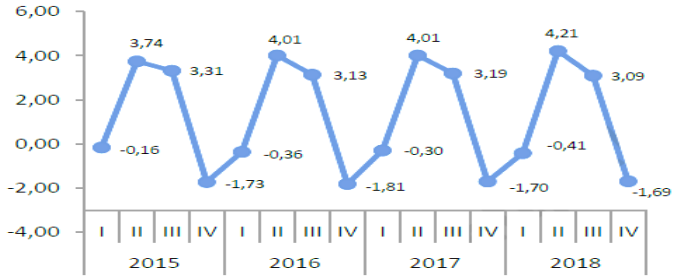
Growth of Quarterly GDP (q to q), 2015-2018 (percent)



In the 2015-2018 period, the growth of KLBI in the construction, agriculture and plantation and wholesale trade sectors of 4.75% has driven the real GDP growth rate in the 2015-2018 period by 2.25%.

Quarterly Structure of Indonesian GDP 2019-2023 and Economic Growth

The performance of the national economy can be seen from the development of Gross Domestic Product (GDP). From the production side, GDP at constant prices (ADHK) 2010 shows the level of economic growth in each business field as a reflection of development achievements. The Indonesian economy in the period 2019-2022 as measured by GDP at constant prices showed an increasing trend, although it experienced a decline in 2020 due to the Covid-19 pandemic. The economic recovery after Covid-19 was very rapid as shown in the second quarter of 2021 which increased to pre-pandemic conditions.

The structure of the Indonesian economy according to business fields did not change significantly during the period 2019 - 2022. The three business fields that had the largest average contribution during this period were the Manufacturing Industry with an average contribution of 19.29 percent. Agriculture, Forestry and Fisheries contributed an average of 13.02 percent, and Wholesale and Retail Trade, Car and Motorcycle Repair contributed an average of 12.93 percent. Meanwhile, Construction and Mining and Quarrying each contributed an average of 10.41 percent and 8.72 percent.

Table. 3. KLBI with the Highest GDP Contribution and Its Growth in 2019-2023

KLBI	Contribution	Growth	Causes
Manufacture Industry	**19,29%**	**4,64%**	1. High demand for textiles as raw materials for masks and medical team clothing in 2020-2021. 2. High demand for textiles during Eid and the new school year 2022-2023.
Agriculture, Plantations and Forestry	**13.02%**	**15,32%**	The fisheries agriculture sector is due to seaweed production. The increase is due to the results of cocoa and palm oil plantations.
Wholesaler and Retail	**12,93%**	**1,3%**	Starting to grow since the existence of e-commerce.
Car and Motorcycle Repair	**12,93%**	**2,5%**	1. Sales of cars and motorbikes and an increase in the supply of domestic goods.

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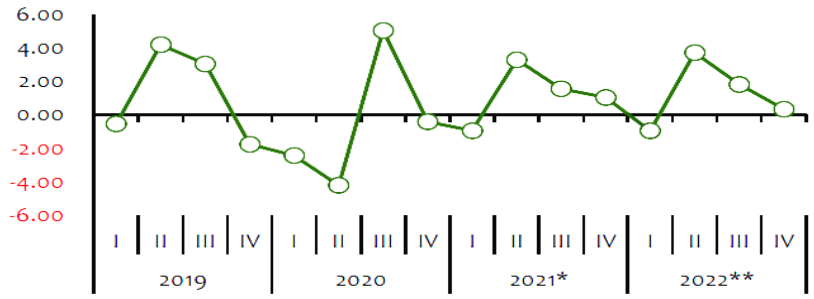
KLBI	Contribution	Growth	Causes
			2. Increasing use of transportation as a means of transporting goods and people (in online taxis).
Contruction	**10,41%**	**3,4%**	Increased due to very rapid infrastructure development projects during President Jokowi's administration.
Mining	**8,72%**	**3,65%**	Increasing influenced by ore and coal mining.
Transportation and Warehousing	**5,1%**	**13,96%**	Increased influenced by the 2022-2023 increase in the quota for hajj pilgrims, tourism, package goods transportation from e-commerce and online transportation.

Grafic. 3
Growth of Quarterly GDP (q to q), 2019-2022 (percent)



Economic growth in the second-fourth quarter of 2019 began to decline due to Covid-19 which had previously hit overseas so that export demand for Indonesian products continued to decline and was reflected in the steep decline in GDP growth, even negative 3%. Then entering the second quarter of 2020, Covid-19 began to hit Indonesia and the government protected the region by implementing a lockdown policy so that almost all economic activities stopped so that economic growth fell to -5%. However, slowly in the third quarter the economy relatively increased its growth of 5% due to the PSBB policy that for essential sectors can operated. Therefore, the growth of KLBI related to e-commerce such as wholesalers, warehousing and transportation, grew by an average of 7.6%, ultimately driving the recovery of the Indonesian economy in 2023 grew by 5.05 percent.

The Use of Big Data in Policy Implementation Based on Economic Growth Per Industrial Sector

From the discussion above, it can be seen that the use of Big Data has been used in calculating economic growth. Furthermore, KLBI growth from Big Data can be used as a reference for mapping industries that play a role in Smart City policy making by local governments in collaboration with BI to encourage potential industries because they can process resources in the region effectively and efficiently so that they have the potential to increase public services and Regional Income. Smart city is a vision of urban development to integrate information and communication technology (ICT) and Internet of things (IoT)

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technology in a safe way to manage city assets. On May 22-23, 2017, the kick-off of the Activity became 100 Smart City program in 2019 was carried out with a roadmap in 2017 at the time of launching as many as 25 regencies/cities, 2018 as many as 50 regencies/cities and 2019 as many as 25 regencies/cities. The six cities and regencies include:

1. **Makassar**

This city is considered as one of the cities in Indonesia with the best smart city in Southeast Asia. . Makassar uses smart city for the purpose of government services, tourism services and regional industrial potential services. With the potential of food and beverage processing industry (500 industries), ready-made clothing industry, convection, sewing, embroidery, border (209 industries), Repair and Installation Services for Machinery and Equipment (163 industries), wood industry, Printing Industry for invitations, brochures, banners, screen printing (146 industries), Medicine industry, herbal, cosmetics (114 industries), Electrical equipment industry, computer equipment, aluminum goods (105 industries), Machinery industry, equipment and supplies (63 industries), Furniture industry, cupboards, sofas, chairs, interiors (63 industries), Other Processing Industries, and Ship and boat manufacturing industry, bicycles (24 industries). Bamboo & rattan crafts (23 industries),

2. **Denpasar**

A tourism-based city that implements a smart city with the Denpasar Prama Sewaka (DPS) application and the Pro Denpasar website with a focus on tourism industry resources and their supporters (transportation and aviation 36.38%, electricity and gas procurement 28.81%, provision of accommodation, food and beverages 18.95%, financial services and money changers 11.2%) which totals 95.34% of PDRB in 2023 with an economic growth rate of 6.04%. In addition, Denpasar residents can use the DPS and Pro Denpasar applications and websites to report urban problems, explore tourist attractions, and contact important numbers.

3. **Surabaya**

A big city that implements smart city innovations in various fields, such as smart governance, smart environment, smart economy, and smart living. Related to smart economy, Surabaya has issued the GOBISS (Go Bisnis to Surabaya) application which records the potential of leading industries, consisting of 288,790 MSME units in Surabaya and has business types in the trade sector, provision of accommodation and food and beverages, and the processing industry - the three sectors that contribute the most to Surabaya's PDRB.

4. **Yogyakarta**

Since the issuance of the Yogyakarta Mayor Regulation Number 15 of 2015, Yogyakarta has implemented Smart City in stages, initially only within the scope of government. Then in 2018 it expanded further through Jogja Smart Service (JSS) covering public services, CCTV-connected security services at several points in the city in real time, and tourism services supported by the hotel accommodation service industry sector, aviation, local transportation and restaurants with a contribution to PDRB reaching 55% and a contribution to employment of 25.34% (BI, 2018).

5. **Sleman Regency**

Sleman Regency is developing a smart city concept for government, public services, branding, economic potential, housing, community welfare and the environment. The economic potential is dominated by 4 sectors contributing the largest PDRB reaching 67% of Sleman Regency's PDRB, namely the agricultural sector, the processing industry sector, the trade sector, and the hotel and restaurant services sector.

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6. **Wonogiri Regency**
This regency is developing a smart city concept to support priority tourism. One of its leading programs is the development of a Tourist Information Center containing information on accommodation, transportation, and tourism information because the three industrial sectors supporting tourism resources are able to contribute 36.68% of PDRB. In addition, the economy is supported by the agricultural sector 29.1% of PDRB and limestone and bentonite mining reaching 18.08% of PDRB. The economic growth rate is 4.2%.

In addition, good KLBI growth is also an indicator of conducive economic growth and good industrial production growth so that indirectly Big Data plays a role in driven investment decisions.

In the agricultural sector, information generated by Big Data can influence national food supply policies, whether food crops can meet or whether rice imports are still needed, or fertilizer subsidies are needed to increase agricultural production to meet national needs. On the other hand, if there is a surplus of production such as plantations and fisheries compared to domestic needs, exports can be carried out.

In the financial institution sector, the use of Big Data has been actively used to improve customer services related to financial transactions, accelerate the process of preparing financial reports, and detect and prevent fraud. In the trade and transportation sectors, especially those based on digital, Big Data has also been used intensively to increase transactions and expand new customers.

The large contribution of KLBI from Big Data also a play role in the company's strategy and mapping in seeing which industry contributions are large and can be invited to collaborate as suppliers, as customers industry, as marketing cooperation in the oligopoly market or in exporting their products.

To optimize the role of Big Data, a Big Data Utilization Forum is needed between policy-making authorities, banking, academics, and industry. This is expected to be the embryo of creating close collaboration between various institutional elements in society in the management and optimal use of Big Data. The good utilization of Big Data is expected to optimize Indonesia's digital potential which plays a very large role in accelerating national economic growth and creating a multiplier effect for economic development and community welfare.

CONCLUSION

Big Data is growing rapidly in terms of quantity and volume and its use, along with the advancement of Information technology has played a very large role in calculating GDP and economic growth both based on current prices and constant prices. Big Data through KLBI data has shown the contribution of each dominant industrial sector to GDP where the growth of each KLBI sector also influences economic growth.

Big Data with the presentation of information per sector can help make better decisions (efficient, effective, useful and fair. The utilization of Big Data based on KLBI has been realized in the implementation of smart cities, which aim to manage and control resources more effectively and efficiently in order to maximize public services, good economic growth brings progress so as to attract investors, the growth of new businesses, and increased trade followed by increased Regional Original Income which ultimately improves the welfare of local communities.

As a recommendation, a Forum is needed to facilitate the utilization of Big Data between policy-making authorities, academics, and industry. This is expected to be the embryo of

creating close collaboration between various institutional elements in society in the management and optimal utilization of Big Data. Good utilization of Big Data and digitalization are expected to have great potential in accelerating national economic growth.

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