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CAN BIG DATA ACHIEVE ENVIRONMENTAL JUSTICE? (PRELIMINARY RESEARCH ON THE PERFORMANCE OF INDONESIAN AGRICULTURAL APPLICATION)

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Abstract

Big data and analytical tools are being used by agricultural startup companies to develop their application performance. Generally, big data is a term that describes a large volume of structured and unstructured data. A few goals of its utilization include promoting environmental justice, improving energy efficiency, as well as tracking climate change by introducing 'smart farms'. However, the utilization is accompanied by some flaws, such as legal regulatory issues involving the gap between applied technology and global government policies. There is also increased development of agricultural applications in Indonesia, which led to the initiation of a digitization program for plantation and livestock through the Go Online Farmers application. The roles of big data are very crucial in providing valuable information to farmers. Therefore, combining the observation of an agriculture-based application's performance with a statutory approach, this research provided some examples of the utilization of big data by agriculture startup companies to achieve their environmental and sustainability goals. These include illustrating the initiative behind the use and the management of the associated policies and legal challenges in the country. Eventually, this research attempted to explain the contribution of big data in promoting environmental justice from a legal perspective.

Keywords: *Agricultural, Big Data, Environment Justice, Legal Challenges, Sustainability Goals*

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I. INTRODUCTION

Environmental protection began in the early 20th century[1] and was marked by the creation of numerous bilateral, regional, and multilateral international agreements by developed and developing countries. This commenced with the 1902 Convention on the Protection of Birds that are Useful for Agriculture and was followed by the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere[2]. Other environmental conventions include the London Convention for the Prevention of the Pollution of the Sea

[1] "14.2 Environmental Laws and Regulations," in *Environmental Economics and Policies*, 1970.
[2] Convention on Nature Protection and Wild Life Preservation in the Western Hemisphere, opened for signature 12 October 1940, 161 UNTC 193, (entered into force on 30 April 1942).

by Oil and the 1967 Treaty on Principles of Governing the Exploration and Use of Outer Space regarding the use of space[3].

In 1972, the United Nations held the Stockholm Conference, which produced an agreement concerning the environment known as "The Stockholm Declaration on Human Environment.[4] The Conference also led to the establishment of the United Nations Environment Program (UNEP) as well as the Action Plan for the Human Environment. The Stockholm declaration contains 26 principles and regulates the importance to safeguard the environment under Principle 2,

> *"the natural resources of the earth, including air, water, land, flora, and fauna, and specifically representative samples of natural ecosystems, must be safeguarded for the benefits of present and future generations through careful planning or management, as appropriate."*[5]

UN environmental conferences are routinely held every 10 years,[6] and exert major influences on the development of international environmental laws.[7] One key milestone in the development of environmental law was the 1992 Earth Summit, held in Rio de Janeiro, Brazil.[8] It highlighted the concerns of countries regarding the sustainability of natural resources for future generations, acknowledging that the vast global development may be detrimental to the environment. Also, the United Nations Conference on Environment and Development (UNCED), the Rio de Janeiro Declaration, the Climate Change Convention, the Convention on Biological Diversity, the Forest Principles, and the 21 Global Agenda were convened in 1992.[9]

In an effort to realize and manage sustainable natural resources, the United Nations made an agreement contained in Sustainable Development Goals (SDGs), a continuation of the Millennium Development Goals (MDGs).[10] SDGs are a global sustainable development agreement endorsed by the UN in

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[3] Melda Kamil A. Ariadno, "Prinsip-Prinsip Hukum Lingkungan Internasional [Principles of International Environmental Law]," *Jurnal Hukum dan Pembangunan* 2, (1999): 107.

[4] Stockholm Declaration on the Human Environment, opened for signature 23 May 2001, (entered into force 17 May 2004).

[5] *Ibid*.

[6] Björn Ola Linnér and Henrik Selin, "The United Nations Conference on Sustainable Development: Forty Years in the Making," *SAGE Journals*, no. 6 (2013): 971–987, https://doi.org/10.1068/c12287.

[7] Patricia Birnie, "The Development of International Environmental Law," *British Journal of International Studies* 3, no. 2 (1977): 169–190, doi:10.1017/S0260210500116973.

[8] Stockholm Declaration on the Human Environment, opened for signature 23 May 2001, (entered into force 17 May 2004).

[9] *Ibid*.

[10] "Millennium Development Goals (MDGs)," United Nations, accessed 30 March 2022, https://www.who.int/news-room/fact-sheets/detail/millennium-development-goals-(mdgs).

2015 (United Nations 2018).[11] They are an action plan to achieve 17 goals and 169 targets globally in the next 15 years by 2030. One of the expectations of SDGs is to uplift disenfranchised groups, such as the hungry and poor.[12]

Meanwhile, agriculture is a pivotal sector in achieving the goal of SDG Number 2 - Zero Hunger. According to the World Food Program, 135 million people suffer from acute hunger, caused by several factors, such as conflicts, climate change, and economic downturns.[13] This number may be doubled by the recent Covid-19 pandemic.[14] However, this SDG aims to end all types of hunger, including malnutrition due to poverty, by focusing on the agricultural sector as a provider of food. This will ensure the achievement of sustainable agriculture by targeting all aspects of the sector, including seed providers, management, marketing, and environmental sustainability efforts.[15] Indonesia was ranked 70 out of 107 countries on the 2020 Global Hunger Index.[16] In 2020, 70 out of 514 districts or municipalities in the country remained vulnerable to food insecurity.[17] Despite the significant developments during the past decades, this data shows that food insecurity is still a pivotal issue to be addressed by the government to achieve the Zero Hunger goal.

Based on 2017 Central Statistics Agency data and surveys (Central Bureau of Statistics 2018), the poverty rate of farmers in rural areas (13.47%) is higher than in cities (10.27%).[18] Similarly, a 2020 research by the Indonesian Institute of Sciences (*Lembaga Ilmu Pengetahuan Indonesia*) found that smallholder farmers, who are the food producers and dominate the agriculture industry, are highly affected by the food security crisis due to poverty.[19] This situation

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[11] "What Are the Sustainable Development Goals?," UNDP, accessed 30 March 2022, https://www.undp.org/sustainable-development-goals.

[12] *Ibid*.

[13] "Global Report on Food Crises: acute food insecurity hits new highs," FAO, accessed 30 March 2022, https://www.fao.org/newsroom/detail/global-report-on-food-crises-acute-food-insecurity-hits-new-highs/en.

[14] "2021 Global report on food crises: Joint analysis for better decisions," Food Secure Information Network, accessed 30 March 2022, https://www.ifpri.org/publication/2021-global-report-food-crises-joint-analysis-better-decisions.

[15] Beria Leimona et al., *Indonesia's 'Green Agriculture' Strategies and Policies: Closing the Gap between Aspirations and Application*, (World Agroforestry Centre, 2015).

[16] "WFP Indonesia Country Brief, October 2021," WFP, accessed 30 March 2022, https://reliefweb.int/report/indonesia/wfp-indonesia-country-brief-october-2021.

[17] "Global Hunger Index," Global Hunger Index, accessed 30 March 2022, https://www.globalhungerindex.org/ranking.html.

[18] "Fact Check: Has the Rate of Rural Poverty in Indonesia Declined Twice as Much as in the Cities?," The Conversation, accessed 30 March 2022, https://theconversation.com/fact-check-has-the-rate-of-rural-poverty-in-indonesia-declined-twice-as-much-as-in-the-cities-107110#:~:text=So%2C%20it%20is%20true%20that,to%202.37%25%20in%20March%202018.

[19] "Ketahanan Pangan Dan Ironi Petani Di Tengah Pandemi COVID-19 [Food Security and Farmer's Irony during COVID-19]," LIPI, accessed 30 March 2022, https://kependudukan.lipi.go.id/mencatatcovid19/ketahanan-pangan-dan-ironi-petani-di-tengah-pandemi-covid-19/.

may pose a challenge for Indonesia in achieving SDGs by 2030. Since the poverty rate reflects the ability of the community to meet its food needs, the participation of the government, international organizations, institutions, and society in agriculture will greatly influence the realization of SDGs. Moreover, the exploitation of the era of the industrial revolution 4.0 by the young generations through the development of startup companies may help improve the agriculture sector. This will also enable the incorporation of new and more innovative approaches.

In order to reduce poverty and injustice in development, specifically in the context of the environment and natural resources, a holistic, universal, and all-encompassing implementation is needed. The development of a sustainable agricultural sector in Indonesia is based on the First Principle of the Stockholm Declaration of 1972, which states that "Humans have the basic right to independence to obtain justice and adequate living conditions in a quality environment that allows a dignified and prosperous life..."[20] Therefore, sustainable development should treat the needs and aspirations of present and future generations as the human rights stated in the International Covenant on Economic, Social and Cultural Rights (ICESCR), which is a multilateral agreement established by the General Assembly of United Nations on 16 December 1966.[21]

The association of ICESCR with the environment led to the development of the Environmental Justice concept in the United States in the 1970s.[22] The Environmental Protection Agency of the United States defined Environmental Justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income in the development, implementation, and enforcement of environmental laws, regulations, and policies.[23] This means that Environmental Justice is a community movement which advocates for fair treatment in the social, economic, and cultural fields regarding any development affecting the environment.

It can act as a reminder for decision-makers or governments in creating policies and regulations in all fields, particularly in the exploration and exploitation of natural resources. The implementation of the sustainable development provisions following the principles of conservation will prevent development inequality. It also ensures that development orientation will not

[20] Stockholm Declaration on the Human Environment, opened for signature 23 May 2001, (entered into force 17 May 2004).

[21] International Covenant on Economic, Social and Cultural Rights, opened for signature 19 December 1966, (entered into force 3 January 1976).

[22] *Ibid*.

[23] Paul Mohai, David Pellow, J. Timmons Roberts, "Annual Review of Environment and Resources," *Environmental Justice* 34, no. 1 (2009): 405.

solely pursue economic improvement, but ensure Environmental Justice is considered. In general, Environmental Justice has a more defined social justice perspective compared to the initial environmental cornerstone of sustainable development.[24]

Similar to other Southeast Asian countries, Indonesia possesses vast rice fields.[25] Most of its citizens consume rice as a food and energy source in their daily lives, strengthening the role of Agriculture as a strategic sector in the country.[26] Based on data from The Economist Intelligence Unit (EIU), the country's food security index increased significantly from 46.5 indexes in 2014 to 54.8 in 2018.[27] [28] Meanwhile, Badan Pusat Statistik (BPS), an Indonesian non-ministerial Central Bureau of Statistic recorded 38.7 million workers in the agricultural sector in 2018.[29]However, this number has continued to decline in the past five years.[30] This necessitates a modernization of the traditional agricultural sector to elevate farmers, ensure their prosperity,[31] guarantee the increased productivity and added value of agricultural products, and promote growth in wages.[32]

In addition, technology, resources, institutions, and market access must focus on diversification. According to FAO, farmers encounter difficulties when dependent on one crop.[33] Diversification guarantees the continuity of production as well as income. Following the development of digital technology, exploiting this progress for the welfare of farmers and to boost the realization of food self-sufficiency has become a norm.[34] Digital ecosystems have also

[24] Urban et al., "Chinese Overseas Hydropower Dams and Social Sustainability: The B UI Dam in Ghana and the Kamchay Dam in Cambodia," *Asia Pacific Policy Study* 2, no. 3 (2015): 573.

[25] "Indonesian Agricultural Innovation through Big-Data Agriculture," Swara Pendidikan, accessed 30 March 2022, http://swarapendidikan.um.ac.id/en/2019/12/17/inovasi-pertanian-indonesia-melalui-big-data-agriculture/.

[26] Agus Syarip Hidayat and Teddy Lesmana, "The Development of Organic Rice Farming in Indonesia," *Review of Indonesian Economic and Business Studies* 2, (2011): 75.

[27] Zhang-Yue Zhou, *Global Food Security: What Matters*? (London: Routledge, 2019).

[28] Anggit Gantina and Drajat Martianto and Dadang Sukandar, "The Development of Food and Nutrition Security Index at Provincial Level in Indonesia," *Jurnal Gizi dan Pangan* 15, no. 3 (2020): 175.

[29] "Inclusive Business in Indonesia—Improving Supply Chain Efficiency through Inclusive Business: Final Technical Assistance Consultant's Report," Asian Development Bank, accessed 30 March 2022, https://www.adb.org/sites/default/files/project-documents/46240/46240-001-tacr-en_2.pdf.

[30] Patricia A. Daly, "Agricultural Employment: Has the Decline Ended?" *Monthly Labor Review* 104, no.11 (1981): 14.

[31] "Successful agricultural transformations: Six core elements of planning and delivery," McKinsey & Company, accessed 30 March 2022, https://www.mckinsey.com/industries/chemicals/our-insights/successful-agricultural-transformations-six-core-elements-of-planning-and-delivery.

[32] "The Future of Food and Agriculture: Trends and Challenges, The Future of Food and Agriculture: Trends and Challenges," FAO, 2017.

[33] "The State of Food and Agriculture 2017. Leveraging Food Systems for Inclusive Rural Transformation," FAO, accessed 18 August 2022, https://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1046886/.

[34] "Farming Smarter: Tackling the Decline in Indonesian Farming," The Jakarta Post, accessed 30 March

become a recent concern for the Indonesian government as various startup companies have been established and are developing rapidly.[35]

According to a recent survey, out of a 268.2 million population, there are 355.5 million mobile phone users as well as 150 million active internet and social media users.[36] Furthermore, 91% of Indonesians have visited e-commerce sites, including brand websites and marketplaces[37], and 90% have made product purchases online.[38] These numbers show that the internet is widely used among Indonesians and should be considered a target for the development of potential numbers to develop internet-based business including in the agricultural sector. Meanwhile, the Google and Temasek Research revealed that Indonesia's digital economy is predicted to grow rapidly and reach USD 100 billion in 2025,[39] thereby becoming the largest in Southeast Asia.

In 2018, the Ministry of Creative Economy issued a report on the Mapping of the Indonesian Startup Database to provide brief information on the development of startups[40] and optimistically create a better startup ecosystem.[41] The Indonesian government also initiated the Go Online Farmers program in the agriculture sector.[42] This program aims to digitize the agriculture, plantation, and livestock sector in order to help farmers increase their crop yields, facilitate sales, and implement more modern farming methods.[43] In collaboration with PT Telekomunikasi Indonesia, a digital platform was created to collect and use data from farmers and land to accelerate the distribution of soft loans to farmers and agricultural insurance applications. The role of big data is certainly crucial in this matter, though some flaws surround the existence of such technology. The utilization is potentially facing

2022, https://www.thejakartapost.com/opinion/2022/04/04/farming-smarter-tackling-the-decline-in-indonesian-farming.html.

[35] "Technology Startups for Agricultural Sector," The Jakarta Post, accessed 30 March 2022, https://www.thejakartapost.com/academia/2016/08/26/technology-startups-for-agricultural-sector.html.

[36] "Digital 2019: Indonesia, Global Digital Insights," DataReportal, accessed 30 March 2022, https://datareportal.com/reports/digital-2019-indonesia.

[37] *Ibid*.

[38] *Ibid*.

[39] "Indonesia's Digital Economy to Dominate Southeast Asia by 2025," The Jakarta Post, accessed 30 March 2022, https://www.thejakartapost.com/news/2018/11/28/indonesias-digital-economy-to-dominate-southeast-asia-by-2025.html.

[40] M. Andy Zaky et. al., *Mapping dan Database Startup Indonesia 2018* [*Indonesian Startup Database and Mapping*], Jakarta 2018.

[41] Dodi Siregar, Agung Purnomo, Rini Mastuti, et. al., *Technopreneurship: Strategi Dan Inovasi [Technopreneurship: Strategy and Innovation]*, Alex Rikki, ed. (Medan: Yayasan Kita Menulis, 2020), 37.

[42] "The Digital Transformation of Agriculture in Indonesia," Brookings, accessed 18 August 2022, https://www.brookings.edu/blog/future-development/2022/01/21/the-digital-transformation-of-agriculture-in-indonesia/.

[43] *Ibid*.

some legal issues related to data mining. The gap between applied technology and government policies and regulations is a common global problem. Therefore, this research attempted to observe the role of big data in promoting environmental justice from Indonesia's legal perspective.

This research was normative juridical, using a statutory and conceptual approach.[44] It was conducted using descriptive-analytical and explanation methods to explain the government's regulation of agricultural startups by utilizing big data that can promote environmental justice, increase energy efficiency, and control climate changes.

III. PRINCIPLE OF ENVIRONMENTAL JUSTICE & SUSTAINABLE GOAL

The implementation of environmental justice in a country does not conflict with the principles of sustainable development but seeks to balance or harmonize economic development with environmental carrying capacity. This is stated in Principle 1 of the Rio Declaration on Environment and Development in 1992[45] that "Human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature."[46] This principle is also related to the implementation of environmental justice to save natural resources by integrating all systems and sectors through the consideration of the precautionary principle and anticipatory ambit on the impact of development activities. This supports Principle 15 of the 1992 Rio Declaration, which asserted that "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. In cases of threats of serious or irreversible damage, the lack of full scientific certainty shall not be used as a reason for responding to cost-effective measures to prevent environmental degradation."[47]

Population growth impacts the sustainability of natural resources, which is also related to sustainable development. Generally, sustainable development is aimed at meeting the present needs of humanity, without reducing or destroying the ability of future generations to survive.[48] The understanding

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[44] Peter Mahmud Marzuki, *Penelitian Hukum* [*Legal Research*] (Jakarta: Kencana Prenada Media Group, 2011), 27.

[45] Rio Declaration on Environment and Development, adopted on 14 June 1992, UN Doc. A/CONF.151/26 (vol. I), 31 ILM 874.

[46] *Ibid*.

[47] *Ibid*.

[48] Rokhmin Dahuri, *Pengelolaan Sumberdaya Wilayah Pesisir dan Lautan Secara Terpadu [Coastal and*

put forward by the Brundtland Commission has a very broad understanding and opened up the possibility of different interpretations. Therefore, the World Conservation Union (IUCN) clarified this understanding by stating that:[49]

> *"Sustainable development means achieving a quality of life (or standard of living) that can be maintained for many generations because it is[50]:*
> 1. *Socially desirable, fulfilling people's cultural, material, and spiritual needs in equitable ways;*
> 2. *Economically viable, paying for itself, with the cost being lower than the income;*
> 3. *Ecologically sustainable, maintaining the long-term viability of the supporting ecosystem."*

Technically sustainable development is an effort to utilize natural resources and environmental services for human welfare, particularly stakeholders, in such a way that the rate (level) of use does not exceed the carrying capacity of the region.[51]

The principle[52] of sustainable development is an integral part of the concepts of environmental protection and development, which essentially are:[53] Inter-generational equity; intra-generational equity; the precautionary principle or approach; the maintenance of biological diversity and biological integrity, which are vital to the continuing existence of ecosystems; and the internalization of environmental costs.

According to the concept of sustainable development, sustainability can be interpreted as inter-generational justice (Inter-generational Equity Principle), which ensures that future generations have inherited natural resources, alongside human and social capital, and are entitled to equitably obtain resources of the same or a better environment.[54]

The principle of sustainability described in policies and strategies should

Marine Research Management] (Jakarta: Pradnya Paramita, 2001), 89.

[49] IUCN-The World Conservation Union, "Guide to Preparing and Implementing National Sustainable Development Strategies and Other Multi-Sectoral Environment and Development Strategies, Prepared by the IUCN's Commission on Environmental Strategies Working Group," n.d.

[50] David Banister, Erling Holden, Kristin Linnerud, "Sustainable Development: Our Common Future Re-visited," *Global Environmental Change* 26 (2014): 130.

[51] Dahuri, Pengelolaan Sumberdaya Wilayah Pesisir dan Lautan Secara Terpadu, 96-97; Dina Sunyowati, *Kerangka Hukum Pengelolaan Wilayah Pesisir Berkelanjutan* [*Legal Framework for Coastal Sustainable Development*], Surabaya: Universitas Airlangga, 2008: 115.

[52] Arief Sidharta and Bruggink. J. J. H, *Refleksi Tentang Hukum [Reflections on Laws]* (Bandung: Citra Aditya Bakti, 1996), 123.

[53] Konrad Erick Denters and Paul J.L.M. de Waart Ginter, *Sustainable Development and Good Governance* (London: Martinus Nijhoff Publishers, 1995); Sunyowati, *Kerangka Hukum Pengelolaan Wilayah Pesisir Berkelanjutan*, 115.

[54] Dahuri, *Pengelolaan Sumberdaya Wilayah Pesisir dan Lautan Secara Terpadu*, 96-97.

be holistic and integrate natural and human resources. Also, intra-generational justice can be reviewed at the national and international levels, while intra-generational justice at the national level guarantees every citizen the right to use the natural resources and the environment in their country. At the international level, intra-generational justice means fairness among countries to obtain natural resources, such as land, air, and sea, including biodiversity.[55]

Principle 15 stated that "the precautionary approach shall be widely applied by states according to their capabilities."[56] This means a policy or regulation must be carefully prepared, though there may be no confidence or certainty about the dangers arising from development activities.[57]

The principles of sustainable development require implementation through laws and government policies. This was explained by Siti Sundari Rangkuti, "Sustainable development is the political will to develop without damaging environmental policies and requires legal instruments in the form of laws and regulations, such as environmental law. The use of law as a means is based on several advantages, namely integrative rationality, legitimacy and sanctions, and support by the availability of implementation mechanisms. Therefore, solving environmental problems is not based on theory alone, but is supported by political will and the enforcement of legal instruments."[58]

B. BIG DATA UTILIZATION IN THE AGRICULTURE SECTOR

Big data includes data sets with sizes that require devices beyond the ability of commonly used software tools to capture, curate, manage, and process data within a tolerable elapsed time. Its philosophy encompasses unstructured, semi-structured, and structured data. However, the main focus of this research was unstructured data. The "size" of big data is a constantly moving target, ranging from a few dozen terabytes as of 2012 to many zettabytes of data. Big data requires a set of techniques and technologies with new forms of integration to reveal insights from diverse, complex, and massive data sets. A 2018 definition stated that:

> *"Big data is where parallel computing tools are needed to handle data… This represents a distinct and clearly defined change in the computer science used, through parallel programming theories, and the losses of some*

[55] Konrad Erick Denters and Paul J.L.M. de Waart Ginter, *Sustainable Development and Good Governance* (London: Martinus Nijhoff Publishers, 1995), 115-116.

[56] Rio Declaration on Environment and Development, adopted on 14 June 1992, UN Doc. A/CONF.151/26 (vol. I), 31 ILM 874.

[57] Denters and Ginter, *Sustainable Development and Good Governance*, 115-116.

[58] Siti Sundari Rangkuti, *Hukum Lingkungan Dan Kebijkasanaan Lingkungan Nasional* [*Environmental Law and Environmental National Policy*], Third Edition (Surabaya: Airlangga University Press, 2005), 70.

of the guarantees and capabilities made by Codd's relational model."[59]

Based on the definitions above, the characteristics of Big Data can be classified into:

a) Volume: the quantity of generated and stored data. The size determines the value, potential insight, and its categorization as big data.
b) Variety: the type and nature of the data. This helps analysts effectively use the resulting insight. Big data draws from texts, images, audio, and videos, and completes missing pieces through data fusion.
c) Velocity: the speed of data generation and processing to meet the demands and challenges of growth and development. Big data is often available in real-time, and compared to small data, they are produced more continually. Two kinds of velocity related to big data are the frequency of generation and the frequency of handling, recording, and publishing.
d) Veracity: the extended definition for big data, which refers to data quality and value. The quality of captured data can vary greatly, affecting the accurate analysis.

Data must be processed with advanced tools (analytics and algorithms) to reveal meaningful information. For example, one must consider visible and invisible issues with various components in managing a factory. Information generation algorithms must detect and address invisible issues, such as machine degradation, component wear, etc., on the factory floor. Through processing by analytics and algorithms, big data can produce a new form of value by helping actors to make faster, smarter, and more impactful decisions.[60]

In the agricultural sector, big data is utilized to make accurate crop predictions, monitor farms through drone technology, speed up plant growth, and increase yield. It also enables scientists to conduct experiments on crop growth in harsh climates. Big data is a driving force for reforming the agricultural industry and creating environmental awareness. Generally, farmers all around the world experience some confusion regarding the type of crop to be planted or harvested. In developed countries such as the US, crop prediction is based on data from the previous years' climatic conditions, such as soil nutrients, rainfall, etc. These wise decisions result in maximum yield and help grow the economic sector through food production.

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[59] Charles Fox, *Data Science for Transport. Springer Texts in Earth Science, Geography and Environment* (Germany: Springer, 2018), 26.

[60] Firas D. Ahmed, Aws Naser Jaber, Mohd Sharifuddin Ahmad, et.al., "Agent-Based Big Data Analytics in Retailing: A Case Study.," in *4th International Conference on Software Engineering and Computer Systems*, 2015, 67–72, https://doi.org/https://doi.org/10.1109/ICSECS.2015.7333085.

Some benefits of big data in the agriculture sector are:

1) Accurate crop prediction; the wait for plant growth and crop yield is a long process and usually leads to loss. In some regions, such as Native America, the people rely on rain dances for good crop growth, production, and a bountiful harvest. However, in recent years, big data has enabled accurate crop prediction without even planting a seed. It uses a sophisticated algorithm to analyze the weather condition and plant data of the last few years and predicts the best crop for the present year. This is the best way to maximize crop yield with less stress.

2) Addressing world hunger; the largest global famine crisis since 1945 was in 2017 when the UN declared that 20 million people were at risk of starvation.[61] The massive famine in Africa was the result of rising temperature and an increase in the global population. Although many humanitarian groups have made great efforts to assist, big data may proffer one of the most valuable solutions. Many scientists turned to analyze plant data to determine the best crop irrespective of the climatic conditions. From the results prepared using big data, chemically engineered seeds have better outcomes, such as increased yield and growth, compared to the control plants. This is one of the solutions to world hunger, although there is an issue regarding the threat of Genetically Modified Organisms (GMOs).

3) Agricultural Automation; due to advancements in technology and big data, automated farming tools, such as farm-bots, drones, and intelligent sprinklers, have been created. Drones are fitted with advanced sensors to update their data, monitor crops, and notify areas requiring improvement. Fleeting robots are used in many parts of the US to plant corn kernels and eradicate weeds that threaten to damage the main crop.

4) Environmental Awareness; humans are unable to predict the exact future climatic conditions, while big data is able. The agriculture industry is not solely an industry or business but may influence all human life decisions. Big data shows companies in the agricultural industry that the environment can be protected at the same or even lower cost. Presently, manufacturing industries, as well as farmers and agricultural companies, are making changes to reduce their

[61] United Nations, "Amid Humanitarian Funding Gap, 20 Million People across Africa, Yemen at Risk of Starvation, Emergency Relief Chief Warns Security Council," United Nations Meetings Coverage and Press Releases, 2017, https://www.un.org/press/en/2017/sc12748.doc.htm.

environmental impact.

Moreover, big data offers great opportunities in agriculture, including:

1) Performance optimization with real-time insights; emerging weather events and disease breakouts can be analyzed through advanced analytics. The key challenge is to provide real-time insights clearly and concisely to enable effective decision-making. This can be achieved through sophisticated algorithms to unlock the valuable insights attainable from big data.
2) Potential to increase productivity; due to the rising population, the global food demand may be doubled by 2050. This necessitates farmers to increase productivity using the limited resources and inputs available. Precision farming will play a major role in achieving this aim, as it helps develop intra-field variability in crops using input and practice applications.
3) Developing highly specific customer segmentation; products can be designed to meet the precise needs of customers through big data. For example, suppliers in areas suffering from black grass can use big data techniques, such as segmenting real-time micro customers to target promotional and marketing activities. This will facilitate better utilization of marketing spending and also help develop more sophisticated pricing strategies.

Based on the above analysis, big data and even other advancements in automated farming will develop in the future. This is the best way for smart agriculture.

Meanwhile, the Central Bureau of Statistics (BPS) in Indonesia plans to use big data to collect agribusiness information from agriculture, including plantations and livestock. BPS cooperated with PT Telkom to develop big data and discover the de facto dwellings of residents. This is in line with the government's policy on the Go Online Farmers program.

C. INDONESIAN AGRICULTURE-BASED STARTUP COMPANIES

The development of AgriTech companies in Indonesia is on the rise. According to the Tracxn research[62], no less than 59 AgriTech startups in Indonesia utilize certain technology to develop their products and services. Out of these startups, a total of 10 companies specifically use big data in their services, namely:

[62] "About Tracxn," Tracxn, accessed 30 March 2022, https://tracxn.com/.

1) *TaniHub*; this is an app-based online marketplace to trade agricultural commodities. It allows farmers and producers to sell products to retailers, wholesalers, and individual customers. The application enables buyers to purchase fruits, vegetables, grains, meat, seafood, etc., and delivers these products through an in-house delivery team called Tani-Express. The mobile platform is available for Android users.[63]

2) *eFishery*; this is an Indonesia-based company offering a smart fish feeding solution for commercial aquaculture. It consists of a feeder that uses motion sensors to detect the fish's appetite and automatically feeds them when agitated or hungry. Also, the mechanism provides a data platform that allows fish farmers to monitor and schedule the feeding in real-time on their phones and control the system as needed.[64]

3) *Crowde*; this is an online platform for connecting farmers with retail investors in order to obtain capital for their operations. It allows farmers to list their projects after registration for investors to select from. There is no lower limit of investment on the platform.[65]

4) *iGrow*; this platform partners with farmers and agribusinesses and allows users to invest in and own (productive farm ownership) farms by allowing the purchase of seeds. The proceeds are utilized to execute the entire farming operation, and the revenue generated by selling the harvest in proportion to the seed investment is shared with users.

5) *Jala*; this is an IoT device for monitoring water conditions in shrimp farms. The device is equipped with multiple sensors for monitoring parameters such as dissolved oxygen, temperature, humidity, pH, salinity, and total dissolved solids (TDS). It is submerged in the pond, where it collects the above-mentioned data and sends the information to the cloud in real-time. The company additionally provides a web-based portal where the collected data is processed and uses decision-making algorithms to produce actionable insights for farmers. Also, it provides a companion application that enables farmers to access data in case of poor internet connectivity. Notable feats for the device include a grant from ASME in March 2015 and Shrimp Club Indonesia

[63] Tanihub Food Solutions, "Sekilas Tentang TaniHub Group [TaniHub Group at a Glance]," Tanihub, 2016, accessed 30th March 2022, https://foodsolutions.tanihub.com/tentang/.

[64] eFishery, "Tentang Kami [About us]," eFishery, 2020, accessed 30 March 2022, https://efishery.com/about_us/.

[65] Crowde, "Tentang Kami: Menciptakan Ekosistem Pendanaan Yang Ramah Petani [About Us: Creating a Farmer Friendly Funding Ecosystem]," Crowde, 2017, accessed 30 March 2022, https://crowde.co/ourStory.

as one of its clients.[66]

6) *Eragano*; this is a mobile application to facilitate effective farming for smallholders. The application's features include AI-generated farm schedules integrated with e-commerce supply and crop protection programs. The application is available on Google Play Store. Notable customers include PISAgro, Agrina, and Paskomnas.[67]

7) *Habibi Garden*; this is an IoT-based precision farming platform. It involves the deployment of a central device that connects to several sensors to record and send data related to light intensity, humidity, moisture, and nutrients to the central cloud platform. The information is processed and used to control ground devices, such as water pumps, to supply water to fields when necessary. All the information is processed and available in a dashboard, which acts as an interface for farmers to monitor their fields.[68]

8) *Aruna*; this is an Indonesian company that provides a cloud platform to fishery businesses to manage their daily operations. Its features include fishery management, data intelligence related to fisheries, and online fishery trading.[69]

9) *Chillibeli*; this is an online community platform for agricultural products. It connects farmers and manufacturers with agents through instant-messaging tools.[70]

10) *InFishta*; this is an online platform that connects investors with fish farmers. It allows investors to choose the cultivation method, determine the funds to be invested, and invest in fish farming projects. Users can receive real-time updates on the projects they invest in and earn from the profits.[71]

These applications have their respective characteristics and use big data to collect data from their customers and sellers. For example, registration or a sign-up is required to make a purchase from the applications. The registration involves inputting personal data into the form and reading the terms and

[66] IGrow, "Tentang IGrow [About IGrow]," iGrow, 2017, accessed 30 March 2022, https://igrow.asia/about.

[67] Elisabeth Adventa, "Eragano, Tempat Bertemu Petani Dan Pembeli [Eragano, Where Farmers And Buyers Meet]," Kontan, 21 October 2018, accessed 30 March 2022, https://peluangusaha.kontan.co.id/news/eragano-tempat-bertemu-petani-dan-pembeli.

[68] "Tentang Habibi Garden [About Habibi Garden]," Habibi Garden, accessed 30 March 2022, https://www.habibigarden.com/index.html.

[69] "About Us," Aruna, accessed 30 March 2022, https://aruna.id/about-aruna/.

[70] "Tentang Kami [About us]," Chillibeli, accessed 30 March 2022, https://www.chilibeli.com/tentang-kami.

[71] "Tentang Kami," eFishta, accessed 30 March 2022, https://infishta.com/.

conditions carefully, as some items may differ among the platforms. A common sentence found in the basic terms and conditions format of many applications is "we may collect your Personal Information." This implies that the owner of the application will save users' personal information to the big data collection. By collecting a customer's personal information, companies are obligated to protect the data as regulated under the applicable law.

D. LEGAL FRAMEWORK ON BIG DATA AND ITS CHALLENGES

The legal challenges resulting from this technology range from data protection to the intrusion of privacy. The fundamental basis for privacy and data protection can be found in Article 28 (G) of the Constitution of Indonesia. It stipulates that every person has the right to: a) protection of themselves, their families, respect, dignity, and possessions under their control, and b) security and protection from threat or fear for doing or not doing something that constitutes a human right. There are presently no specific laws in Indonesia concerning the protection of private and family life. The most relevant regulation for the protection of privacy is related to personal data.

Provisions on the personal data protection can be found in Law No. 11 of 2008 regarding Electronic Information and Transactions (21 April 2008), as amended by Law No. 19 of 2016 (25 November 2016) (the 'Electronic Information Law'). The procedural guidelines for the Electronic Information Law are contained in Government Regulation No. 82 of 2012 regarding the Implementation of Electronic Systems and Transactions (27 February 2012) ('Government Regulation 82'). However, none of these regulations offers a comprehensive set of provisions for the protection of personal data but rather contains a general idea of personal data protection without specific guidelines. On 1 December 2016, the Ministry of Communication and Informatics (MOCI) issued a regulation specifically for the protection of personal data contained in an electronic system. This is called MOCI Regulation No. 20 of 2016 regarding the Protection of Personal Data in Electronic Systems (1 December 2016) ('MOCI Regulation 20'). MOCI Regulation 20 provides an implementation for the Electronic Information Law and Government Regulation 82. The Electronic Information Law, Government Regulation 82, and MOCI Regulation 20 are jointly referred to here as the PDP Regulations.

The application of the PDP Regulations appears to be rather broad. This can be seen from the definition of Electronic System Providers (ESP) under the PDP Regulations, which covers every person, state administrator, business entity, and community providing, managing, and/or operating an electronic system, either individually or jointly, for electronic system users, personal

purpose and/or another party's purpose. The term 'electronic system' is defined as a set of electronic devices and procedures that function to prepare, collect, process, analyze, retain, display, publish, transmit, and/or disseminate electronic information. The MOCI interpreted this definition to mean that any person or entity that stores data electronically is considered an ESP using an electronic system that should comply with PDP regulation.

As a civil law country, Indonesia has not applied the concept of omnibus laws, as all the requirements pertaining to data protection are covered by the PDP Regulations. Generally, a privacy or data protection officer refers to an authorized person(s) who shall supervise, investigate, and determine the applicable sanctions for any party that violates data protection obligations. Under the PDP Draft Law, such authority is granted to the MOCI, which may receive complaints or reports from the public and then investigate and sanction ESPs that flout their obligations.

The PDP Draft Law only provides a general requirement that the consent of the subject is obtained to authorize the collection, use, or other processing of any data. However, anonymization, de-identification, or pseudonymization by the data pursuant is not included in the regulations. Also, restrictions on or allowances for profiling, automated decision-making, online monitoring or tracking, big data analysis, and artificial intelligence do not exist in the current PDP Regulations.

E. FUTURE POLICY CHALLENGES

The Indonesian government showed a keen interest in pursuing big data transformation in governance. On June 12, 2019, President Joko Widodo (Jokowi) issued Presidential Regulation No. 39 of 2019 on the One Data Policy. This regulation is intended to gather national data under an accessible, accurate, integrated, and sophisticated system.

Jokowi's administration seems to believe that big data is key to improving the government's effectiveness and efficiency. Some ministers have experimented with the use of big data, such as the Finance Ministry in tax intensification and the Education and Culture Ministry in school registry management. Also, Jokowi's recent presidential campaign was colored with the story of the impact of big data in his electoral victory.

Beyond the magic and myth, big data is commonly accepted as a large data set that motivates the use of more advanced means of processing and storing data rather than the traditional methods. The term big data encompasses data volume, speed (velocity), diversity (variety), and quality (veracity). The

advent has promoted humans as users to look beyond static data, leading to its utilization and integration into various walks of life.

Although of high relevance, big data remains an under-addressed topic in politics. The use of technology is currently limited to complementing existing organizational or administrative practices, such as digitizing analog data or allowing remote registration of public services, rather than creating an entirely new value stream from the newly available technology. In addition, the use of big data as a core component in the public policy process remains minimal.

The policy cycle traditionally consists of several consequential steps required to create, assess, and implement policies. The cycle begins with agenda setting, followed by policy discussion, formulation, and budgetary preparations. Furthermore, it moves to the implementation and provision evaluations to examine the ability of the employed means to deliver the expected performance. An outcome evaluation is conducted after the policy implementation to assess the success. This last step is usually unresponsive to public opinion or external expertise.

Although there was previously no means to accurately calculate the possibilities of breakout or failures in the policy actions, this does not have to be the norm. The government as an entity has traditionally managed large amounts of data, such as civil administrative or tax data. With the recent availability of new types of data and analytical techniques, the government can process real-time data and allow the integration of the feedback cycle into each step of the policy-making process.

This will require government entities to build on their existing large data sets as well as find access to new ones. They also need to improve their institutional capabilities in providing the talent and the legal umbrella necessary. Since the success of a big data initiative is determined by the number of insights gained from the data and not only the size, a diverse talent pool would be needed to build meaningful prescriptive analysis. This is the reason government agencies frequently struggle to hire.

This demand has provided room for a technology transfer partnership between the public and private sectors. A solid partnership could help the public sector tap into private companies' professional talent and pace, as well as offer a complementary huge data-set that comes from these companies.

One of the successful cases of this public-private partnership is the collaboration between Jakarta Smart City and Qlue, a private company that provides citizen reporting apps in Jakarta and enables the collection of data on urban problems to ensure better budgetary planning. Previously, the Public

Discussion for Budgetary Planning forums (Musrenbang) was inefficient because the meetings were conducted on a set timeline that required citizens to be present, barring many workers from access to express their concerns. The process was heavily skewed to benefit persons with a major interest, and since the data parameter was limited, the allocated budget majorly correlated with the size of each district. This is problematic as some small districts in Jakarta experienced more problems, such as regular flooding, unsafe urban slums, and poor waste management.

Therefore, Qlue is collecting reports on problems in neighborhoods to create a new data set that complements the existing demographic, geographic, and existing budgetary requests, as well as past disbursements. Through a map of problems reported by citizens, the budget allocation in the Musrenbang may provide a clearer snapshot of the problem's root cause in the district. Consequently, the budget allocated for neighborhood development in Jakarta has become more efficient and helps solve citizens' concerns more accurately.

The aforementioned regulation on one data is the first milestone towards better utilization of big data. However, information alone is not power but becomes effective under the rigorous actions of all stakeholders involved. Proper implementation can be ensured by strong and data-literate leadership with a clear vision within the government body.

The public sectors need brave leaders to advance the data-literacy agenda. Big data implementation can only be useful through integration into government performance metrics. Without real stakes in place, information derived from big data will not result in better policy decisions.

Utilizing big data involves improving the efficiency and effectiveness of policies by empowering the government to produce informed policies that are beneficial for citizens and can be analyzed in real-time. It can equip the government to make quick decisions without compromising quality.

F. THE EMPIRIC BENEFIT OF UTILIZING BIG DATA IN THE AGRICULTURAL SECTOR

The fundamental targets of big data processing [72] in the agricultural sector are rapid population growth, balanced food production, and other factors such as weather, climate, water clarity, etc., that could affect production. Technology, such as the Internet of Things (IoT), cloud computing, big data, robotics, and Artificial Intelligence (AI) are believed to help increase

[72] M. N. Islam Sarker et al., "Big Data Driven Smart Agriculture: Pathway for Sustainable Development," *2019 2nd International Conference on Artificial Intelligence and Big Data (ICAIBD)* (2019): 60–65, https://doi.org/10.1109/ICAIBD.2019.8836982.

agricultural production. Smart agriculture is a technology that may resolve as well as prevent threats, challenges, and risks, such as climate changes, pet and plant diseases, and resistance. Agricultural big data refers to information regarding agriculture and requires a certain analytical approach and technology that can convert data into value.

Data is an influential tool in decision-making and involves an analysis of a situation. Agricultural big data means that large amounts of data are created naturally at different levels, from sowing seeds to harvesting. This technology can analyze data from various sources and regions. The collection of agricultural big data is referred to as "crowdsourcing" and can be done through "flying vehicles" or drones with a special camera or smartphone. The data is stored in a database and processed by an algorithm. Utilizing big data in the agricultural sector involves researching seed characteristics, weather, and soil conditions (pH and nutrition). The data sources can be from biological, geospatial, and environmental aspects.

The major challenges of utilizing big data in the agricultural sector are technical and organizational issues, which are interconnected. The technical challenges are related to technology, such as the installation of the tool, technical capabilities, IT infrastructure, power supply, and maintaining the data transfer network. Conversely, the organizational challenges refer to investments, personnel recruitment, monitoring, expertise teams, and managerial aspects.[73]

IV. CONCLUSION

Global population growth is inversely proportional to the management of natural resources. This can be seen in several developing countries, which do not monitor population growth, leading to reduced environmental carrying capacity, and preventing marginalized communities from obtaining healthy and adequate natural resources, as stipulated in the Declaration of Human Rights. The emergence of environmental justice is a reflection of the lack of attention to the existence of marginalized people who are less concerned about the environment.

Consequently, big data offers considerably huge opportunities in the agricultural sector by prioritizing environmental protection and by optimizing performance, potentially increasing productivity. This can tackle the increasing global food needs and develop specific customer segmentation to promote

[73] Hendro Arieyanto and Jimmy Rumengan, "Paper Review: Smart Agriculture Dengan Pengolahan Big Data," BINUS University Graduate Program, accessed 28 February 2022, https://mti.binus.ac.id/2020/06/04/paper-review-smart-agriculture-dengan-pengolahan-big-data/.

production according to customer requirements.

Implementation of sustainable development principles requires legal instruments, such as laws and government policies. The PDP regulation in Indonesia is relatively new and in development, explaining its present failure to discuss important issues, such as big data, automated decision-making, AI, and the IoT. As a result, there is still a legal vacuum regarding data protection under certain conditions. Although the latest PDP legislation draft addresses more complex issues, such as biometric information as sensitive data that is entitled to a particular treatment, it is still under discussion, and the final content of the laws is yet to be confirmed. The Indonesian government has also expressed an interest in performing big data transformation by issuing Presidential Regulation 39/2019 regarding the one-data policy. The regulation is intended to collect national data in readily accessible, accurate, integrated, and sophisticated systems.

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