



LEVERAGING INDONESIA LOGISTICS ECOSYSTEM WITH FRONTIER TECHNOLOGY

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ARTICLE INFORMATION

ARTICLE HISTORY

Received

02 September 2024

Accepted to be published

31 Desember 2024

KEYWORDS:

National Logistics Ecosystem

Big Data

Data Analytics

Internet of Things

Blockchain

Green Technology

ABSTRACT

Sebuah negara dengan sistem logistik yang baik terlihat melalui proses distribusi yang efisien, biaya logistik yang rendah, dan waktu pengiriman yang dapat diprediksi. *Logistic Performance Index* (LPI) adalah indeks yang menggambarkan keberlanjutan sistem logistik suatu negara. Untuk memiliki LPI yang baik, Indonesia mengeluarkan Instruksi Presiden Nomor 5 Tahun 2020 tentang Penataan *National Logistics Ecosystem* (NLE) dengan membentuk tim NLE untuk mengatur ekosistem logistik Indonesia. Namun, setelah NLE ada, LPI Indonesia pada tahun 2023 justru menurun dibandingkan tahun 2018. Seperti yang akan dibahas dalam penelitian ini, pembangunan berkelanjutan sistem logistik Indonesia diperlukan, terutama digitalisasi teknologi terdepan. Metode penelitian yang digunakan dalam makalah ini adalah metode kualitatif dengan pendekatan studi kasus. Peneliti memperoleh data dari berbagai dokumen, makalah akademik, dan juga laporan. Selain itu, peneliti juga mewawancarai langsung pegawai yang bertugas di NLE untuk mendapatkan informasi lebih lanjut. Hasilnya, peneliti memperoleh area perbaikan menggunakan teknologi terdepan di NLE. Pertama, *Big Data* dapat mencegah NLE dari masalah kehilangan data karena banyak aplikasi yang terhubung ke NLE. Kemudian, analitik data dapat menganalisis ketersediaan kontainer dan kapal. Selanjutnya, dalam IoT, NLE dapat menerapkan segel bea cukai elektronik dan jalur pengiriman. *Blockchain* sendiri berguna dalam transparansi informasi, keamanan, dan keterlacakan. Terakhir, teknologi hijau dapat diterapkan melalui perencanaan sistem dan tata ruang seperti menjaga area pelabuhan hijau yang berkelanjutan. Digitalisasi ini diharapkan dapat meningkatkan kinerja logistik di Indonesia, terutama di NLE.

A country with a good logistics system is seen through an efficient distribution process, low logistics costs, and predictable delivery times. Logistic Performance Index (LPI) is an index that describes the sustainability of a country's logistics system. To have a good LPI, Indonesia issued Presidential Instruction Number 5 of 2020 concerning Structuring the National Logistics Ecosystem (NLE) by forming an NLE team to organize Indonesia's logistics ecosystem. However, after the NLE existed, Indonesia's LPI in 2023 will actually decrease compared to 2018. As will be discussed in this research, sustainable development of the Indonesian logistics system is needed, especially the digitalization of frontier technologies. The research method used in this paper is a qualitative method with a case study approach. Researchers obtained data from various documents, academic papers, and also reports. Apart from that, researchers also directly interviewed employees on duty at NLE to obtain further information. As a result, researchers obtained areas of improvement using frontier technology in NLE. Firstly, Big data can prevent NLE from data missing problems because there are many applications connected to NLE. Then, data analytics can analyze the availability of containers and ships. Furthermore, in IoT, NLE can implement electronic customs and shipping line seals. Blockchain itself is useful in information transparency, security and traceability. Last but not least, green technology can be implemented through system and spatial planning such as maintaining a sustainable green port area. This digitalization is expected to improve logistics performance in Indonesia, especially in NLE.

1. INTRODUCTION

Indonesia has shown various efforts to improve its ranking in the EODB by implementing reforms in various sectors. In the 2020 EODB report, Indonesia managed to rank 73 out of 190 countries (World Bank, 2020). Some reforms include simplifying the licensing process, digitizing the tax administration system, and increasing access to credit services. The Indonesian government has also tried to improve infrastructure and regulations that support a more conducive business environment. As a result of these efforts, there has been a significant increase in several indicators such as ease of starting a business and access to credit.

One aspect that is closely related to EODB is logistics performance. The Logistics Performance Index (LPI) provides an overview of the efficiency and sustainability of a country's logistics system. Good logistics performance can support the improvement of EODB by ensuring that the distribution process of goods runs efficiently, logistics costs remain low, and delivery times are predictable. Indonesia, despite having made various improvements to its logistics infrastructure and regulations, still faces challenges in terms of the speed of international shipping and the quality of logistics services. By improving logistics performance, Indonesia is expected to support the ease of doing business and attract more foreign investment.

In 2023, Indonesia has a total score of 3.0 or is ranked 61st in the LPI. This value is slightly lower compared to the 2018 LPI which had a score of 3.15 or ranked 46, but is still better than the 2016 LPI with a score of 2.98 or ranked 63. Compared to upper-middle-income countries, Indonesia is above average with a score of 2.54. However, when compared to partner countries in Asia such as China and India, as well as ASEAN countries such as Singapore, Malaysia, and Thailand, Indonesia still has a lot of homework on the logistics performance side.

In detail, Indonesia's logistics performance shows varying results in each LPI component. From the input side, logistics indicators show positive performance with an increase in scores on the customs and infrastructure components. However, on the outcomes side, there was a decrease in scores on the international shipping, tracking and tracing, and delivery time components. The Indonesian government needs to accelerate structural transformation through the National Logistic Ecosystem (NLE) and continue infrastructure development for

connectivity to improve overall logistics performance. Physical infrastructure development must be accompanied by NLE development and change management.

Before the 2023 LPI results are released, Presidential Instruction No. 5 of 2020 concerning the Arrangement of National Logistics Ecosystem to form an NLE team in 2020 concerning the Arrangement of the National Logistics Ecosystem to form an NLE team formed in 2020 which ends in 2024. The NLE team has several action plans for ecosystem arrangements, one of which is the simplification of government business processes in the technology-based logistics sector and ease of state revenue payment transactions and payment facilitation. With the NLE, Indonesia's LPI score should increase, but some developments and accelerations must be carried out so that the NLE is more effective and efficient in helping, one of which is the development of a moving logistics track and trace system and a financing or payment system through the Indonesian banking system.

In the 2023 LPI Report, it is explained that connectivity as measured by the number of transportation connections can be linked to logistics performance regardless of the mode of transportation used. Having many options related to connectivity will have a positive impact on logistics performance, including increasing competition for logistics services, software and hardware investment, increasing logistics operators, and exposure to best practices for existing business processes.

A further initiative is needed to improve the LPI score, especially through digitalization. Policy making that leads to the use of frontier technologies in supply chain visibility platforms will be more promising for increasing the LPI score. Moreover, reforms are also needed to increase port productivity such as modernizing customs and border agencies with a focus on automation, risk management, and integrity.

Research Objectives

This research has several objectives, namely knowing the potential for implementing frontier technologies in the NLE system in order to increase the LPI score. Then this research will identify the benefits and obstacles that occur when some improvements in IT have been enhanced in the NLE system. Furthermore, this research will answer the following questions: "how does frontier technology play a role in supporting the progress of the logistics system in Indonesia?"

Research Benefits

This research will add the literature review on the use of technology in order to improve logistics performance in Indonesia, especially in NLE. The results of this research can provide references or recommendations to various parties in formulating regulations or policies relating to Indonesia's supply chain management.

There are many benefits that are acquired by implementing frontier technologies in NLE. From the government side, there is a big possibility (1) to increase the LPI score by utilizing data analytics and IoT, (2) to secure the information and reduce asymmetric information by blockchain, and (3) to maintain economic balance and environmental ethics.

For the private sector, this can create a competitive advantage between companies so that competition will become more transparent and each company will try to improve its services. For service users, the technology offered in this research will make it easier for service users to access order logistics processes.

2. LITERATURE REVIEW

National Logistic Ecosystem (NLE)

National Logistic Ecosystem (NLE) is a logistics ecosystem platform that aligns the flow of international goods and documents from the arrival of the means of transport until the goods arrive at the warehouse, oriented towards cooperation between government and private agencies, through data exchange, process simplification, elimination of repetition and duplication, and supported by an information technology system that covers all related logistics processes and connects existing logistics systems (NLE, 2024).

NLE is regulated in the Instruction of the President of the Republic of Indonesia Number 5 of 2020 concerning Structuring the National Logistics Ecosystem which will take effect from 2020-2024. The regulation explains that improving Indonesia's logistics performance involves many parties starting from the Minister, Cabinet Secretary, Police Chief, heads of non-ministerial government agencies to the Governor. Structuring the national logistics ecosystem begins with coordinating the preparation of direction and general policy for the arrangement carried out by the coordinating ministry for the economy. Then the Ministry of Finance is tasked with simplifying business processes and making NLE payment

transactions easier by collaborating with the Corruption Eradication Commission and the Governor of Bank Indonesia. Apart from that, other Ministers support the implementation of the NLE under the supervision of the cabinet secretary.

The Presidential Instruction also explains the action plan for structuring the NLE which contains 4 programs. The first program contains the simplification of government business processes in the field of technology-based logistics. This program is implemented by simplifying the goods inspection process through a single submission system (SSm), collaborating systems between ministries regarding the submission of manifests and implementing a risk management system between ministries/agencies. Then the second program contains logistics system collaboration, both international and domestic, between logistics activity actors in the government and private sectors. This program contains activities that increase the efficiency of logistics processes by facilitating access to logistics services through collaborative logistics platforms such as the transportation, shipping and warehousing sectors. The third program aims to provide easy state revenue payment transactions and facilitate payments between business actors related to logistics processes through access to payment services via online platforms. The final program is in the form of structuring the port system and layout as well as distribution channels through the One Gate, One Billing and One System systems at Tanjung Priok Port. These are programs that can improve national logistics performance.

Seamlessly Integrated Logistics System

Every successful and smooth supply chain management (SCM) must have an integrated logistics system as its backbone. In seamless logistic systems, there is a harmonization between the parties involved in it. Integrated logistics is a holistic approach to optimizing every stage in the SCM and focuses on eliminating silos and building cooperation between suppliers and stakeholders (Jameela, 2024). A seamless supply chain requires collaboration between governance, people, processes, technology and strong leadership. With good resources, technology and governance, this integrated supply chain will provide competitive advantages and profitable growth (Shaikh, 2016).

WCO Framework for Data Security

In technology applications in the logistics ecosystem, it is important to pay attention to data protection and privacy following the international standard framework. According to the SAFE Framework of the World Customs Organization (WCO), data exchange between customs administrations or with the private sector must be carried out after consultation with the relevant governments to ensure data protection and privacy. Data collected or transmitted by customs must be treated with confidentiality, stored securely and adequately protected following applicable national laws.

In the NLE, standards are also needed regarding the harmonization of data submission requirements. This is very important to improve efficiency and transparency in the international trade process. Customs, in collaboration with other government agencies, needs to create a system that allows traders to submit the required information electronically once to a designated authority, such as Customs. This step supports the close integration of commercial processes and information flows in the global supply chain and is in line with the Single Window concept. By adopting international standards such as the UN/CEFACT Recommendations and Guidelines, the WCO Single Window Compendium, and the WCO Data Model, the government can ensure that these systems not only speed up the process of clearing goods but also improve the competitiveness of the national logistics ecosystem by reducing bureaucratic barriers and improving coordination between agencies (standard 6).

Based on WCO Integrated Supply Chain Management (ISCM), data protection and privacy in cross-border data exchange are crucial aspects that must be considered in the national logistics ecosystem, especially considering the increasing connectivity of international trade. Legislation related to data privacy, although varying between countries, generally stipulates that personal and commercial data processed automatically must be protected to a standard equivalent to the domestic laws of the country providing it.

In the context of national logistics, this requires business actors and logistics service providers to ensure that the data collected and transmitted meets the legal requirements of the countries of origin and destination. Compliance with these regulations not only ensures the protection of individuals' right to privacy but also maintains trade secrecy, which in turn strengthens the integrity and efficiency of the national logistics ecosystem. The use of

technologies such as data encryption and role-based access management is also important to support compliance with these regulations, especially in handling data that is stored long-term or used for purposes other than national security or goods handling.

Big Data

Big Data is a collection of data with a massive amount or volume. Big Data can be triggered by several reasons, including the increasing number of companies and company transactions in the business environment. This also can happen along with the growth of the organization and the advancement of technology implemented that causes an increase in the ability of computers to access, store and process data. There are 5 characteristics of Big Data which are usually called 5V.

1. Volume: A huge amount of data can be generated every time. This means that a very large and sometimes unstructured set of data can be created at one time. The flow of these data can be up to thousands of Terabytes in size.
2. Velocity: Data can be accumulated and accessed at very fast speeds. It is possible that the organization can utilize the data immediately at the moment (real-time).
3. Variety: Data can be called Big Data if it has various characteristics and is not homogeneous. It has many variables and is very diverse, covering various types of data, both structured data and unstructured data in a database.
4. Veracity: Big data has vulnerabilities in terms of accuracy and validity, so it requires depth to analyze Big Data in order to produce the right decisions.
5. Value: Big Data has a very high value if it is processed in an appropriate way or it can also be said how valuable or meaningful the data is.

Data Analytics

SCM is a complex process that produces a great amount of logistics data. Data will be useful if it can produce valuable information to enhance the quality of decision making. To achieve this goal, data analytics skills are needed to analyze raw data, identify trends, and extract insight to answer business problems (Harvard Business School, 2021).

Nowadays, data analytics can be divided into 5 categories. The higher the level of analytic category, the smarter and faster the level of decision making.

1. Descriptive analytics: answer the question what happened?

2. Diagnostic analytics: answer the question what happened and why?
3. Predictive analytics: answer the question what will happen, when, and why?
4. Prescriptive analytics: answer the question what decision will be made next?
5. Cognitive analytics: self-learning and automated decision-making process, a computer program that works like the human

Figure 1 shows the steps of data analytics category maturity when it has been implemented in the organization. An organization needs to understand its current scale and maturity position of data analytics based on its current capabilities, especially the IT infrastructure level (Intel, 2017). As organizations evolve, they will move from the historical 'what and why?' question to the look-forward 'what will happen and what should we do?' question.

Machine Learning is an important key in AI technology. It is a computational algorithm that allows machines to 'learn from data' and make a prediction about new data. Advanced companies in the world are starting to think about cognitive analytics. This is a next level of machine learning which involves human interactions with machines.

Internet of Things (IoT)

IoT is a network of physical objects embedded in electronic devices, software, sensors, and network connectivity that allows objects to collect and exchange data using the internet (Kothari et al., 2018). IoT is not a single technology, but rather a combination of several technologies combined and connecting the digital world and the physical world. In short, IoT can be said to be a combination of machines (devices) and networks.

The Internet is used as a communications infrastructure, storage mechanism, and medium for data processing and synthesis. IoT characteristics include self-awareness, control, interconnectivity, transferability, and self-decision making. Through IoT, many benefits can be felt ranging from social, and economic to environmental benefits (Vass et al., 2021). IoT creates capabilities that enable an object or device to connect to the internet, collect data, and act on that data, without human intervention.

Green Energy

The emergence of various environmental problems such as global warming and carbon emissions makes humans look for ways to have

a sustainable life. Green Supply Chain Management (GSCM) is a concept that makes it possible to synchronize environmental regulations to improve the logistics processes and performance.

At its core, GSCM requires companies and organizations to balance their economic objectives with environmental performance to remain competitive and adhere to regulatory requirements and community expectations. GSCM has become a significant new pattern to provide competitive advantages for companies, minimize the impact on the environment and increase technological efficiency. (Gawusu et al, 2022). In addition, GSCM also forces companies to design and implement environmentally friendly management strategies aimed at reducing the environmental impact of their operations.

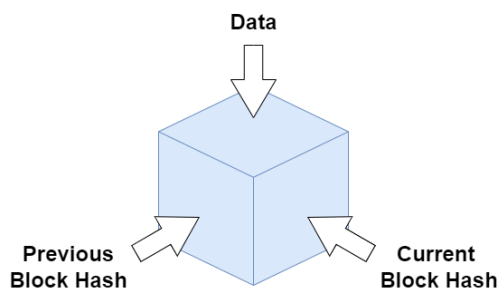
GSCM strives to improve supply chain management capabilities by integrating business processes and aligning supply to satisfy customers. According to Zhu et al. (2007), GSCM encompasses every phase of a product's life cycle, from design and production to distribution, consumption by end users, and, finally, disposal by the consumer at the end of its life cycle. Moreover, Hsu and Hu (2008) define GSCM as a framework that integrates environmental regulations to enhance the performance of processes and products.

Blockchain and Smart Contract

Blockchain is an information recording system that is conducted collectively in a distributed ledger system and shared in a peer-to-peer environment so all information can be validated by a consensus of the parties involved in it. The idea of blockchain technology was first published in 1991, when Stuart Haber and W. Scott Stornetta introduced their work on cryptographically secured chains of blocks. Blockchain technology became famous after Satoshi Nakamoto in 2008, at which time, used blockchain technology to record cryptocurrency transactions, Bitcoin.

Blockchain consists of a series of blocks where each block has 3 main components, as shown in Figure 2, namely Data, Hash, and Previous Hash. Transaction data will be stored in a block and each block will have a hash value (256 bit). The hash value is produced by a hashing process where the value of data is converted cryptographically to a unique alphanumeric code. The hash can be compared to a fingerprint because it will be used as the identification mark of a block.

Figure 2. Block Components



Blockchain can be called a 'ledger in digital form' because blockchain is used as a place to record transactions among the parties involved in the environment. When a transaction is completed and validated, a new block will be formed along with the hash value. Next, when a new transaction is added, a new block will be added to the existing blockchain. The blocks in the blockchain are connected to each other with reference to the previous block's hash. This process can be described as a series of blocks connected by a chain (hash value), as shown in Figure 3.

'Smart Contract' is a feature that is usually embedded in blockchain technology; It is a computer program that facilitates execution of an action when certain terms and conditions have been met without involving third parties. Smart contracts enable the automatic execution of various contracts such as the transfer of financial value or properties (Okazaki, 2018). The system of smart contracts replaces the need for a usual contract and usually includes conditions for rules, penalties and actions that will be applied for all the parties involved in the transaction (Dutta, et al., 2020).

3. RESEARCH METHODOLOGY

Researchers will discuss how the implementation of frontier technologies can be further developed in NLE systems. Through a case study approach, researchers will find out how frontier technology will help the logistics ecosystem in Indonesia. To answer this question, researchers collected data from various sources ranging from documents, academic papers, interviews, and reports. The data is analyzed to emerge themes or patterns so that at the end of the research, researchers can conclude solutions to existing problems.

First, the researcher chose to conduct direct interviews with employees in charge of NLE to ask what NLE is and how the system works. Then the researchers used reports such as the Logistic Performance Index (LPI) Report 2023 which contains rankings of countries and their logistics performance and what things are used as indexes to measure this performance

and NLE Annual Report 2021 and 2022 which contain the progress of NLE development and the outcome acquired from the platform. Finally, researchers used journals and articles to achieve a holistic understanding and observe the development of logistics systems in other countries and how they use technology in their systems.

In the analysis step, researchers examine whether there is a correlation between technology and the development of Indonesian logistics performance. The results of this analysis will provide an understanding of how frontier technology can develop a country's logistics system. Next, the author will interpret the results of the analysis to answer existing problems and provide recommendations for technology development. For example, if the analysis shows that technology influences technological development, researchers will provide steps to develop technology in the logistics system in Indonesia.

4. RESULTS AND FINDINGS

Digital Transformation in NLE

There are several problems that occurred in Indonesia's logistics that make Indonesia's LPI score in its current ranking, namely (1) duplication and repetition on document submission, (2) information asymmetric in supply and demand, (3) no single platform that integrated the whole logistics processes, and (4) inadequate quality of infrastructure. The problems have contributed to the high cost of logistics in Indonesia, even quite high when compared to neighboring countries in ASEAN.

To solve Indonesia's logistics problems, a breakthrough is needed by creating an integrated national logistics ecosystem which has been mandated in Presidential Instruction Number 5 of 2020. The Presidential Instruction mandates 42 action plans to be implemented by the NLE team, which are divided into four main pillars: simplification of government business processes, collaboration of logistics platforms, ease of payment, and spatial planning.

In an effort to simplify business processes, the government has implemented a single submission (SSm) module to simplify various business processes, such as :

1. SSm of Licensing: a system that allows to carry out the process of submission of licenses related to import and export to government agencies through one system;
2. SSm of Carrier: a system that allows to carrying out of clearance process to all government agencies in seaport/airport through one system;

3. SSm of Quarantine-Customs: a system that allows simplified import declaration through one system and joint inspection by Quarantine and Customs, both export and import, so there is no repetition in data submission and physical inspection;
4. SSm of Export: a system that allows to simplify export declaration through one system

From the private sector, collaboration has also been carried out with logistics stakeholders to develop online features such as :

1. Delivery Order Online: a system that allows settling Delivery Order online
2. Container Delivery Letter Online: a system that allows to loading/release to/from a Temporary Storage Area, without submitting physical documents
3. Trucking: a system that allows to make warehousing order through available platforms in NLE;
4. Warehouse: a system that allows to make warehousing order through available platforms in NLE;
5. Vessel: a system that allows to make domestic vessel order through available platforms in NLE;
6. Container Depot: a system that allows to make container order through available platforms in NLE;
7. Payment: a system that allows the payment of logistics services, payment of taxation, and financing facilities via NLE

Based on the 2021 NLE Annual Report, Table 1 shows the survey results of the implementation of NLE in 2022 and 2023. Based on the survey, the respondents agree that NLE has had a positive impact on time efficiency and logistics costs. In 2023, SSm Licensing had a significant impact on time and cost efficiency at 54,6% and 97,8%, followed by SSm Quarantine-Customs at 73,4% and 46,1%.

Based on the 2022 NLE annual report, a number of systems and feature developments have been carried out to increase efficiency and transparency in the NLE system. Improvements and refreshments were made to the NLE website/portal features to make them easier for business actors to access. In addition, NLE also launched the NLE Mobile application which allows business actors to access logistics services more easily via mobile devices.

The NLE team will continue to try to invite other logistics companies to join the NLE system. NLE has provided an API Catalog to facilitate business actors in collaborating using API with NLE. Furthermore, with the completion of the third pillar, NLE has collaborated and

developed collaborative systems with the Bank. NLE initiated Business to Business (B2B) collaboration between Banks and Logistics Platforms so that in the future payments can be made at NLE.

Frontier Technology

Frontier technologies represent the cutting edge of innovation, leveraging digitalization and connectivity to transform industries and address pressing global issues (UNCTAD, 2023). These frontier technologies, including Big Data, Artificial Intelligence (AI), the Internet of Things (IoT), Blockchain, and Green Technology, have the potential to change how humans communicate, drive significant economic growth and solve some critical issues.

To support the achievement of NLE's goals, technology is one important factor. Technology makes transactions easier, faster, and no longer limited by distance between countries. As frontier technologies continue to evolve, policymakers, businesses, and international organizations need to work together to create a better logistics environment that maximizes their positive impact while mitigating potential harm.

This section will discuss how frontier technologies give benefits to the development of the NLE system. There are some areas of improvement in the NLE system that can be enhanced by implementing these technologies so several issues and problems in SCM can be solved.

Big Data in NLE: Making a Harmonized Data Collaboration

Big data refers to a condition where data is collected in high volume, high velocity, high complexity, and originating from various sources. Data from various business sectors has been growing sharply and offers a good prospect for business transformation.

A logistics system involves many interconnected organizations and depending on the products/services, the logistics system can include many phases, multiple geographic locations, several accounts and payments, and means of transport (Tijan et al., 2019). NLE, which tries to simplify the complexity of the logistic process in Indonesia by making a connection between all parties in a national logistics ecosystem has become a data-rich system because it collects various types of logistics data from various sources whether it comes from the government agencies or the private sector.

What impacts must organizations face on the rapid development of Big Data? In their book, Laudon & Laudon (2016) state that “Businesses are interested in big data because they can reveal more patterns and interesting anomalies than smaller data sets, with the potential to provide new insights into customer behavior, weather patterns, financial market activity, or other phenomena”. In managing Big Data, organizations have a challenge to analyze and find new information that is contained in these data sets by using Data Mining techniques. The information that has been analyzed is expected to help organizations in making decisions or policies.

Managing big data, especially when the sources of data come from various entities and applications, certainly has its challenges. Logistics processes which start with the production of goods/services until purchased by the end customers, involve many parties and have complexity. In an integrated SCM system, there must be a relationship between data input and data output throughout the whole process. To produce good logistics information, there must be adequate data management that can harmonize all data from every stage in SCM. Data previously have been stored and utilized in silos, but now can be collaborated to make an enhancement in Indonesia's logistics system.

A complex system, like an integrated logistics system, can lead to data missing in every step of the logistics process. Data missing problems can happen in the NLE system because it has been integrated with many applications. This problem can happen because of some factors, such as the different applications used by each party, different data types but the substance is the same, different ways how entities monitor the data, and different maturity of technology used. For example : (i) entity X uses data in Excel format whereas Entity Y uses data in JSON format, (ii) entity X uses kilogram unit to count container weight whereas Entity Y uses tonnage unit to count container weight, (iii) others entities used a code that is different with code that is used practically in customs declaration.

It is better if there is a national logistics data standard that compiles existing data variety in the logistics system. This standard can refer to existing data, for example, import and export data refer to WCO Data Model. With the existence of data standards then every party involved in the NLE system has the same view about the official logistics data.

Unharmonized data used in the systems can reduce the information quality that can be achieved from traceability information systems

and lead to information errors. It is important to harmonize every data element that will be used in the NLE system so the information gained from data mining in the system has its value to help organizations in decision or policy making. Moreover, Data harmonization can be used to compare the performance of each group entity connected to the system.

However, to derive business value from data, organizations need new technologies and tools capable of managing and analyzing non-traditional data along with their traditional enterprise data (Laudon and Laudon, 2016). Another issue, besides data harmonization, is how the NLE team can harmonize the different levels of technology adapted by each party connected to the NLE system. The NLE system must be able to reach companies whose technology is advanced or still simple. For example, facilitate data streaming via API, host-to-host, data virtualization (for big enterprises) and via email (for small enterprises).

Implementation of Data Analytics in NLE

Data from NLE can be used to carry out several data analytics projects. The NLE team has been implementing the National Analytic Dashboard to provide descriptive information about current logistics performance. There are still many potential data analytics projects that can be developed in NLE. As an integrated system that collects various logistics data, the analytics scale and maturity in NLE can be enhanced to a predictive or prescriptive level.

Generally, in conducting data analytics projects, data scientists will refer to the Cross-Industry Standard Process for Data Mining (CRISP-DM) framework as the guidelines. First of all, data scientists require adequate in-depth knowledge regarding the overall business processes of the logistics system. Apart from that, it is also necessary to identify the root of problems that occur so that it can be determined whether the solution to the problem can be solved with a data analytics project.

After understanding the current business problems, data scientists also must understand what data is in the whole of the NLE platform. Rozados & Tjahjono (2014) divide SCM big data sources into four levers, namely marketing, procurement, warehouse, and transportation as shown in Figure 6 These four lever connections can be used as a reference to determine data analytics topics.

Data analytics usually is aimed at producing information that can help management in determining business strategies and problem-solving. To achieve this goal, data scientists will develop several models that can

be utilized to transform raw data into actionable knowledge. In SCM there are some positive outcomes that can be acquired from data analytics projects, namely operation efficiency, profit maximization, cost reduction, and customer satisfaction.

Unilever and Koch Industries use AI tools to collect comprehensive data on existing and potential suppliers such as financial data, diversity scores, purchase orders, invoices, and customs documents (Hoek & Lacity, 2023). By using the data that has been collected, both companies can find new alternative supplies in a short time and still pay attention to the quality of the new suppliers.

Amazon has developed an anticipatory shipping model that uses big data and predictive analytics to predict customer orders before they are placed. By analyzing vast amounts of data, including customer purchase behavior, browsing history, and regional demand patterns, Amazon pre-ships items to nearby distribution centers (Padmanaban, 2014). This strategy significantly reduces delivery times and enhances customer satisfaction by ensuring that products are closer to the customer even before the order is made.

When Generative AI is developing rapidly, Maersk and Walmart deploy a chatbot to facilitate automated negotiations with suppliers (Hoek & Lacity, 2023). The chatbot helps Maersk and Walmart to reach the suppliers efficiently and reduce the cost of trade agreements.

In terms of executive summary, NLE has utilized the National Analytic Dashboard to provide comprehensive information on national logistics. There are some data analytics projects that can be implemented by using NLE data, namely advanced and real-time public dashboards, supplier profiling as targeted advertisement, container and vessel availability analysis, supply and demand analysis, and chatbots.

Implementation of IoT in NLE

In supply chain management, IoT can help the efficiency and performance of the supply chain itself. Sallam et al. (2023) explains that there are several IoT applications in the supply chain.

IoT can be applied in inventory management to monitor the location, status, and movement of goods across supplies in real-time. Coca-Cola has a vending machine that utilizes IoT to view stock, sales trends and machine functionality (bytebeam, 2023). The device in this machine will automatically send a refill request when stock is running low. With this

technology, the continuity of Coca-Cola supply will continue to be maintained and the machine will not be empty. This real-time visibility helps companies respond quickly to changes in demand, address out-of-stock or overstock issues, and optimize their inventory.

IoT also can be implemented in asset management and tracking. With the advent of IoT, asset tracking and management can use technologies such as Global Positioning System (GPS) and Radio Frequency Identification (RFID). This provides benefits to companies in the form of increased operational efficiency and cost savings. Apart from that, real-time tracking can increase asset security, reduce the risk of theft, and ensure that goods are delivered on time so that customers can be satisfied. New Jersey Transport Authority (NJTA) uses IoT in its supply chain for traffic management and motorist protection (Hai Bui, 2023). IoT sensors collect data and this data is used by management system operators to provide a fast response to the accident location and reduce congestion in the surrounding area. This innovation enhances the NJTA's ability to manage traffic more efficiently and respond more quickly to accidents, significantly reducing congestion and improving safety on the turnpike. DHL has IoT capabilities that enable it to provide data that can be used to guarantee high roller cage availability (Hai Bui, 2023). In addition, DHL uses IoT in intelligent heating, ventilation and air conditioning systems and makes real-time changes according to the weather to ensure the safety of goods delivered. These IoT applications allow DHL to enhance operational efficiency by ensuring essential equipment is always available while also significantly reducing energy consumption through adaptive, real-time environmental controls

In terms of movement goods control, NLE has utilized the Autogate system that allows monitoring the movement of goods loading/releasing to/from ports. There are some IoT concepts that can be implemented in NLE, namely electronic customs and shipping line seal.

Implementation of Blockchain in NLE

Currently, the use of blockchain technology is still popular in crypto asset commodity trading. However, the potential of blockchain technology can be developed and utilized in broader business transactions, for example, to record financial transactions, medical records, property ownership, and there are even ideas for applying blockchain in a logistics system.

In an integrated system like NLE, where data from government agencies and private sector entities are collected in one platform, it is important to make a clear governance regarding the issue of data transparency, security, and traceability in the whole NLE environment. Information transparency, security, and traceability issues are often related to questions: *Who has control over the data? Who will manage the data server? Who will record and approve the data record? Have we got enough information? Is the distributed information secured?*

1. Information Transparency

Transparency in the logistics system is important to maintain the company's operations and goods/services production. Each entity in the logistics system needs trusted information to make a better strategy for optimizing their profit or reducing the logistic cost. For example, the exporter needs information about the availability of container and vessel arrival schedules so they can make better estimations for their exportation cost planning.

One major benefit of blockchain is to create transparency because every member of the network has access to the same data (a single point of truth)(Tijan et al., 2019). The blockchain system is decentralized because the server network is entirely run by its members (not a central authority). A database based on blockchain technology differs from a conventional database because each participant in the network may have a complete copy of the database (Berneis et al., 2021).

When a new transaction is added to the ledger, the transaction must be shared within the blockchain's peer-to-peer (P2P) network. The new transaction will be signed with private key cryptography owned by members before it is shared with the network so the transaction is verified in the environment. All members of the network can verify the transaction in the block. If no consensus of validity is reached, the new block will be rejected. Otherwise, if the transaction is valid, the new block is added to the chain and a new hash will be generated and linked to the previous block hash.

2. Information Security

The decentralization and cryptography nature of blockchain provides an additional layer of protection against cyberattacks, data hacking and data manipulation. Blockchain systems limit access only to authorized parties with cryptographic authorization to minimize the risk of hacking and ensure data security throughout the supply chain (Witjaksono et al., 2023). In the blockchain system, every party has

a node that is connected to the server and has a right to secure their own node. The system works by distributing a copy of the database to each party and those parties only can then make changes to the database according to a collectively accepted consensus.

3. Information Traceability

In the system of NLE, the data is generated in every feature or step of the logistics process, and then data is documented as a transaction and logged as the history of the transaction. Blockchain technology can effectively contribute to: (i) recording every single step of the logistic process in the flows of blockchain nodes, (ii) tracking orders, receipts, invoices, payments, and other official documents, and (iii) tracking digital assets such as warranties, copyrights, certifications, and prohibition and restriction requirement documents.

The traceability of goods/services can be of great interest for supply chain management (Berneis et al., 2021). Data recording system that has been implemented in NLE can be used to construct a traceability information system that is related to international trade. The data can also be utilized as risk management tools that are used to maintain the desired information about goods/services and their surrounding components through all or part of the NLE environment.

Import and export activity involves many entities such as shipping agents, customs, warehousing agents, and banks. The problem that often occurs is the occurrence of risks in each of the steps of import or export activity, for example: unavailability of containers and no scheduled arrival of the ship. It is necessary to identify the supply chain activities to find out what risks occur, where these risks occur and what causes these risks to occur.

Implementation of Green Technology in NLE

A macro policy that promotes and makes it easier for companies to carry out green transformation is needed in implementing green energies in SCM. There are many ways that can be used to implement green energy in the supply chain. The use of green technology in SCM is more concentrated on production and transportation but building a paperless system and reducing the printed physical documents is also a simple form of maintaining environmental ethics.

Decarbonization strategy which focuses on reducing the carbon footprint of its logistics operations is very important. Transportation activities in inbound and outbound logistics are often of attention because they still produce

significant pollutants. In Indonesia, currently, there are still many trucks that are old and produce more emissions. A policy regarding truck rejuvenation is necessary as a step to protect the environment, considering that shifting to electric vehicles is still very expensive.

In completion of the fourth pillar of NLE, smart and green ports can be considered as a part of the system and spatial layout arrangement. Beach pollution, especially due to loading and unloading activities, must be reduced to a minimum level. The existence of green open space must be sought and maintained to the maximum level so that a sustainable green port area can be maintained (BJTI Port, 2018).

5. CONCLUSIONS

From our research, we found an opportunity to implement frontier technology into the NLE system to improve the LPI Score. Currently, NLE itself has implemented a single submission module to simplify the licensing process, transportation, quarantine inspection, and customs as well as export activities. The private sector is also working with the Indonesian government to develop several systems, such as online delivery orders and container delivery letters. Trucking, warehouse, vessel, container, and payment systems have also been integrated with the NLE system.

Frontier technology plays an important role in helping to improve IT business processes in the NLE system. Related to Big Data, the government can create national logistics data standards that can harmonize data from various entities. This will accelerate the data exchange process so that the process in the NLE system will run faster and easier to understand. Data analytics can help improve operational efficiency, increase profits, reduce costs, increase customer satisfaction, and encourage the discovery of new insights from data collected by the NLE. The application of the Internet of Things in the form of electronic customs and shipping line seals will certainly increase the security and speed of the goods movement process. Blockchain can help improve transparency, security, and traceability of information. Green Technology is one of the excellent policies to be implemented in the logistics system in Indonesia to reduce pollution. The application of this frontier technology has the potential to increase the LPI Score obtained by Indonesia.

However, there are still many challenges in the application of frontier technology in the logistics system in Indonesia. One of the problems that arises is the need for harmonization of regulations between government and private agencies, especially those that have aligned and integrated business processes. In addition, there is a gap in technological infrastructure, both at ports and airports, which are still centralized in certain locations. The application of Green Technology also requires quite high shifting costs. Therefore, further study is needed regarding the non-IT aspects of the application of this frontier technology.

This study only examines the possibility of improvisation in the IT sector. There is still potential for improvement in the non-IT sector, such as improving regulations, improving business processes, and improving infrastructure and spatial planning of ports and airports. Further researchers can examine sectors for improvement in the non-IT sector or conduct research by taking samples from countries other than Indonesia. Further researchers can examine more details about the implementation of each frontier technology in the logistics system, improvement in the non-IT sector and conduct research by taking samples from countries other than Indonesia.

The implementation of Frontier Technology certainly requires strong support from various sectors, both public and private. The government can issue regulations related to matters that have not been regulated, such as blockchain and Artificial Intelligence regulations, to provide legal certainty for business actors who utilize this technology. In addition, the government can also simplify and integrate business processes between government agencies so that the implementation of IT becomes more effective and efficient. The private sector is expected to increase IT maturity in each company so that it can be directly integrated with the logistics system which will later be improved by the government. Companies are also expected to not only focus on profits but also pay attention to how logistics transactions can run quickly, safely, smoothly, and easily accessed by consumers.

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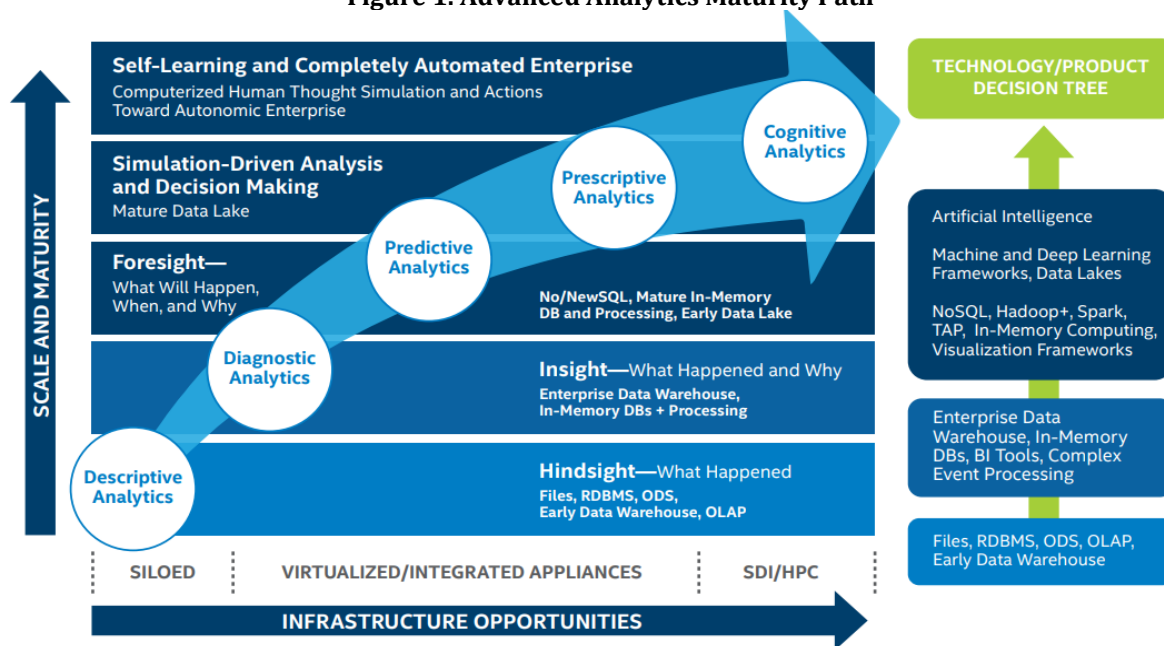
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APPENDIX

Figure 1. Advanced Analytics Maturity Path



source : Intel, 2017

Figure 3. How Blockchain Works

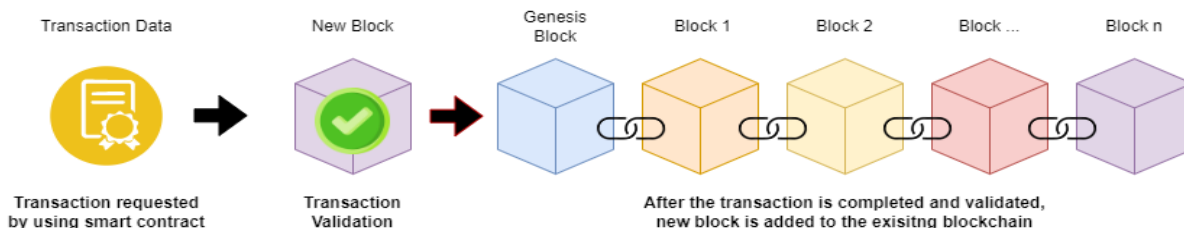
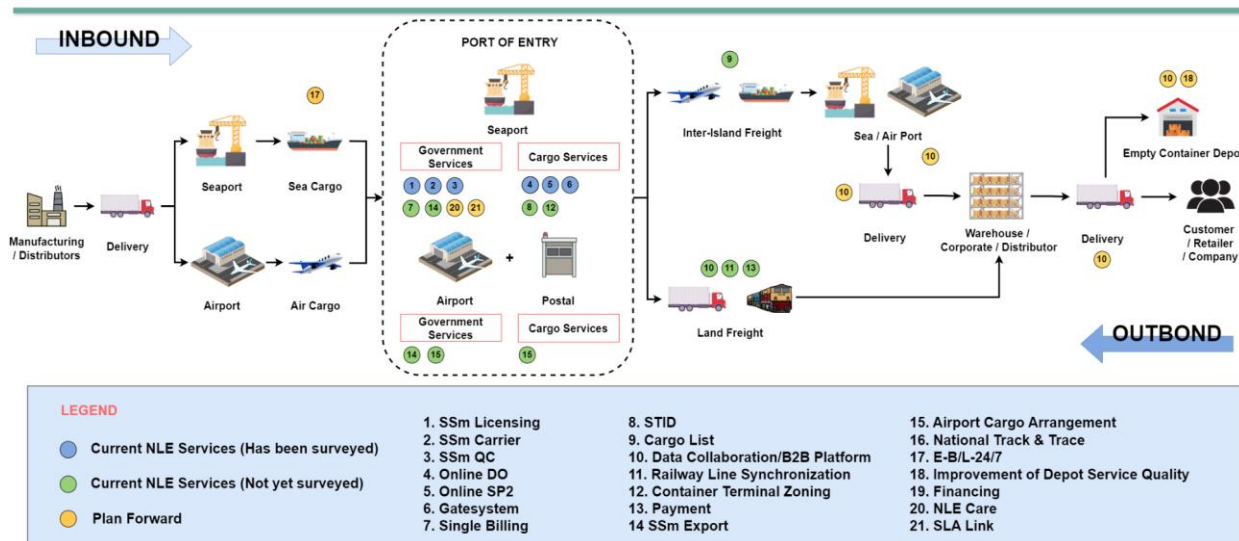


Figure 4. Supply Chain in Indonesia

GENERAL SUPPLY CHAIN IN INDONESIA



source : NLE

Table 1. NLE Outcome Survey (by Prospera)

Services	2022 (by perception)		2023 (by quantitative)	
	Time Efficiency	Cost Efficiency	Time Efficiency	Cost Efficiency
SSm Quarantine-Customs	28,9 %	24,9 %	73,4 %	46,1 %
Delivery Order (DO)Online	49,5 %	36,8 %	24,6 %	45,5 %
Container Delivery Letter (SP2) Online	54,8 %	38,9 %	47,0 %	32,4 %
Autogate	44,9 %	27,0%	-	-
SSm Licensing	-	-	54,6 %	97,8 %
SSm Carrier	-	-	21,6 %	45,5 %

source : NLE

Figure 5. Area of Improvement in NLE

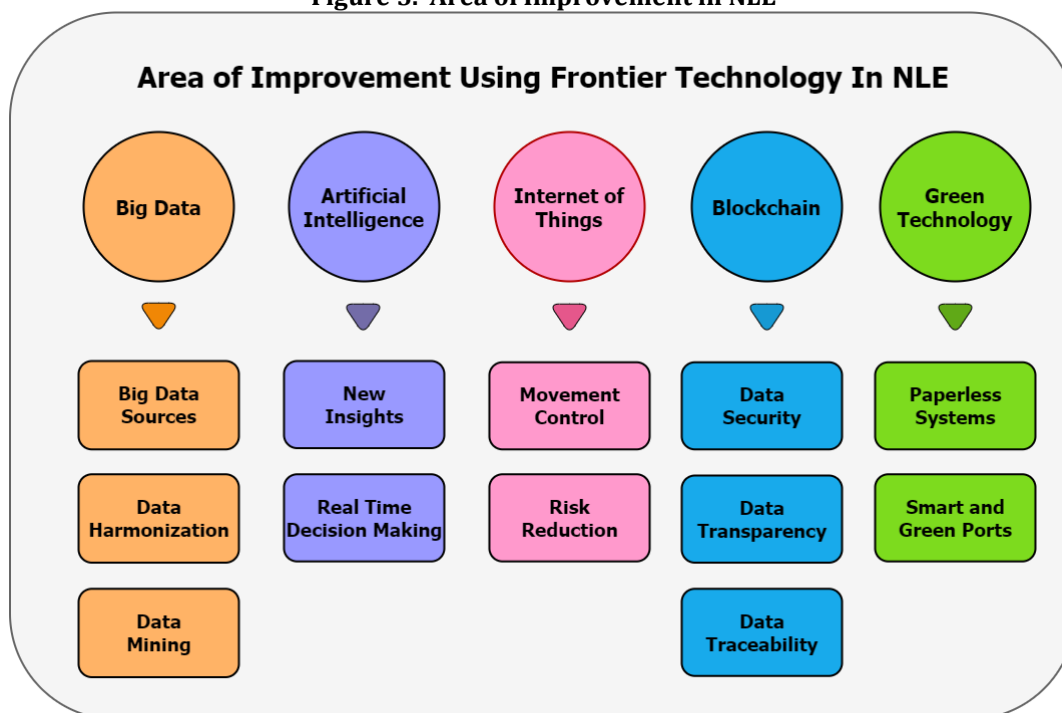
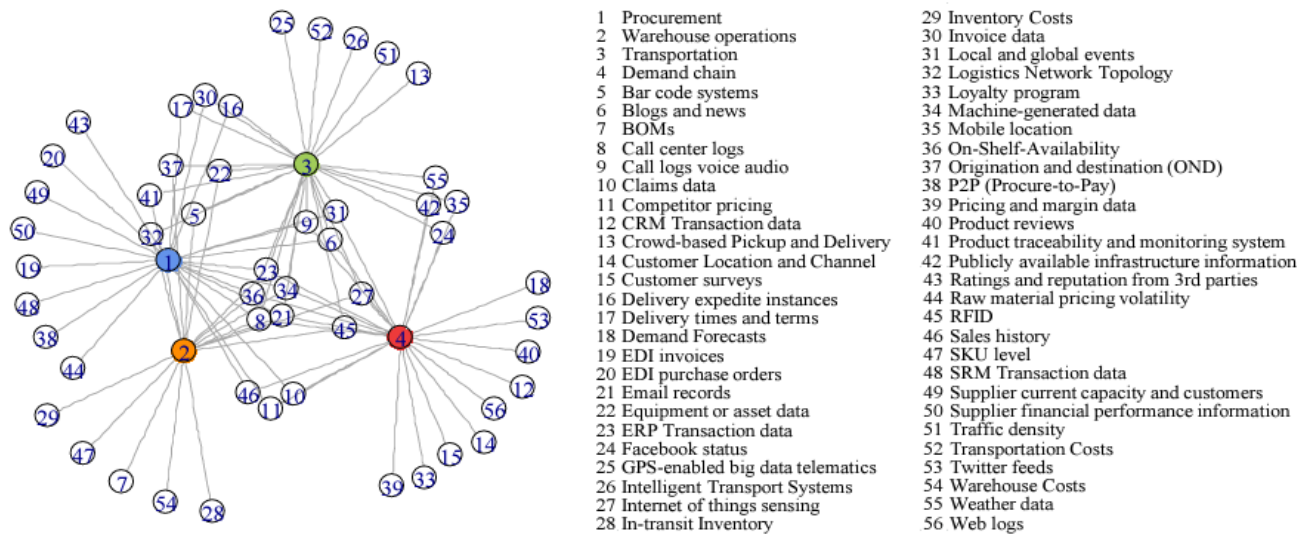


Figure 6. Kamada-Kawai Network of Big Data Source in SCM



source : Rozardos & Tjahjono, 2014

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