SUSTAINABLE AUTOMOTIVE INDUSTRY IN DEVELOPING COUNTRY WITH BUSINESS INTELLIGENCE TECHNOLOGY IN FACING SOCIETY

by Abdusy Syakur Amin -

SUSTAINABLE AUTOMOTIVE INDUSTRY IN DEVELOPING COUNTRY WITH BUSINESS INTELLIGENCE TECHNOLOGY IN FACING SOCIETY 5.0

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ABSTRACT

In the face of Society 5.0, the automotive industry, especially in developing countries, are encouraged to continue to establish itself by producing sustainable products and services. Various challenges ranging from meeting market needs, production, and sales need to be supported by advances in Industry 4.0 technology, one of which is business intelligence technology. Therefore, this study aims to develop a framework for the sustainable automotive industry's needs based on conditions in developing countries. The method used is a qualitative approach with Focus Group Discussion (FGD) and content analysis to analyze the results of the FGD and interviews. The results show that the proposed framework can be applied in the automotive industry in developing countries. Where industrial development pillars and firm-specific variables support technological capabilities, which mainly apply Business Intelligence technology to analyze market needs, potential, and other advanced technologies that need to be used to support a sustainable automotive industry. The sustainable automotive industry in facing Society 5.0, which is supported by Business Intelligence technology, needs to pay attention to the impact on economic performance, social, environment, and resources to produce sustainable products and services.

Keywords: automotive; Business Intelligence; industrial 4.0; society 5.0; sustainable industry

INTRODUCTION

The globalization of the world economy allows particular economies to focus on the products or services they can provide. It enables them to capture the market worldwide by increasing their access to more capital flows, technology, cheaper imports, and larger export markets. The consequences of globalization have offered benefits directly from economies of scale and scope, which can potentially lead to the reduction of costs and price and encouraging the economic growth. Specialization and division of labor tend to emerge in industries, which are co-located in particular geographic areas (Kuroiwa & Heng, 2008). Foreign Direct Investment Flows (FDI) had increased dramatically over the last three decades or so. Governments across the world, in developing and developed countries alike, are trying to attract Multinational Enterprises (MNEs) to locate in their country, using generous financial and fiscal incentives.

Most Asian countries have been following an export-led growth approach (The World Bank, 2020), in which Multi-National Corporations (MNC) and their manufacturing affiliates established in the region have played a significant role. Including in the automotive industry that is globally increasing, especially in developing countries. More than 100 developing countries, including Indonesia (International Monetory Fund, 2018; World Trade Organization, 2018), which developing countries still need more effort to develop their automotive industry sector (Nag et al., 2007). China is a developing country that was growing very fast, especially in component production (Nag et al., 2007; Teo et al., 2016). The automotive industry in India also grows with produce two-wheelers and small vehicles and Thailand, which produce passenger car and pick-up trucks. If India is concerned about being an exporter of the Middle East and South Asia, Thailand is strengthening its export in ASEAN, even in Asia and developed countries. However, in an Asian country with many developing countries in it, Japan still dominates this automotive industry. In major, Japan FDI mainly driven in this industry, even Thailand, through Japanese firms, concentrated entirely on the export market. In Indonesia also, In assembling operations, domestic players in Indonesia remained partners with MNCs, and most are Japanese companies (Nag et al., 2007).

In Indonesia, the automotive industry has been recognized as an important Indonesian economic sector (Rasiah, 2006). In terms of GDP growth, exports, labor productivity, and employment, the contributions of this sector have risen significantly since the late 1990s. The industry has been recognized as a vehicle for introducing and diffusion of new technology from MNCs and to small medium enterprises through subcontracting arrangements (Aswicahyono, 2000). The government has recognized that the sector's prospects, both domestically and abroad, is bright (Amin, 2008). The Indonesian government has intervened extensively to spearhead the sector's technological modernization (Aswicahyono, 2000; Hill, 1988, 1995, 1997, 2006; Jacob, 2005; Okamoto & Sjoholm, 2001; Sjoholm, 1999a, 1999b, 2002; Wengel & Rodriguez, 2006). Aswicahyono (2000) argued that no Indonesian manufacturing industry had received more policy and analytical attention from the government than automotive. However, the performance of the industry in trade terms has been marginal. For example, the industry's export-import balance has always been negative (Amin & Hermina, 2009), suggesting that the industry has yet to achieve global competitiveness. Several scholars noted that FDI had a positive impact on host countries' technology development (Aitken et al., 1997; Barrios et al., 2005; Martin Bell & Albu, 1999; Hobday & Rush, 2007; Javorcik & Spatareanu, 2008; Kohpaiboon, 2006; Kugler, 2006; Lopez, 2008; Marin & Bell, 2006).

Concerning this matter, this research discusses technological utilization from the perspective of the automotive industry's technological capability literature. Drawing upon evolutionary theory, the technological capability approach emerged in the late-1970s and early-1980s through a set of empirical studies on the nature, intensity, and determinants of technological change in developing countries. However, today, technological developments lead to artificial intelligence in the Industrial Era 4.0 and facing Society 5.0. Therefore, the technological capabilities must adapt to Industrial Era 4.0 and Society 5.0 for a sustainable automotive industry.

In the Industrial Era 4.0, all of human activities, in many sectors, are supported by utilize the advanced and intelligent technology (Ardito et al., 2019; Debora, 2019; Kamble et al., 2018; Muhammad Nizam, 2018; Oztemel & Gursev, 2020; Piccarozzi et al., 2018; Zhou et al., 2015), such as artificial intelligent (Mitchell et al., 2013; Russel & Norvig, 2012), cloud computing (Hayes, 2008; Ratten, 2020; Velte et al., 2009), mobile application (Charland & Leroux, 2011), advanced and autonomous robotics (Bock, 2007; Mistry et al., 2014), cognitive computing (Hurwitz et al., 2015; Modha et al., 2011), big data analytics and data science (Arockia et al., 2017; Maneth & Poulovassilis, 2017; Manoj et al., 2018; Sagiroglu & Sinanc, 2013), internet of things (Li et al., 2015; Wortmann & Fluchter, 2015), cybersecurity (Singer & Friedman, 2014), augmented and virtual reality (Isberto, 2018; Sowmya et al., 2015), integration system (Gorton & Liu, 2004), 3D graphics, simulation, and additive manufacturing (Calignano et al., 2017; Niaki et al., 2019). It can be concluded that the Industrial Era 4.0 is very related to technology. This condition finally gave rise to the concept of Society 5.0, where all their life activities are supported by intelligent technology. Society 5.0 is the concept of society that human-centered and technology-based that first developed in Japan as an impact of Industrial 4.0 (Fukuyama, 2019b; *Society 5.0*, n.d.).

In facing Society 5.0, it is important to prepare technological capabilities maximally for the sustainable automotive industry, especially in developing countries where technology penetration is uneven in various sectors. Business Intelligence technology can be a solution to prepare the sustainable automotive industry. BI technology provides the past, current, and future (predictive) views of business operation, including business performance management, competitive intelligence, intelligence reporting, benchmarking, online analytical processing, and predictive analysis (Chaudhuri et al., 2011; Han & Kamber, 2006; Niu et al., 2009). BI technology utilizes artificial intelligence related to the Industrial Era 4.0 to perform an effective market analysis to support the development of innovation and productivity in the company (Sun, 2020).

In industry sectors in the Industrial Era 4.0, including in the automotive industry, BI and artificial intelligence are used and developed rapidly, especially in developed countries, while developing countries just started developing. The previous works that use intelligent technology such as Business Intelligence, artificial intelligent, or data science analytics in the industry, among others: (1) Ahmad et al explored the role of business intelligence for sustainable tectile and apparel industry in the Industrial Era 4.0 (Ahmad et al., 2020); (2) Hoffman et al discuss and demonstrate how the process in the automotive industry can more efficient using artificial intelligence and data science (Hofmann et al., 2017); (3) Cruz et al proposed the framework of social Business Intelligence from Twitter social media for automotive domain (Cruz & Llavori, 2018); (4) Technology is also used as digital service in the automotive industry (Tian et al., 2016); (5) Bordeleau et al explores the factors linked to business intelligence and analytics for manufacturing medium enterprises (Bordeleau et al., 2020); (6) Gusikhin et al discuss about the applications and trends of intelligent system which used in the automotive industry (Gusikhin et al., 2007); (7) Tubaro et al discuss about micro-work service as low profile human activity behind the artificial intelligent for long supply chain in the automotive industry (Tubaro & Casilli, 2019); and so on. Based on the background above, this research investigates the utilization of Business Intelligence technology based on the technological capabilities issue for the sustainable automotive industry in developing countries facing Society 5.0.

METHODOLOGY

This research uses qualitative methods with exploring literature and related works, Focus Group Discussion (FGD) and interview for evaluating the proposed framework (Masadeh, 2012; Stewart et al., 2012), and qualitative content analysis technique to analyze the interview data (Williamson et al., 2018). FGD and interview involving researchers in the fields of Informatics, Information Technology, Information Systems, and Industrial Engineering from several universities in Indonesia such as Pasundan University, Garut College of Technology, State Islamic University of Sunan Gunung Djati Bandung, STMIK LIKMI School of Business and Information Technology, and Sangga Buana University.

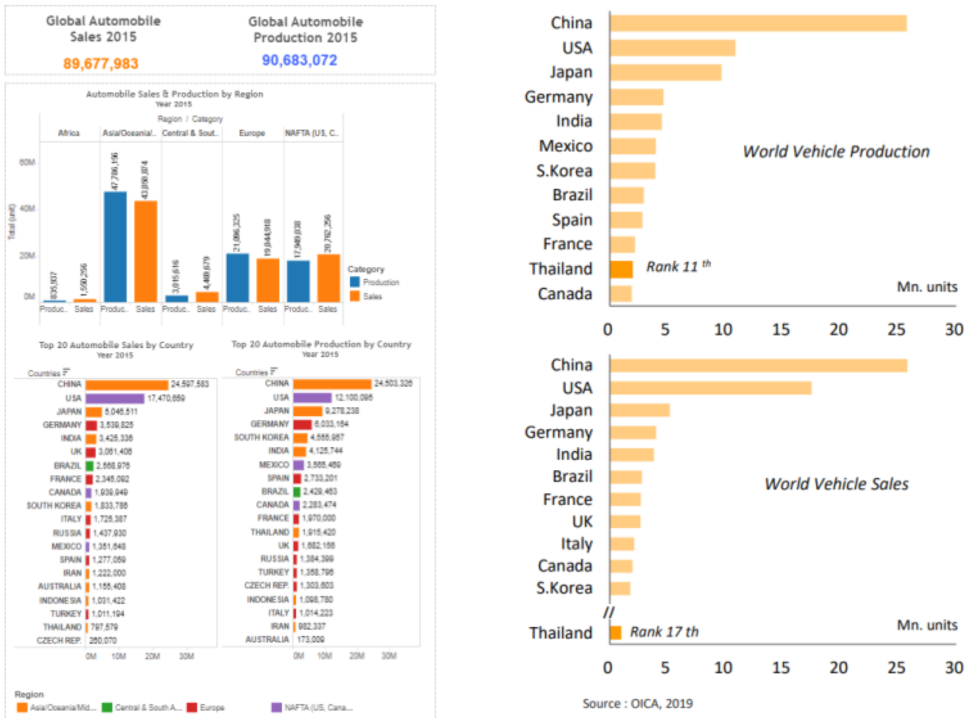
After the proposed framework has been refined based on the results of the FGD, this study maps industrial development pillars, firm-specific variables, technological capabilities, Business Intelligence, and industry 4.0 technology for sustainable automotive industry impact. The mapping was carried out on the issue of the sustainability of the automotive industry in both developing and developed countries as a benchmark. The automotive industry's sustainability issue is a case study from elaborates on the existing research and theory. In operations management research, a case study is an effective approach that is useful in an exploratory sense to create a new research proposition and enable a complete understanding of the context when addressing 'how' questions (Bordeleau et al., 2020).

RESULTS

This section provides about the automotive industry's condition in the developing country, which strives to develop and sustainably meet market needs. This section explains the relationship between Business Intelligence and Society 5.0, the technological capabilities in preparing the implementation of Business Intelligence technology, and the proposed Business Intelligence framework for the automotive industry in facing society 5.0.

Sustainability Issue of the Automotive Industry in the Development Country

More than 100 developing countries, including Indonesia, China, Thailand, India, and so on, can be competitively able to compete with developed countries in producing and selling automotive products. At least some developing countries, such as Indonesia, in 2015 were included in the top 20 countries with competitive automotive sales and production rates (OICA, 2020; Yongpisanphob, 2020). Moreover, Figure 1 (a) and (b) show that China is the largest automotive product producer with the highest sales rate. Of course, this development continues today. Until 2020, production and sales of automotive products in Indonesia try to move (Figure 2 (a)) (Gabungan Industri Kendaraan Bermotor Indonesia (GAIKINDO), 2020b), as well as other developing countries such as Thailand (Figure 2 (b)) (Yongpisanphob, 2020), Malaysia (Figure 2 (c)) (Malaysian Automotive Association, 2020), and India (Figure 2 (d)) (Autobei Consulting Cgroup, 2020). The Covid-19 pandemic triggers the disruption to supply chains and the sharp drop in consumer purchasing in the automotive industry in many countries, especially in developing countries. Figure 2 shows the production and sales in Indonesia, Thailand, and India as the representation of developing countries. Based on data from the ASEAN Automotive Federation published on its website, the production of motorized vehicles in the region only reached 1,641,099 units in the first seven months of 2020 (Gabungan Industri Kendaraan Bermotor Indonesia (GAIKINDO), 2020e, 2020g). That means a sharp decline of 41.4 percent from 2,801,048 units in the same period in 2019.



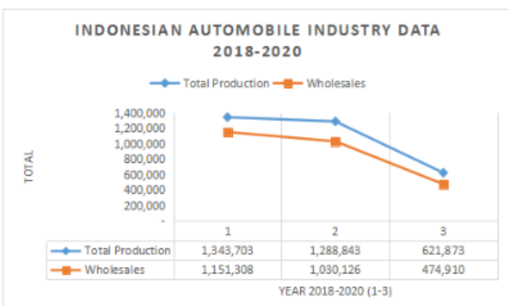
(a) (b)

Figure 1. (a) Global automobile sales and production by region in 2015 (OICA, 2020)**; (b) Global automobile sales and production by region in 2019** (Yongpisanphob, 2020)

The largest decreases were in Indonesia and Thailand, followed by the Philippines and Malaysia. Indonesia, which is ASEAN's largest market, reduced its production by 48.6 percent to only 427,607 units from 831,662 units. In ASEAN, Thailand, known as Detroit, also recorded an alarming decline in production by 42.5 percent to 812,721 units from 1,403,153 units in the January-August 2019 period. Meanwhile, the Philippines also posted a quite large production decline of 32.9 percent to 39,171 units from 58,386 units last year. Malaysian production also slowed 30.7 percent to 263,876 units from 380,552 units in 2019. Vietnam also posted negative growth of 24.3 percent to 88,651 units from 117,159 units in the January-August 2019 period. In terms of sales, the region only sold 1,396,927 units, down 38.4 percent compared to last year. Indonesia's sales fell 51.1 percent to 323,507 units from 661,919 units last year, while the Philippines fell 47.6 percent to 123,489 units from 235,544 units in the January-August 2019 sales period. Thailand's sales fell 33.4 percent to 456,858 units from 685,652 units. Malaysia also only sold 285,045 units, or 28.4 percent lower than last year. Vietnam also fell 25 percent. Myanmar and Brunei are the exceptions, with positives at 12.5 percent and 9.3 percent, respectively.

However, in the new normal phase after the Covid-19 pandemic, the developing country's automotive industry started to rise again. In Indonesia, the Ministry of Industry is optimistic that the national automotive industry and business will increase once the new normal era is enacted in the midst of the coronavirus (Covid-19) pandemic (Gabungan Industri Kendaraan Bermotor Indonesia (GAIKINDO), 2020f). Car sales support this optimism in wholesales in July 2020, an increase of 100.3 percent from the previous month to 25,283 units. This figure is also higher than April (7,868 units) and May (3,511 units) when the local government imposed the activity restrictions to reduce the spread of the Covid-19 pandemic. This growth is an important momentum for the automotive industry's growth as a turning point, because this sector is a multiplier effect. It can boost other sectors such as used vehicles, leasing, to insurance (Gabungan Industri Kendaraan Bermotor Indonesia (GAIKINDO), 2020d). Because the Covid-19 pandemic made new financing for one of the leases during the first semester of 2020, 47 percent decreased. The main trigger was the significant decline in the automotive industry, as evidenced by a 42 percent decline in new car retail sales, which only reached 291 thousand units in the first six months of 2020 (Gabungan Industri Kendaraan Bermotor Indonesia (GAIKINDO), 2020c).

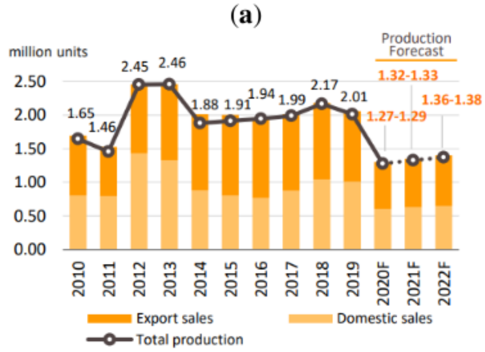
Moreover, the automotive industry in China began to squirm as the economy recovered rapidly. Car sales in China are projected to reach 25.3 million units by 2020 (Gabungan Industri Kendaraan Bermotor Indonesia (GAIKINDO), 2020a). The world's largest auto market continues to lead the global auto industry's recovery after suffering a blow to its lowest point at the start of the Covid-19 pandemic. Xu Haidong, senior official at the China Automobile Manufacturers Association (CAAM), projected that car sales in China this year would reach 20.2 million passenger vehicles and 5.1 million commercial vehicles, including trucks and buses.



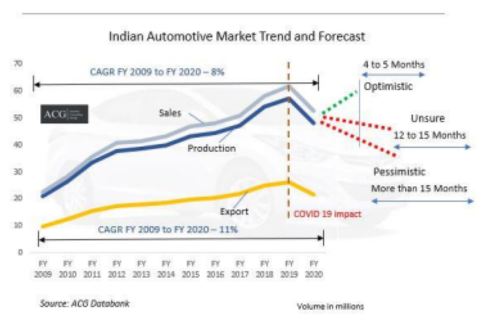
(a)

	JAN-JUNE 2020	JAN-JUNE 2019	VARIANCE UNITS	VARIANCE %
Passenger Vehicles	157,174	265,482	(108,308)	(40.8%)
Commercial Vehicles	8,875	19,158	(10,283)	(53.7%)
TOTAL VEHICLES	166,049	284,640	(118,591)	(41.7%)

(b)



(c)



(d)

Figure 2. (a) Production and sales of the automotive industry in Indonesia until 2020 (OICA, 2020)**; (b) Total production volume of the automotive industry in Malaysia until 2020** (Malaysian Automotive Association, 2020)**; (c) Production and sales of the automotive industry in Thailand until 2020** (Yongpisanphob, 2020)**,**

production in the first quarter of 2020 is 0.48 (Statista Research Department, 2020)**;** **(d) Production and sales of the automotive industry in India until 2020** (Autobei Consulting Cgroup, 2020)**.**

Business Intelligence in Society 5.0

The industrial 4.0 era utilized the technology in various human activities such as the Internet of Things technology, cloud computing, artificial intelligence, and even Business Intelligence (Muhammad Nizam, 2018; Office of Chief Economist Bank Mandiri, 2018; Sadiyoko, 2017; Suwardana, 2017; Zhou et al., 2015). Today, society's growth is shifted to Society 5.0, where intelligent technology supports all human activities (Fukuyama, 2019a; *Society 5.0*, 2019). Society 5.0 develops new value by collaborating and cooperating with various systems and preparing to standardize data formats, templates, system design, etc., and build the required human resources (Ferreira & Serpa, 2018; Hayashi et al., 2017). Furthermore, developments in the production of intellectual property, international standardization, IoT device construction technologies, big data analytics technologies, artificial intelligence technologies, and so on are expected to foster competitiveness in a super-smart society. Technology continues to grow over time with intelligence that continues to override human capabilities. It is also considered that Artificial Intelligence has the ability to take over the role of humans. Society 5.0 is created to stop this - a new age that connects people through technical advances (Wahyudin, 2020).

There are three principles of Society 5.0, according to Christofel Angelo and Johan Alvin, namely (Wahyudin, 2020): openness, inclusivity, and collaboration. Over time, science can advance more and more. With the idea of Society 5.0, technical assistance will benefit all human activities. Those principles are supported by HEROES strategy for Society 5.0, among others:

- **H**ear and listen to the voice of customers. The approach means that a brand does not only provide customers with creativity. However, they will need to listen to customer criticism and input.
- **E**levate the value of product and service. In this strategy, by giving personality to their products, brands need to increase their brand value. It can make the item have an emotional meaning for customers.
- **R**ead the future need. This strategy aims to help companies innovate their goods and services. It will keep customers interested in the company and its goods by tracking trends and adapting them to what the company is selling.
- **O**pen mutual communication. Business owners were encouraged to do open contact to support their brand in this strategy. Promotion should not be performed alone in the modern period, but by the partnership, since it attracts a larger variety of clients.
- **E**nsure the moment of truth. This method guarantees the facilities offered to its customers by the brand. Besides, in cyberspace, a brand may have a good logo, but it won't be significant if it is not followed by good service.
- **S**ocialize and declare to people. This strategy demonstrates the value of engagement between brands and customers. Then, after the plan has been completed, customers can feel engaged with the brand and create trust.

Business Intelligence technology is a part of Industry 4.0 technology that analyzes the data to find the insight knowledge, even a wisdom, to support the business strategy. So, in facing Society 5.0 Business Intelligence technology is an important and innovative strategy for using technology, especially in industry. The HEROES strategy can be supported with the advantages of Business Intelligence technology such as (Ahmad et al., 2020): (1) obtained quality information for decision-making; (2) enhanced ability to analyze the expected opportunities and threats; (3) improved organizational knowledge; (4) improved information sharing; (5) better analysis and information retrieval; (6) improved efficiency; (7) faster decision-making; (8) more accurate and quick reporting; (9) enhanced quality of decision making; (10) improved customer service; and (11) escalate revenues. Fulfilling the human need, producing the technology that supports human activities, until predicting the future need in the Society 5.0 can be done efficiently and effectively with Business Intelligence technology. Figure 3 describes the relationship between Industry 4.0 and Business Intelligence technology in the Society 5.0 era.

Industry 4.0 has advanced technology, such as (Ahmad et al., 2020; Ardito et al., 2019; Kamble et al., 2018; Oztemel & Gursev, 2020; Piccarozzi et al., 2018; Zhou et al., 2015): Cybersecurity, cloud computing, additive manufacturing, mobile technology, artificial intelligence including machine learning and natural language processing, machine to machine technology, cognitive computing, big data analytics, augmented reality, 3D printing, advanced robotic, internet of things, and RFID technologies. Figure 3 shows that Business Intelligence technology is a part or a value creation of Industry 4.0 development (Bordeleau et al., 2020), specifically in the big data analytics technology. In the era of big data which data have a big volume, high variety, and rapid velocity (Arockia et al., 2017; Sagiroglu & Sinanc, 2013), Business Intelligence technology has a role that can provide powerful data analysis with techniques such as: data science (Gowrishankar et al., 2019; Maneth & Poulovassilis, 2017; Manoj et al., 2018), data mining (Jiawei et al., 2006; Wu et al., 2014), data warehouse (Lamani et al., 2019), data discovery and visualization (Bumblauskas et al., 2017; Philip Chen & Zhang, 2014), data integration (Kadadi et al., 2014; Wamba & Mishra, 2017), data quality management (Fan & Geerts, 2012), and data governance (Cheong & Chang, 2007; Khatri & Brown, 2010; Ladley, 2013). Business Intelligence's output is self-service Business Intelligence technology that provides robust information based on data analytics. It is in line with meeting the needs of Society 5.0. The technology that is created and used must of course be in line with the requirements of its users so that this technology can be utilized optimally. The optimal use of technology to support Society 5.0 can be analyzed first based on the community's needs by using Business Intelligence technology.

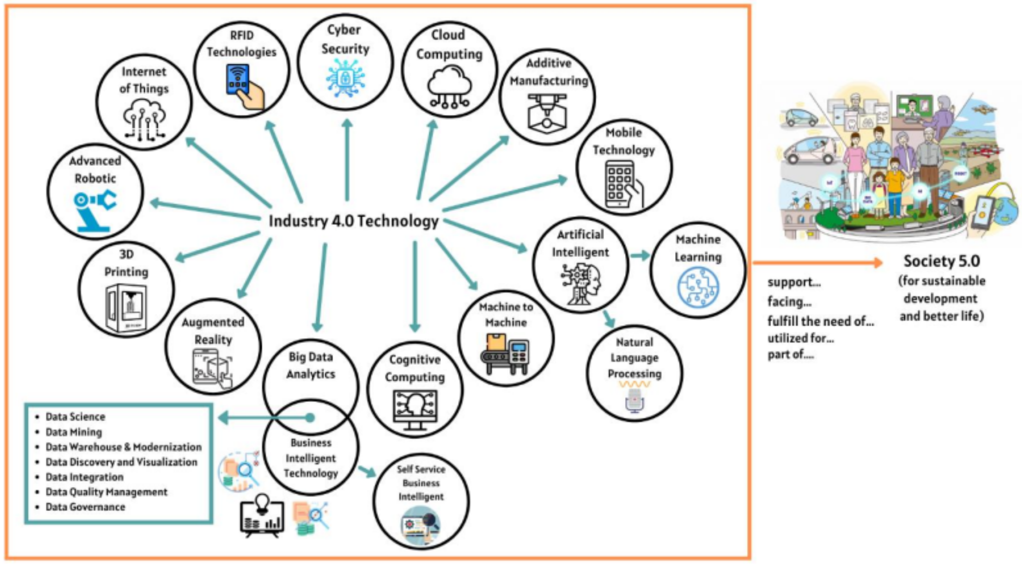


Figure 3. The relation between Industry 4.0 technology and Business Intelligence technology for Society 5.0

Technological Capabilities in Preparing the Business Intelligence Technology for Automotive Industry

In dealing with Society 5.0, where technology is centered on facilitating human activities, of course, it must also be supported by the ability to use technology itself. Especially in the automotive industry in developing countries, which continues to develop the quality of production and sales. Apart from using business intelligence to capture market needs, the company's internal quality must also be improved. In developing countries, such as Indonesia, the technological capability of automotive industry is still bewildering. The automotive firms should be encouraged to improve it, as the automotive industry can become prime mover of acquiring and improving the advanced technology industry (Amin, 2008). To develop particular industry in a latecomer regime, four industrial development pillars require focus, viz., basic infrastructure, high-tech infrastructure, global networking, and network cohesion (Felker et al., 2013). Unfortunately, the research's empirical results show that the Indonesian automotive industry still experienced poor basic infrastructure support and impoverished high-tech infrastructure. Despite the weakness of both types of supporting infrastructures, the results show that automotive firms have enjoyed a relatively good quality of global networking and network cohesion.

Figure 4 provides the framework of industrial development pillars and technological capabilities to achieve economic performance of the industry. This scheme is developed and applicable to developing countries based on research in Indonesia. Technological capability is a process of accumulating technical knowledge or a process of organizational learning (Rosenberg & Frischtak, 1985). The technological capability enables the enterprises to undertake a range of productive tasks, extending from pre-investment analysis to product and process engineering, manufacturing, and introducing new technologies as they appear. The flow or functional categorization of technological capabilities based on a manufacturing firm's task is the most critical element of technological capability as the set of learning mechanisms available to acquire new or improve existing investment and production capabilities (M Bell, 1987; Biggs et al., 1995; Lall & Siddharthan, 1982; Wei, 1995). In this case, technological capabilities must be supported by industrial development pillars and firm-specific variables to get high-quality economic performance. Of course, Business Intelligence technology capabilities can improve industrial performance accompanied by technology in the Industry 4.0 era to face Society 5.0.

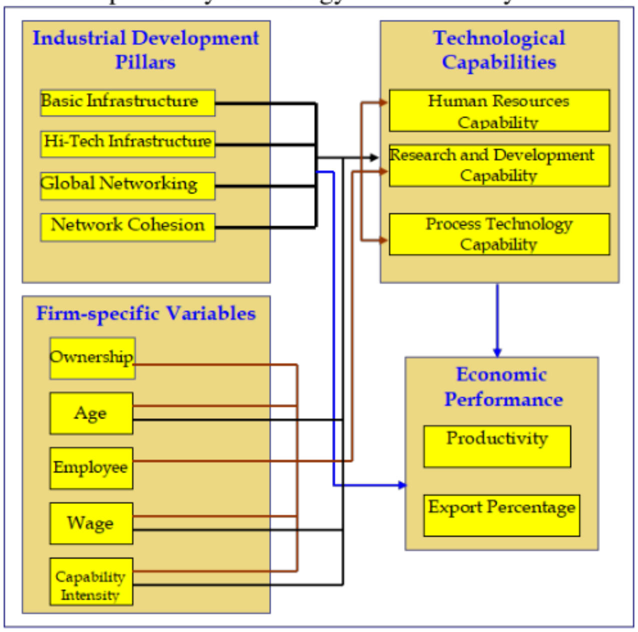


Figure 4. The relation between industrial development pillars, technology capabilities, firm-specific variables, and economic performance.

The pillars of industry development (especially industry in the developing countries) to sustain several decades of rapid growth and employment absorption, value addition, and sustained exports, consist of (Rasiah & Gachino, 2004; Rasiah, 2004a, 2004b, 2007):

- **Basic infrastructure**, the first pillar of a dynamic cluster, is a strong role by governments (federal or local) to provide stability (macroeconomic, political, and security) and efficient basic infrastructure. It is a government's role to provide better transportation access, reliable telecommunication network, sufficient water, and energy supply, easier public services, namely immigration, permit, health, security, etc. Hence, the firms could focus on conducting their operation in the most efficient and effective ways.
- **High technology infrastructure**, the second pillar is the environments where the institutions coordinating learning and innovation are evolving effectively to stimulate technology acquisition through learning by doing, licensing, adaptation, training, standards appraisal mechanisms, a strong intellectual property right framework to prevent moral hazard problems facing innovators and research and development. The second is vital for the continuous evolution of technological capabilities in the cluster. The high technology infrastructure level refers to the existence of higher educational institutions and training facilities for science and technology, R&D institutes, research laboratories, testing facilities, the availability of skilled workers, scientist and engineers, technical training programs, and

R&D spending within the importing economy. These facilities are critical for developing countries because local firms would be dependent on foreign sources (Lall & Siddharthan, 1982). These educational institutions, facilities, and equipment are necessary to develop a highly-skilled workforce capable of handling advanced technology. In most developing countries, the government takes responsibility for developing technological infrastructure because the private sector's contribution is very minimal (Hill, 1990, 1995; Lynn, 1985). The limited availability of the resource in the private sector and firms' inability to appropriately appropriate the returns from their investments are the reason behind the above condition. Such investments tend to enter public domain quickly due to the classical free rider problem and weak legal system that cannot protect intellectual property rights (Hill, 1995).

- **Global networking**, the third pillar, noted that the cluster should be globally connected with markets and value chains. Global markets provide the economies of scale and scope and competitive pressure to innovate. On the other hand, global value chains assist economic agents in the cluster to orientate their strategies to the critical dynamics that determine upgrading and value addition, where the global value chain supports increasing the global demand (Gereffi, 2002).
- **Network cohesion**, the fourth pillar, describes the demand for encouraging the interdependence and interaction between actors involved in cluster. Expansion of the elements of interdependence and inter-activeness by articulating the role of producer-user relations in innovation (Lundvall, 2016). The nature of interface and coordination between vertically connected economic agents is vital in the horizontal evolution of innovation activities. Connectivity and coordination are critical for knowledge flows - beyond simply codified information that markets can coordinate. Intermediary organizations such as industry-government coordination councils and chambers of commerce play an essential role in increasing connectivity and coordination in dynamic clusters. Trust and loyalty were identified as factors that could strengthen the network cohesion (Rasiah & Lin, 2005).

Then, the industry has firm-specific variables, among others:

- **Ownership** is a critical variable because of foreign capital's significance in the emergence and subsequent development of automotive production in developing countries such as Indonesia. Local firms operating in developing sites typically enter automotive manufacturing through licensing technology from multinationals or subcontract relations with subsidiaries at host-sites. An assessment of ownership is important to examine differences in technological capabilities in automotive manufacturing in Indonesia given that foreign firms have participated in the industry for over three decades.
- **Age**, firm which has a longer experience in operating the facilities is considered enjoy stronger experience and tacit knowledge. Therefore, age is considered to provide a positive relationship with exports and technological capabilities. However, new firms in particular countries do not represent zero experience in operating the facilities, since other countries, especially foreign firms, may have experienced similar facilities. The statistical relationship may not be positive in foreign firms using superior technology from abroad and enjoying strong access to global markets, which may have recently opened or relocated operations locally.
- **Employee**, the number of employees is generally accepted that minimum scale economic are important in automotive manufacturing, and hence size is an important variable. Number

of employees is expected to have a positive and significant impact on the firm's performance.

- **Wage** can be used as a reward received by workers. However, due to the large reserves of labour in Indonesia, wages may not show statistically meaningful results. Nevertheless, given the premium involving skilled and knowledge workers, a positive relationship can be expected between human resources and wages.
- **Capability intensity**, to establish a firm, sufficient investment is required. However, to sustain the operation of the firm and acquire advance technology, buying up dated machines and equipment, the firms need some additional financial support. The more advanced technology, machines, and equipment are entailed, the more capital is involved. Capital intensity is expected to show a strong and positive effect on technological capability and a firm's performance.

Industrial development pillars and firm-specific variables will support the technological capabilities of the industry that consist of:

- **Human resources capability** has a significant role in acquiring, implementing, adapting, and modifying technology through innovation activities. Human resource development can be conducted in several forms, such as providing training and education institutions and its financial support and implementing advance human resource practices. Human Resource capability was expected having a strong and positive impact on the firm's performance
- **Research and development (R&D) capability**, the learning process leads firms to participate in new product development eventually. While beginners mostly learn and absorb, more established firms typically learn and develop new products. Except for the funding of public labs and universities, firms seldom participate in basic research. Hence, firm-level R&D is largely focused on process technology and product development, especially diversification of use and proliferation. Given its underdeveloped institutional and systemic facilities and the preponderance of labor-intensive assembly and processing operations, R&D is unlikely to produce statistically meaningful results involving exports and human resources. The data collected enabled the computation of two R&D proxies, viz., R&D expenditure as a percentage of sales and R&D personnel as a share of employment. Because of the inability to differentiate R&D personnel involved between product and process technology, this proxy was measured to relate both product and process R&D.
- **Process technology capability** indicates the process advancement carried out by particular firms and the firms' product advancement. More advance the process and product presented by the firms show the firm's ability to acquire the technology. Process Technology capability was expected to have strong and positive impact on the firm's performance.

The industrial development pillars and technological capabilities will give an effect for productivity and sales (export percentage) as economic performance. Three alternatives proxies were used to represent the economic performance indicators such as: export percentage, export incidence, productivity, and log productivity. The export percentage represents the intensity of the firm to compete in the global market. Export incidence represents the firm's ability to participate in global market, especially for the local firms that have no foreign partnership. Firm's productivity represents the ability of the firm to operate in an efficient way to produce a profit. The technological capability variables are expected to enjoy a strong and positive relationship with the economic performance variables.

Business Intelligence Technology Framework for Automotive Industry in Facing Society 5.0

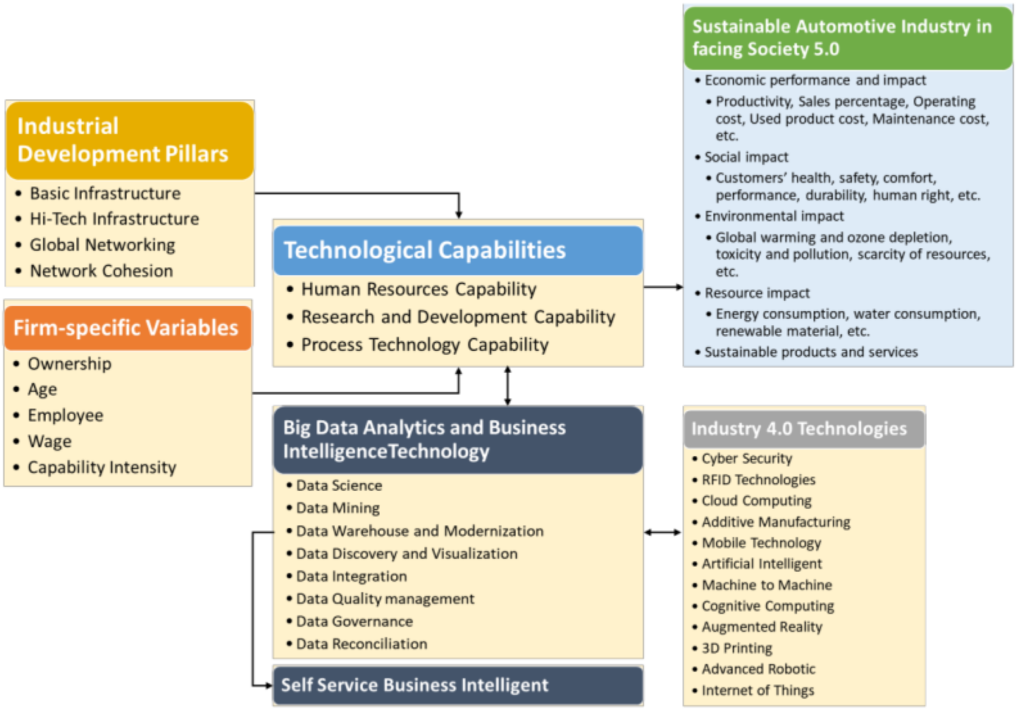


Figure 5. Business Intelligence Technology Framework for Automotive Industry in Facing Society 5.0.

Figure 5 provides the linkage between industrial development pillars, firm-specific variables, and technological capabilities that implement the Business Intelligence technology to support the economic performance and social and environmental impact of the automotive industry in facing Society 5.0. The proposed framework is a general scheme that can be implemented in industries other than the automotive industry. However, the framework is built based on the conditions and needs of the automotive industry in developing countries which is then combined with the application of Business Intelligence technology as part of industrial technology 4.0 to face Society 5.0. The application of Business Intelligence technology can be used as a powerful, effective, and efficient step to analyze the needs of Society 5.0 so that its economic performance can be increased and sustainable.

Technological capabilities and Business Intelligence technology have a reciprocal relationship where the capability to use technology is required to apply Business Intelligence technology. Likewise, Business Intelligence technology can analyze the need for increasing technology capability in the industry. Three categories classify the criteria in automotive product sustainability based on the customer view, which is a suitable Society 5.0 paradigm, among others environmental impact, social impact, resource, and economic impact (Jasinski et al., 2016; Panuju et al., 2020). Business Intelligence technology can also analyze the needs for industry 4.0

technology that needs to be used for industry in achieving good economic performance, social, resource, and environmental impact, and sustainability of products and services.

DISCUSSIONS

Focus Group Discussion (FGD) and interviews were conducted to evaluate the proposed Business Intelligence technology framework for the automotive industry in Society 5.0. The FGD involved several partitions and researchers from several universities in Indonesia whose focus of the study was informatics, information systems, information technology, and industrial engineering. The FGD and interviews conducted discussed the relationship between the components and variables in the framework being built, then whether the framework could be implemented in other industries besides the automotive industry. Besides, it also discussed the role of BI technology in Industry sustainability at Society 5.0, especially in the automotive industry, and the possibility of the framework being applied in developing countries.

The results of the FGD and interviews can be drawn as follows:

1. Each component has a relationship, either directly or indirectly. Each component has their respective roles and functions that work in synergy and support each other. The framework is well connected, at least it already describes input, process and output.
2. This framework is very possible to be implemented in the automotive industry and the automotive industry because if viewed from the function of Business Intelligence technology in general, all aspects of the company that are implementing current technology have been accommodated by the proposed framework. When applied outside the automotive industry, integrated technology infrastructure support is needed in accordance with the concept in the proposed framework. The proposed framework can not only be used in industries that create a product by nature but can also be implemented in industries that are project in nature, such as building construction services.
3. The framework can also be applied in developing countries with sufficient technological support, for example, connectivity, electricity, technology infrastructure and network capacity, besides good human resources and supporting state policies. A country like Indonesia currently deserves a number of companies to use this framework, or maybe several companies in Indonesia or other developing countries have started using it, which needs to be further studied.
4. Can also consider production capability, whose function is to: (1) define the capability for the production of certain components; (2) provide other information about production capabilities; (3) providing information about the current state of ability (available or achievable), and (4) determining the period of the capability to do a job. However, production capabilities are another part of the capabilities that must be owned by the industry beyond technology-related boundaries, so that production capabilities become a constraint on the proposed framework for implementing Business Intelligence technology.
5. In the data section, Data Reconciliation is also needed. Because in companies related to banking transactions such as payment gateways/fintech, data reconciliation must be done regularly. It is also related to the financial management needed by the company. So that this reconciliation data is added to the proposed framework.
6. Seeing the current large data needs, with large volumes, velocity and variations of data (big data), business intelligence has an important role to play in optimizing complex / large data structures for the needs of new business strategies. Therefore, the proposed framework intersects with big data analytics techniques that accommodate big data needs.

Then, with FGD and interview, this research maps the relationship between each component and variable in the proposed framework with several issues related to sustainability and developing technology in the automated industry. Table 1 shows the sustainability issues in the automotive industry, both from developing countries and developed countries adopted by developing countries. This issue is related to the industrial development pillars, firm-specific, technological capabilities, Business Intelligence technology, and the required industrial technology 4.0 and the impacts that need to be considered for the sustainability of the automotive industry.

Table 1
Relation between Sustainability Issues in Automotive Industry and Proposed Framework

Sustainability Issues in Automotive Industry	Industrial Development Pillars	Firm-specific variables	Technological Capabilities	Business Intelligence Technologies	Industry 4.0 Technologies	Sustainable Automotive Industry Impact
Shifting the emphasis from conventional hardware systems to software and service platforms has introduced services that utilize personalized mobile service platforms for navigation, infotainment, and communication and provide intelligent, customized, and contextual experiences (Tian et al., 2016).	High-tech	all firm-specific variables	Human resource, process technology	Data discovery and visualization, data integration	Cloud computing, Machine learning, Internet of Things, mobile technology.	Economic, sustainable product and service
Onboard diagnostics (OBD) makes it easy for vehicle and user data to be obtained. Services and in-car applications for real-time car maintenance and use have been developed, and connected car systems have been created that have been used for predictive analytics, driver behavior prediction, and enhanced safety (Gusikhin et al., 2007; Tian et al., 2016).	High-tech	all firm-specific variables	Human resource, R&D	Big Data Analytics, Data Analytics and Mining	Artificial intelligent	Economic, sustainable product and service
Tracking the customer's engagement to have a more in-depth insight into business marketing processes in real-time to respond more effectively (Cruz & Llavori, 2018). For a good analytical experience, with the things (products or services) to be monitored, the organization must specify the most relevant research areas.	High-tech, network cohesion	all firm-specific variables	Human resource, R&D, process technology	Social business intelligence, data streaming, Data mining		Economic, social, sustainable product and service
Customer insights, satisfaction, loyalty, and engagement (Ahmad et al., 2020). Rapid delivery of	Basic, high-tech, global networking, network	all firm-specific variables	Human resource, R&D	Big Data Analytics, Data Mining, Data Science,	Cloud technology, 3D printing,	Economic, social, sustainable product and

Table 1
Relation between Sustainability Issues in Automotive Industry and Proposed Framework

Sustainability Issues in Automotive Industry	Industrial Development Pillars	Firm-specific variables	Technological Capabilities	Business Intelligence Technologies	Industry 4.0 Technologies	Sustainable Automotive Industry Impact
customer insights, improving customer experience, loyalty, financial information on acquisition, and engagement. Merchandising customization, stronger consumer insights, assessment of good potential business partners.	cohesion			Data Discovery and Visualization tools: MicroStrategy BI solutions based on SAP HANNA, Informatica PowerCenter, Cognos, SAS Tableau, Power BI)	augmented reality, artificial intelligent (machine learning)	service
In-vehicle intelligence (Gusikhin et al., 2007), such as vehicle system control (Motor control, automatic transmissions, anti-skid steering, and climate control, anti-lock breaking systems (ABS)), virtual sensors, speech recognition	Basic, high-tech	all firm-specific variables	Human resource, Process technology	Self-service Business Intelligence	RFID technology, internet of things	Economic, social, resource, environmental, sustainable product and service
Reducing cost and improve efficiency within vehicle assembly in manufacturing planning systems (Gusikhin et al., 2007).	Basic, high-tech	all firm-specific variables	Human resource, R&D, process technology	Data Science, Data warehouse and modernization, data discovery and visualization, data quality management.	Additive manufacturing, machine to machine, advanced robotic	Economic, social, resource, environmental
Production control in automotive assembly and supply chain management (Gusikhin et al., 2007).	High-tech, global networking, network cohesion	all firm-specific variables	Human resource, process technology	Data warehouse and modernization, data discovery and visualization, data quality management.	Artificial intelligent	Economic, sustainable product and service
Service diagnostic and prognostics, warranty management, and corporate knowledge management (Gusikhin et al., 2007).	Basic, global networking, network cohesion	all firm-specific variables	Human resource, R&D	Data mining, data discovery and visualization, data quality management		Economic
Autonomous vehicle (Faisal et al., 2019; Haboucha et al., 2017; Kato et al., 2015; Schwarting et al., 2018; Tubaro & Casilli, 2019).	High-tech	all firm-specific variables	Human resource, R&D, process technology	Big Data Analytics and Data mining	Artificial intelligence, advanced robotics, internet of	Economic, social, resource, environmental, sustainable product and

Table 1
Relation between Sustainability Issues in Automotive Industry and Proposed Framework

Sustainability Issues in Automotive Industry	Industrial Development Pillars	Firm-specific variables	Technological Capabilities	Business Intelligence Technologies	Industry 4.0 Technologies	Sustainable Automotive Industry Impact
					things, cloud technology	service
Total Quality Management (TQM). For supply chain decision-makers and administrators, TQM is used to develop their information flow capabilities. TQM is an efficient operational technology in the automotive industry, and inefficient contact can be avoided with successful disintermediation measures while minimizing product flow lead time (Ahmed & Omar, 2019). There can also be manipulation of facts if the productive intermediaries do not function with honesty. Improving the quality of supply chain communication processes is another big target of automotive multinationals, so they have recruited local automotive suppliers to develop their communication practices.	Basic, global networking, network cohesion	all firm-specific variables	Human resource, R&D, process technology	Big data analytics, data science, data warehouse and modernization, data discovery and visualization, data quality management, data governance		Economic, sustainable product and service
In developing countries, electric vehicles have become a sustainability issue for the automotive industry with environmentally friendly emissions (Onn et al., 2018).	High-tech	all firm-specific variables	Human resource, R&D, process technology	Big data analytics and data science.		Economic, social, resource, environmental, sustainable product and service
Environmental, resource, economic, and social impact of automotive product sustainability (Panuju et al., 2020).	Basic, high-tech, global networking, network cohesion	all firm-specific variables	Human resource, R&D	Big data analytics, data science and visualization		Economic, social, resource, environmental, sustainable product and service
Supply chain management for sustainable business operation, product development, until marketing in the automotive industry (Diabat et al., 2013; Lemghari et al., 2019; Mangla et al., 2018; Zimmer et al., 2017). It also green supply chain management for the automotive industry (Diabat et al., 2013).	High-tech, global networking, network cohesion	all firm-specific variables	Human resource, R&D	Big data analytics, data science, data warehouse and modernization, data discovery and visualization, data quality management		Economic, environmental, sustainable product and service

Table 1
Relation between Sustainability Issues in Automotive Industry and Proposed Framework

Sustainability Issues in Automotive Industry	Industrial Development Pillars	Firm-specific variables	Technological Capabilities	Business Intelligence Technologies	Industry 4.0 Technologies	Sustainable Automotive Industry Impact
Infrastructure and technology are the dominant support the manufacturing firms manufacture goods that are environmentally friendly and offer a sustainable competitive advantage (Waqas et al., 2018).	Basic, high-tech	all firm-specific variables	Human resource, R&D, process technology	Big data analytics, data science, data warehouse and modernization, data discovery and visualization, data mining, data quality management	Additive manufacturing, advanced robotic, machine to machine, internet of things	Economic, environmental, sustainable product and service
Sustainability issues in the automotive industry promote the implementation of service capabilities in accordance with environmental legislation as a way of preserving competitiveness (Opazo-Basáez et al., 2018). As a result, manufacturers have increasingly incorporated digital and green service initiatives to help operations and effectively resolve environmental concerns that affect the business's competitiveness. Research evidence indicates that, since this is the only way to achieve efficiency benefits from green servitization, companies willing to provide green services should consider first providing digital services.	Basic, high-tech	all firm-specific variables	Human resource, R&D, process technology	Data Science, Data Mining, Data Warehouse and Modernization, Data Discovery and Visualization, Data Integration, Data Quality management, Self Service Business Intelligence	Additive manufacturing, advanced robotic, machine to machine, internet of things	Economic, social, resource, environmental, sustainable product and service

CITATIONS AND FOOTNOTES

Business Intelligence technology as a part of industry 4.0 technology can be used to analyze the market need, company potential and performance, production processes to sales, even as a feature of automotive products with robust information through an effective and efficient process. In meeting the challenges of Society 5.0, the automotive industry in developing countries needs to build a sustainable product and service strategy. This study places Business Intelligence technology and big data analytics in relation to the industry's technological capacities. This study's proposed framework has industrial development pillars and firm-specific variables that support the company's ability to use and adapt to technology. Industrial development pillars consist of basic infrastructure, high technology infrastructure, global networking, and network cohesion. Meanwhile, firm-specific variables consist of ownership, age, employee, wage, and capability intensity. The technological capabilities needed from the industry include human resource capabilities, research, and development capabilities, and process technology capabilities.

Business Intelligence technology produces self-service business intelligence with insightful knowledge, powerful information, and wisdom to support industrial business processes, from employees to policymakers. This technology supports and is supported by the ability to adapt and use technology. The information generated results from techniques such as data science, data mining, data warehouse, data discovery, data integration, data governance, and data quality management. In addition, this intelligent business technology is also related to other industrial 4.0 technologies. With technological capabilities supported by business intelligence, it can produce a sustainable automotive industry that is reliable in facing the needs of Society 5.0 with various impacts, both economic, social, environmental, and resource impacts to produce sustainable products and services.

Based on the FGD evaluation results, the proposed Business Intelligence framework for the automotive industry in facing Society 5.0 is generally accepted and has a connection between its components that supports the sustainability of the automotive industry business processes in developing countries. Even possible to be implemented for other industries in general. Several issues in the automotive industry were also mapped according to the framework that was built. However, future research must have quantitative research that measures the relationship between the components in the framework. Besides, it is also essential to analyze which components and variables have the most influence (key factors) in supporting the automotive industry's sustainability in facing Society 5.0. It is also necessary to implement the framework in detail and in-depth issues related to the automotive industry's sustainability in developing countries.

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