

Review

Building a Competitive Advantage for Indonesia in the Development of the Regional EV Battery Chain

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Abstract: In the process of the electrification of the vehicle industry, an important issue is to adapt production to new technological solutions and to achieve a break-even point in the production costs of an electric vehicle in the short term compared to its traditional counterparts. By the end of 2020, 10 million electric cars were sold worldwide. In today's globalized and crisis market realities, it is very difficult for state authorities to build a competitive advantage. Based on the concept of M.E. Porter, generating competitiveness does not take place at the macroeconomic, but at the mezzoeconomic level. The key purposes of this review paper are threefold: firstly, to identify the infrastructure for the production of electric cars (market size, resources) in some major Asian countries, including Indonesia; secondly, to identify the importance of FDI for Indonesia and the essence of their relations with China, and thirdly, to investigate whether Indonesia is able to build a competitive advantage in the form of a regional EV battery chain hub. The Indonesian government should ensure a more sizeable investment in lithium-ion battery production in order to complete a whole downstream supply chain, which includes the synthesis of the remaining high-quality battery materials.



Citation: Konewka, T.; Bednarz, J.; Czuba, T. Building a Competitive Advantage for Indonesia in the Development of the Regional EV Battery Chain. *Energies* **2021**, *14*, 7332. <https://doi.org/10.3390/en14217332>

Academic Editor: Adolfo Dannier

Received: 12 October 2021
Accepted: 2 November 2021
Published: 4 November 2021

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Keywords: EV battery; nickel 1; competitiveness; FDI; Indonesia

1. Introduction

In recent years, transport electrification has become a key element of the industrial strategy for almost all governments worldwide. It is also becoming a target for most global vehicle manufacturers. In the process of the electrification of the vehicle industry, an important issue is to adapt production to new technological solutions and to achieve a break-even point in the production costs of an electric vehicle in a short term, compared to its traditional counterparts. Electric vehicles (EVs) are equipped and powered by batteries. Among them, lithium-ion batteries seem to be one of the most suitable batteries for EVs because of their high energy density, long cycle life, modular and low maintenance, and eco-friendly features [1]. Electric vehicles which emit no greenhouse gases are believed to be a promising solution to combat climate change and environmental pollution challenges [2].

In 2020, global car sales were down 16% due to the worldwide pandemic crisis. In the same period, electric car registrations increased by 41%, reaching 3 million units sold in 2020. By the end of 2020, 10 million electric cars had been sold worldwide [3]. The EV sales were based on three main pillars: supportive regulatory frameworks created by single governments and regions; additional incentives given to the customers related to EV sales, and the number of EV models expanded and the lower battery cost. In addition, all global vehicle manufacturers announced their electrification plans, which affected the sales rise in the first quarter of 2021. The global electric car sales increased by around 140% compared to the same period in 2020. Two regions affected the sales: China, where around 500,000 vehicles were sold and Europe where around 450,000 vehicles were sold. The U.S. achieved doubled sales compared to the first quarter of 2020, albeit from a much lower base [3].

Battery electric vehicles are set to be the dominant type of transport by 2050, accounting for 56% of all vehicles set to be sold that year [4]. This development of sales could increase the number of electric vehicles to 950 million by the middle of the century. This also creates a great opportunity for Indonesia, which possesses immense resources of nickel used to produce batteries for electric cars.

In today's globalized and crisis market realities, it is very difficult for state authorities to build competitive advantages. Based on the concept of M.E. Porter, generating competitiveness does not take place at the macroeconomic, but at the mezzo economic level. This is why governments must focus not on the economy as a whole, but on specific industries, while bearing in mind that some activities of the value chain are performed outside of the country [5]. Moreover, competitiveness can be gained by improvements, innovations, new technologies and production methods. Sometimes this can be achieved with FDI. FDI stimulates economic growth, generates capital, creates jobs, and encourages product and process innovation, transfers of knowledge and new technologies as well as good management practices [6–10].

Indonesia is a member of the G-20, the largest economy in Southeast Asia, the world's fourth most populous nation, and the world's 10th largest economy in terms of purchasing power parity [11]. Indonesia is a market economy in which the government plays a significant role, giving priority to infrastructure development with the help of foreign and private investment. Tambunan [12] lists Indonesia's economic advantages, which have increased the attractiveness of foreign investment: vast and diversified natural resources (including nickel), the huge potential of the domestic market thanks to a large population, competitive labor costs, and a constantly increasing level of openness because of recent policy liberalization towards a market-based economy, including privatizations and open access to almost all sectors. The McKinsey Global Institute [13] underlines the three main challenges for Indonesia: labor productivity, the uneven economic growth distribution, and the infrastructure bottlenecks. The Santander Trade Markets also adds to this list: resilient economic growth, low government debt and prudent fiscal management.

Indonesia has the largest car market and is the second-largest car manufacturer among the ASEAN countries; the country exploits its own resources of raw materials for this purpose. In August 2019, the Indonesian President signed a decree to support the electric vehicle industry [14]. The strategy included plans to start the production of EVs in 2022, aiming for EVs to reach a 20 percent share of total car production by 2025 [15]. The competitive advantage of Indonesia in the development of the regional EV battery chain is due to the richness of key mineral resources, such as nickel ore and crude oil. In January 2020, the government introduced a ban on exports of unprocessed nickel ore. The aim was to improve the value-added opportunities for nickel products and to support the local industry [16]. The richness of mineral deposits is not the only reason for the country's intention to build its growing position in the EV supply chain; its geographical position is also significant, with direct sea shipping routes to Japan and China. These two countries are leaders in the development of new technologies, including the production of power cells for different products. Large Chinese companies are investing in the Indonesian mineral industry to obtain the supplies needed for battery production. This gives Indonesia an opportunity to build a significant competitive advantage in this sector.

The key purposes of the review paper are threefold: firstly, to identify the infrastructure for the production of electric cars (market size, resources) in ASEAN countries, including Indonesia; secondly, to identify the importance of FDI for Indonesia and the essence of relations with China, and thirdly, to investigate whether Indonesia is able to build its competitive advantage as a regional EV battery chain hub.

The definition of these key purposes led to the formulation of three research questions, which were developed following a study of the literature. They are as follows:

RQ1: Is Indonesia able to build its competitive advantage based on FDI in the EV battery sector?

RQ2: Will Indonesia become a regional EV battery hub?

RQ3: Is it possible for Indonesia to produce nickel 1?

The article uses the method of analysis of secondary research and criticism of the literature, as well as the observational method. The method of analysis and logical construction was also used, which allowed the division of the research challenge into smaller factors. The collected data were interpreted as phenomena affecting the elements and processes of a given system.

The paper is structured as follows: Section 2 provides an overview of the literature on the concept of the Diamond Model by M.E. Porter, and the criticism of this model, in terms of omitting FDI to build a competitive advantage for the country and the sector, was discussed. Section 3 describes the production and sale of cars in Indonesia and describes Indonesia as a key market for foreign investment. In Section 4, the results and discussion are presented. The paper ends with conclusions, limitations and suggestions for further research.

2. Literature Review

2.1. *Diamond Model of Michael E. Porter—Concept and Critique*

This is a concept and critique of M.E. Porter's Diamond model. Michael E. Porter, a leading authority on the competitive strategy of nations, elaborated a conceptual model called the Diamond model in 1990. According to Porter, generating competitiveness does not take place at the macroeconomic, but at the mezzo economic level. He believes that in order to build a nation's competitiveness, one should focus on factors determining the competitiveness of industries [5]. It should be emphasized that one country cannot achieve a competitive advantage in all areas, but only in selected industries. In the Diamond model, four basic groups of factors are distinguished: factor conditions, demand conditions, related and supporting industries and firm strategy, structure and rivalry [17]. Porter describes that factor determinants are related to the availability, quality, and effectiveness of the use and innovations of production factors, such as: infrastructure, human, physical, knowledge and capital resources. Home demand conditions are characterized by three significant elements: the nature of buyer needs, size and pattern of growth demand and internationalization of domestic demand. The related and supporting industries provide close relationships between home-based and world-class suppliers. "The fourth broad determinant of national competitive advantage in an industry is the context in which firms are created, organized and managed as well as the nature of domestic rivalry" [17]. Apart from the four basic factors of competitiveness, M.E. Porter also mentions two more factors: the government, whose policy affects the four attributes of competitiveness indicated above, and chance, i.e., positive or negative events (e.g., acts of pure invention, major technological discontinuities and wars), which also significantly change the operating conditions for industries. All the indicated elements interact with each other, creating a specific system.

This model is widely accepted and used by researchers to describe the competitive advantages of various industries and countries. Nevertheless, this model was also criticized by the researchers. Dong-Sung et al. [18] even stated clearly that "when analyzing the competitiveness of countries with various attributes, different countries require different criteria". A.M. Rugman [19] underlined that M.E. Porter focused only on the national level and did not take into account the international activity of countries and enterprises. Rugman and D'cruz [20] stated that M.E. Porter underestimated the importance of international entities in the worldwide economy. J.H. Dunning responded in a similar way and emphasized that the model did not include international aspects such as globalization, the increasing role of multi- (or trans-) national enterprises and foreign direct investments [6,21,22]. However, Rugman and Hoon Oh [23] pointed out that "international competitiveness does not necessarily mean globalization or global competition. It should rather consider the reality of regional competition".

Based on M.E. Porter's single Diamond model, scholars provided some extensions, modifications and corrections [24]. International activity was incorporated into the model as a key element by Rugman, and D'cruz [20], Moon et al. [25] and Jin and Moon [26].

J. Dunning [6] proposed another concept, which enriched Porter's Diamond model with three new elements: foreign direct investment, government policy and pro-competitive activity. Cho and Moon [27] elaborated on the so-called Nine-Factor model of competitiveness, which explained the dynamic role of the human factors. They posed a question: how can a country build its international competitiveness if it does not have any of the groups of factors mentioned by M.E. Porter? They concluded that skilled and unskilled human factors (workers, politicians, bureaucrats, entrepreneurs and professionals) are able to use physical factors to build international competitiveness. They also noticed that the role of individual groups grows along with the economic development of the country. Finally, Dong-Sung et al. [18] proposed a "dual double diamond" model covering the four elements of national competitiveness: physical and human factors both in national and international contexts.

2.2. Foreign Direct Investment from the Macroeconomic Perspective

Among the many theoretical approaches of foreign direct investment (FDI) there are two that present the concept from the macroeconomic perspective. These approaches were devised by Japanese researchers, K. Kojima and T. Ozawa, as well as J.M. Dunning.

The model created by Kojima and Ozawa [28] attempted to explain both international trade and foreign direct investment. The goal of T. Ozawa's model was to describe FDI within a comparative advantage, particularly by taking into account the factor equipment of the home and host countries [7]. Based on the example of Japan, Ozawa noted that the prospect of industrial expansion was limited in a situation where there was a shortage of land as well as natural resources (especially energy and minerals). Therefore, Japanese companies, having limited access to domestic resources, were forced to extend their subsidiaries abroad through direct investments [29,30]. On this basis, Ozawa concluded that foreign investment could increase the efficiency of a country with a lower level of development in the production of labor-intensive goods.

Later in the article, Ozawa [31] described that many developing countries, especially the emerging, newly industrialized Asian countries, such as Indonesia, Malaysia and Thailand successfully developed their economies by opening policies outwardly. He presented the relationship between FDI and the intensity of trade, as well as changes in the economic structure and development of the country (using a "black box" model) consisting of five stages: (1) outward orientation, (2) comparative-advantage-augmenting FDI (inward and outward), (3) the magnified power of trade, (4) natural progress of structuring and (5) super-growth [31].

J.M. Dunning created the eclectic theory of FDI in 1976. This theory allows for the comprehensive recognition and assessment of the importance of factors influencing the development of foreign production of manufacturers in the initial and later period [32]. Dunning incorporated elements from three previous, separate but related components called O-L-I: ownership advantages, location advantages, and internalization advantages. The ownership advantages (O) regard tangible assets (natural resources, low cost of labor) and intangible assets (patent or trademark, technology, management skills, organizational systems). The location advantage (L) is mainly due to differences in factors between the home and the host countries. The advantage of internalization (I) relates to the company's ability to produce and trade goods using the existing network of subsidiaries. Investments abroad are made due to the greater attractiveness of the foreign market than the domestic market.

Borensztein, De Gregorio and Lee stated that technology diffusion, i.e., the degree of the spread and implementation of new technologies, plays a key role in the process of the country's economic development. This is carried out due to the imports of high technology products, and the acquisition of foreign technologies and well-educated human capital. The results suggest that the transfer of technology within FDI is more productive than domestic investment, especially when the host country has adequate human capital [33].

Taking into account the specifics of this article, it is worth emphasizing that governments may limit the possibilities of investment expansion by pursuing a protectionist trade policy. The strong argument here is that FDI may create additional competition that destroys local industries. However, it can also offer a set of incentives for foreign investors to stimulate the inflow of FDI to develop certain sectors that are considered strategic from an industrial policy perspective. Foreign investors are encouraged to invest in another country, especially when the host country has lower costs and higher production efficiency.

In summary, it can be said that FDI stimulates economic growth, generates capital and create jobs. It encourages product and process innovation transfers, knowledge and new technologies, as well as good management practices [8,9]. Markusen and Venables [34] showed that, from some case studies of Southeast Asian economies, FDI can act as a catalyst and lead to the development of local industry. As a result, this local industry may become so strong that it reduces the position of multinational corporations in the market. Arnold and Javorcik [10] discovered that foreign acquisitions of Indonesian plants resulted in increased productivity. This was the result of restructuring, as the acquired plants increased investment outlays, employment and wages. The intensity of exports and imports in these enterprises also increased.

3. Competitiveness of Indonesia in the Automotive Industry

3.1. Production and Sales of Cars in Indonesia

Asia-Pacific is one of the regions that has made further developments in vehicle electrification. Two key markets of the ASEAN region, Indonesia and Thailand, take the lead in this regard.

Indonesia is the largest economy in the ASEAN countries and in Southeast Asia. Indonesia has a large population (275 million inhabitants in 2020) and a growing middle class. Both factors have a powerful consumer influence.

Indonesia's automotive industry is located in West Java (Bekasi, Karawang, Purwakarta), near Jakarta, the capital of the country. The area of West Java has the highest car demand and a relatively well-developed infrastructure. Therefore, it has become the production base of Indonesia's automotive sector.

Indonesia is the biggest car market and one of the biggest car producers in Southeast Asia. However, in 2017 the installed car production capacity was utilized at only 55 percent. The yearly production capacity is estimated at 2.2 million units per year.

The country was a large car manufacturer (just behind Thailand) in the ASEAN region in 2020, but also behind China, Japan and South Korea (see Table 1). This year production has fallen due to the turbulence of the COVID-19 pandemic and government lockdowns.

Table 1. Production of passenger cars in 2016–2020 in selected Asian countries.

Country	2016	2017	2018	2019	2020
China	23,554,031	23,638,856	22,726,556	20,675,568	19,344,024
Japan	8,212,033	8,218,436	8,214,183	8,252,646	6,933,486
South Korea	3,783,030	3,782,703	3,692,685	3,629,252	3,254,147
Thailand	1,944,417	1,988,823	2,167,694	2,013,710	1,427,074
Indonesia	1,177,389	1,216,615	1,343,714	1,286,848	690,150

Source: [35–39].

The spread of coronavirus heavily impacted the global demand for passenger cars in 2020. [35]. Among the ASEAN countries, Indonesia's sales plunged by 48 percent y/y (the highest decrease in the region) but the country maintained second position behind Thailand (excluding China and Japan; see Table 2). In China, car sales reached 19.7 million in 2020 increasing China's share of global sales to 31.1%. In 2020, Japan's car sales decreased by more than 11%, compared to South Korea's sales which saw an increase of 9.0% [35].

Table 2. New passenger car registrations in 2016–2020 in selected Asian countries.

Country	2016	2017	2018	2019	2020
China	24,040,133	24,016,153	23,219,840	21,163,413	19,743,117
Japan	4,386,472	4,378,933	4,375,813	4,295,672	3,814,090
South Korea	1,479,066	1,517,322	1,519,321	1,489,156	1,623,657
Thailand	768,788	871,650	1,041,739	1,007,552	792,146
Indonesia	1,061,735	1,079,534	1,151,291	1,030,126	532,027

Source: [35–39].

3.2. Indonesia as a Key Market for Foreign Investment

Investments in manufacturing, financial services and mining accounted for the largest proportion of total FDI investments in Indonesia in 2019. These investments reached USD 23.4 billion and accounted for about 65 percent of inflows in 2019. The main investors were from Japan and Singapore with over a 61 percent share of FDI inflows in 2019 (see Table 3).

Table 3. FDI in Indonesia in 2014–2019 (Millions of dollars).

	2014	2015	2016	2017	2018	2019
FDI inflows	21,811	16,664	3921	20,579	20,563	23,429
FDI inflows growth (in %, year before = 100%)	-	−24%	−124%	425%	0%	14%
FDI outflows	7077	5937	−12,215	2077	8053	3380
FDI outflows growth (in %, year before = 100%)	-	−16%	−306%	117%	288%	−58%

Source: [40].

Indonesia began to create friendly investment conditions. It lowered the minimum equity requirement for foreign investors. The policy of liberalisation enabled Indonesia to rank 17th among the top 20 host economies. In 2019, Japan was the largest investor with a 34.8% share of total investments, followed by Singapore, the UK, Thailand and the USA (see Table 4).

Table 4. Main investing countries and sectors in Indonesia in 2019.

Main Investing Countries	2019, in %	Main Investing Sectors	2019, in %
Japan	34.8	Manufacturing	42.9
Singapore	27.0	Financial intermediation	13.8
United Kingdom	6.8	Wholesale and retail trade	12.6
Thailand	5.1	Mining and quarrying	7.6
USA	4.0	Electricity, gas and water supply	7.3
South Korea	4.0	Real estate	5.9
China	3.8	Construction	4.7
Canada	3.7		

Source: [41].

This policy, adopted by the Indonesian government in 2019, removed a potential investment risk for foreign companies. The country was able to improve the overall market perception by consolidating political and economic stability and introducing structural reforms. As a general rule, foreigners can only invest through setting up a limited liability company (Perseroan Terbatas or PT) as a joint venture or a company up to 100% owned by a foreign investor.

Indonesia is one of the main investment targets for Chinese, Japanese and Korean automakers, which are becoming the key growth drivers of production in the ASEAN region, following the example of some leading Japanese OEMs, which have operational plants in the region. Chinese OEMs are entering the ASEAN market and boosting investments. They intend to use their new ASEAN locations as export hubs. In addition, the Korean automaker, Hyundai, is building a factory in Indonesia to begin operations in 2021. This will produce vehicles not only for the ASEAN market but also for the Middle East [42].

China is one of Indonesia's main export markets. Its market is the biggest in the world for motor vehicles, representing one-third of the total worldwide sales in 2020. However, due to the coronavirus pandemic in 2020 car sales fell by 1.9 percent to 25.3 million,

compared to 2019. A total of 1.9 million EVs are predicted to be sold in China in 2021. [43]. In 2030 China and Europe combined will represent 72 percent of all passenger EV sales. In Europe the sales are driven by strong vehicle CO₂ regulations and in China by the encouraging EV credit system. All automakers will push the EV sales onto the markets with stringent regulations in the next 10 years. The U.S. is currently behind both leading markets, but is likely to catch up with both of them by 2030 [44].

Vehicle manufacturers and policy makers in all regions are boosting their attention and the actions related to EVs, which are attractive options to help reach environmental objectives. As a result, by 2040 about 31% of the world's passenger cars will be electric [44]. The growing number of EV vehicles translates to a higher demand for EV batteries. It also means a change in the material demand result of replacing ICE by EVs [45–47].

4. Results and Discussion

4.1. *The Key Role of Batteries in the Supply Chain (Trade Relations in EV between China vs. Indonesia)*

With the increasing demand for lithium-ion batteries from the EV industry, the technology has advanced significantly in terms of the energy density, cost, charge and discharge cycle. Research is currently underway to improve the efficiency of three components: the cathode, anode and electrolyte, and to reduce the cost of the materials used. The goal of battery manufacturers is to lower the overall cost of the battery pack. Due to the quick implementation of this technology, battery prices reduced to 85% compared to the 2010 level and can now achieve between 130 USD/kWh [48] and 176 USD/kWh [49].

Presently available battery technologies for the EV are lead–acid, nickel-based, and lithium-ion. A mix of cobalt, nickel and manganese oxides, together with the lithium as a cathode, dominate the electric vehicle battery production nowadays [50]. The cobalt content of battery materials is less planned for the future batteries of electric vehicles [51]. Some EV manufactures are intending to remove cobalt. Some EV manufactures are intending to remove cobalt. In NMC and NCA batteries cobalt content is reduced whilst the nickel content is increased (because of a better energy density). CATL's cathode NMC 811 (80% nickel, 10% manganese, 10% cobalt) could even be replaced by SK Innovation's NMC 955 [52]. In 2028, the global battery cathode capacity is estimated to reach 1.24 TWh compared with 127 GWh in 2020 [52].

For many years, China has pursued a strict policy of tightening political and economic cooperation with countries that have deposits of strategic raw materials for their industry. The advantage of China's long-term policy of securing access to raw materials through capital investments or long-term contracts is the gaining of a dominant position, in relation to other countries and regions of the world, in the subsequent stages of the battery supply chain. A CATL example of such a strategy is China's position in the processing and chemical processing of raw materials, where the country's share was 48% in 2019. At this stage in the supply chain, Europe's share was 7% in the same year. China also holds a dominant position in the sole production of lithium-ion cells, where their share amounted to 66% in 2019. The share of South Korea and the USA in this segment was 13% each. The share of other countries was only 6–7%, which left little scope for the diversification of supplies for European producers. China is also one of the most important suppliers of cathode and anode materials, holding a dominant position in the production of battery cell components, along with Japan and South Korea. Together, these three countries account for a combined 86% share of both segments in the production of cell components. Europe's share in this segment is below 1% [53,54].

In 2020 EV lithium-ion battery production accelerated, reaching 160 gigawatt-hours, up 33% from 2019. China dominates and accounts for over 70% of the global battery cell production capacity [3]. Battery megafactories are large producers of lithium-ion battery cells, and China has taken the lead to build and enlarge battery capacity [55]. It is projected that, by 2029, out of the 115 lithium-ion battery megafactories worldwide, 88 will be active in China [56].

In 2020, China accounted for the largest share of battery demand at almost 80 gigawatt-hours, while for Europe this figure was 52 gigawatt-hours, and for the U.S. it was 19 gigawatt-hours [3].

4.2. The Increasing Role of Nickel

The overall demand for batteries (90 percent) will come from EVs over the next decade, and the remaining 10 percent mainly from grid storage. The batteries will need vast amounts of key battery materials such as lithium, cobalt and nickel. The growth in demand translates to approximately 985,000 tonnes of nickel and 259,000 tonnes of cobalt in 2030, compared to 66,000 tonnes and 17,000 tonnes in 2017, respectively (based on an estimated global average battery pack size of 53 kWh) [57]. This means that the demand for both minerals will rise by 55% and 332% of the global supply, respectively in 2030. In particular, in the year 2020, a total of 80,700 tonnes of nickel and 83,500 tonnes of lithium carbonate equivalent were consumed in batteries globally, an increase of 32 percent and 39 percent YOY, respectively [58]. The demand for nickel is set to have an annual average growth rate of 29% from 2021–2030, exceeding lithium [59].

To meet this challenge, Indonesia intends to use its vast raw material resources to develop the EV hub in the region. The country is richly supplied with the mineral resources that the EV industry needs. Indonesia produced an estimated 760,000 tonnes of nickel in 2020 (11% less compared to 2019), with another 21 million tons in reserves [60]. This means that the country accounts for around 30% of the world's nickel production and about 22% of global reserves. However, not all types of nickel can be used as a material for EV batteries. Therefore, Indonesia should not only mine more raw materials but also focus on more advanced, environmentally friendly mining technology.

Nickel deposits come in two forms: sulfide and oxide (or laterite). Identified land-based resources (with 0.5% nickel or greater) contain at least 300 million tons of nickel, of which 60% are in laterites and 40% in sulfide deposits [50]. Nickel sulfide deposits are formed from the precipitation of nickel minerals by hydrothermal fluids [61]. Nickel laterite deposits are formed from the intense chemical and mechanical weathering of ultramafic parent rocks [60] and are usually operated as open pit mines. Laterite deposits require larger capital costs to be viable compared with sulfide operations [61]. Historically, most nickel was produced from sulfide ores, including deposits in Canada, Russia and South Africa. However, these deposits are becoming depleted and now the nickel miners must focus on the lower-quality nickel laterites, such as those found in the Philippines, Indonesia and New Caledonia [61].

Stainless steel producers use both high-purity Class 1 products in pure nickel metal form, and lower-purity Class 2 products such as nickel alloys and chemicals in various forms.

Only 5 percent of the market is driven by the battery industry [48]. Whether the nickel is Class 1 or Class 2 is very critical for the EV battery industry. The main concern is the quality of the nickel. Theoretically, all Class 1 nickel can be used to produce nickel sulfate. This type of nickel is typically used in the form of powder or briquettes [62]; at best, only 46 percent can be used in batteries [48].

Class 2 nickel could also be used to make nickel sulfate, but the manufacturing costs of this purity are potentially too high. Some EV manufactures are intending to remove cobalt. In NMC and NCA batteries cobalt content is reduced whilst the nickel content is increased (because of a better energy density). Today, nickel sulfate production depends on Class 1 nickel.

According to BloombergNEF, the supplies of Class 1 nickel could run short as early as 2023 as lithium-ion battery demand increases [63]. One of the solutions is to mine laterites and convert them into nickel sulfate, and Indonesia intends to take advantage of this opportunity.

The Indonesian government's intention is to turn the country into a global production base for car manufacturing and it aims to become the largest electric vehicle production

hub in Southwest Asia. The main target, in the long term, is to establish an independent car manufacturing plant with all components locally manufactured. This should have a positive influence on the number of employed workers in the future. Starting as early as 2013, the Indonesian government approved a tax exemption for the production of low-cost, low-emission cars. These vehicles must contain 84 percent locally made components to qualify for a tax exemption [64].

4.3. Indonesian Government's Policy towards Nickel

In August 2019, the Indonesian President signed a decree to support the electric vehicle (EV) industry [14]. The strategy included plans to start the production of EVs in 2022, and aimed for EVs to reach a 20 percent share of total car production by 2025. The import of complete cars would be allowed for three years under a quota system before the companies are prepared to produce greener cars. However, in 2023, 35 percent of EV vehicles should be manufactured from local components [15].

As the push for global transport electrification intensifies, Indonesia is seeking to promote EV development and the construction of battery production facilities, encouraging domestic and foreign producers not only to invest in plants that produce batteries, but also in plants that produce battery chemicals extracted from nickel ore.

Indonesia has a long experience with the mining and production of nickel. Earlier, during the time of the Dutch East Indies, there were small-scale mines. Nickel production expanded rapidly during the 1960s as the Indonesian government became involved in the production and export of the metal [65].

The government banned exports of unprocessed nickel ore in January 2020, two years earlier than expected [16]. Its intention was to improve value-added opportunities for nickel products and to strengthen the local industry. This ban was the second after the previous ban of 2014 did not attract foreign companies to invest.

The immense deposits of nickel are not only the reason for the country's growing dominance in the EV supply chain. Indonesia is located on the edge of the Pacific, which gives the country direct nautical transport routes to Japan and China; both of these countries are major players in the battery supply chain. On top of that, China has become a leader in the production of cathodes and anodes. Japan and China require minerals for their production which Indonesia can easily deliver. Therefore, major Chinese companies are investing in the Indonesian mineral industry. The ore export ban, introduced by the government in January 2020, caused an increase in Class 2 nickel production (nickel pig iron (NPI) and ferronickel (FeNi)). It represented a large nickel feedstock for stainless steel industries in Indonesia and China. The investments via brownfield expansions and greenfield projects created additional NPI capacity. The estimated production of NPI grew by 53% YOY in 2020 [66]. The Indonesian sector has lower production costs than smaller NPI producers in China. For the companies operating in Indonesia there is a double opportunity in the EV market; they have the chance to become involved in the creation of an integrated EV domestic market, and to begin exporting to China. However, the key to success is to transform Class 2 laterite deposits into battery-grade nickel.

Chinese steel and battery companies (China's Contemporary Amperex Technology Co. Ltd.—CATL, Ningbo Lygend Mining Co., Tsingshan Holding Group and Delong Holdings operating in Indonesia, made a commitment to increase their collective investment from the currently invested USD 16 billion to around USD 20.9 billion by 2024, and to around USD 35 billion by 2033 [67]. The Indonesian government also signed a memorandum of understanding with South Korea's LG Energy Solution to set up a global production hub for lithium-ion batteries [68]. The EV battery plant will be part of a broader integrated investment plan costing USD 9.8 billion, which includes a new nickel mine, smelter and refining operations. LG will lead the consortium [69]. The plant will mainly supply lithium-ion batteries for EVs made by the Hyundai Motor Group.

The other global suppliers of EV battery materials are interested in setting up nickel-processing facilities in the country. For example, Germany-based BASF and French nickel

processor Eramet are considering building a nickel- and cobalt-refining complex, which will begin operation in the mid-2020s. The facilities would supply an annual 42,000 tonnes of nickel and 5000 tonnes of cobalt, for use in cathode materials. These new projects would add an additional capacity to the other three nickel-refining plants under construction, which will begin operations by 2023 [16].

The Indonesian government not only encourages foreign companies to invest but sets up state-owned companies to be part of the battery supply chain. The four state-owned companies created the Indonesian Battery Corporation, settled on a partnership with CATL for a total investment of USD 5 billion, as well as LG Chem, for a total investment of between USD 13–17 billion [70].

The majority of interest and investment comes from China, whose significance in the global battery market is hard to overstate. China's strategy is to secure future raw material supplies.

5. Conclusions

Indonesia is the world's largest producer of nickel ore, which, after a special processed treatment, is a key ingredient in the ion-lithium battery. The most pressing issue is the ability to manufacture Class 1 nickel, which is dedicated to ion-lithium battery production (RQ3). On top of that, special innovated technology must be implemented to avoid environmental concerns. The carbon footprint of the technology required to complete the processing route could potentially be a large problem for an exploration into green EVs. Today, electric car production generates more emissions than the production of internal combustion engines. In this context, the important issue is shifting towards green raw materials by using low-carbon manufacturing technology. These two factors will be a key part of the future of decarbonizing supply chain and should be especially considered by the Indonesian authorities.

Indonesia seems to have a solid basis within the current automotive industry, which could create the conditions to develop a complete EV supply chain (RQ2). However, the two aforementioned factors, are just two assets. Indonesia is one of the key automotive markets in the region of Southeast Asia, but it is still in the early stage of developing its EV sector. The Indonesian government should ensure a more sizeable investment into lithium-ion battery production in order to develop a complete downstream supply chain, including the synthesis of the remaining high-quality battery materials. The Indonesian Battery Corporation, which is focused on this objective, may not be enough to turn Indonesia into a global player, rather than merely a regional one within the ASEAN region and China. Indonesia cannot become a global player without inviting the big players from the EV battery industry (e.g., China, Japan or South Korea) into their domestic investments. This should be carried out in the global context of the international supply chain. Moreover, the development of the EV industry can increase the employment rate in the industry, with the employment level in the internal combustion powertrain industry remaining unaffected.

In the context of the EV market, FDI plays a very important role (RQ1). Thanks to FDI, it is possible to inflow resources and technologies that are not available in the country. This is very important for Indonesia, which has limited resources. Thanks to FDI, Indonesia can raise the necessary funds to become a key hub for EV batteries. It is important that FDI (mainly from China) is based on partnership. In this case, the Indonesian government must play a large role, which should ensure a proper level of mutual relations.

By building its competitive advantage in the EV battery market, Indonesia cannot allow China to dominate in both relations (RQ2). In the long run, this may reduce the role of Indonesia to that of a supplier of EV components to China. Therefore, only mutually beneficial relations are an opportunity for Indonesia to partner with China. Achieving this level of diplomacy requires the Indonesian economy to be more open to other countries in the long term.

The openness to cooperate with other countries will lead to multilateral benefits. It will result in an inflow of capital in the form of FDI from various countries worldwide.

Three important points should also be kept in mind in this context:

1. The environment: in the context of nickel mining, this is an important issue that cannot be ignored, especially in the coming years.
2. Hydrogen as a fuel for cars: in terms of the possible popularization of this fuel, this may significantly affect the extraction of nickel.
3. Indonesia must invest in high-tech renewable energy in order to become the one of major global producers in the supply chain of ion-lithium batteries. Moreover, the Indonesian government's policy in boosting the EV industry should also benefit from a growing ion-lithium battery demand, of which nickel-containing batteries currently dominate the market. This demand could create a market deficit of nickel in the coming years and increase prices. This scenario appears to be serious considering the shortage of the semi-conductors currently facing the automotive industry.

The authors are aware of the limitations resulting from this article, which include a number of indicated elements, such as the level of openness of the Indonesian economy on an international level, environmental protection, domestic resources or alternative fuel for cars (hydrogen). The development of these elements may be the subject for further research that will contribute to a more precise description of the car market in the coming years.

Author Contributions: Conceptualization, T.K., J.B. and T.C.; methodology, T.K.; software, T.C.; validation, T.K., J.B. and T.C.; formal analysis, J.B. and T.K.; investigation, T.K. and J.B.; resources, T.K. and J.B.; data curation, T.K.; writing—original draft preparation, T.K. and J.B.; writing—review and editing, T.K., J.B. and T.C.; visualization, T.K.; supervision, J.B.; project administration, T.C.; funding acquisition, T.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the University of Gdansk.

Conflicts of Interest: The authors declare no conflict of interest.

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