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Impact Of Global Semiconductor Shortage on The Domestic New Energy Vehicle Supply Chain in Australia And Measures to Mitigate Such Risks in The Future

Binghui Li *

Asia Pacific School of Logistics, INHA University, Inchon, 21900, Korea

* Corresponding Author Email: 200114@yzpc.edu.cn

Abstract. Different industries have been affected by the shortage of semiconductors globally, and one of the most affected industries is the New Energy Vehicle (NEV) industry within Australia. Semiconductors play a massive role in NEV features like battery management and power management. These factors include the COVID-19 pandemic, the rise in electronics demand, natural calamities, and most importantly the shortage which has affected NEV production and sales in Australia. This paper discusses the consequences of the lack of supply of such components on the Australian NEV supply chain: They stop production, low inventory levels, financial losses, and slowed innovation. It brings out vulnerability issues including dependence on limited suppliers from Asia and the absence of chip-making factories within North America. Based on the identified threats, the paper outlines the following solutions: supplier diversification, increasing inventory levels, raising supply chain visibility, investing in domestic semiconductor production, incentives for buyers, and sourcing non-semiconductor material technologies. Such measures are strategic and intended to secure an NEV supply chain in Australia that is both sustainable and environmentally friendly.

Keywords: Semiconductor shortage; New energy vehicles (NEVs); Supply chain resilience; Mitigation strategies.

1. Introduction

The automotive industry is transitioning into a new era of New Energy vehicles (NEVs) due to accelerated pressure to make the environment cleaner. NEVs, including electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs), are one key player in this shift. Cores to the working and performance of such cars are semiconductors necessary for systems like battery management, power control, and self-driving [1]. Increased dependence on semiconductors is evident to show that it is a crucial component in the manufacturing and development of NEVs. Hence, the recent global semiconductor shortage is a major setback in the industry. The shortage of semiconductors, which was first reported in the early part of 2020, has affected different industries [2]. Several circumstances contributed to the shortage, such as the COVID-19 pandemic, which impacted the physical manufacturing and distribution of chips, an increased use of electronics during the pandemic, and natural disasters that struck the manufacturing plants. Taiwan, South Korea and the USA are some of the main semiconductor manufacturing hubs, with Taiwan Semiconductor Manufacturing Company of Taiwanese and Samsung Electronics of South Korea being leading firms [3, 4]. This geographic distribution has compounded supply chain risks, greatly affecting production and resource availability.

While the current Australian NEV market is relatively smaller than markets like China, Europe, or the USA, further growth is observed. Australia's shift towards NEVs is stimulated by incentives applied by the authorities, growing public awareness, and the general trends toward the use of environmentally friendly vehicles [5].

As discussed in the subsequent sections of this study, the research shall explore the semiconductor shortage and its direct impact on NEV production and sales in Australia and include real-life examples of some of the manufacturers and importers who have been impacted. Then, it will consider the long-term impacts on innovation and financial stability, effects on competition, and the environment. The analytical work will also continue to address the structural weaknesses of the NEV supply chain that

the shortage across Australia's industry has exposed. Last, the work will put forward short-term and long-term recommendations, including using different suppliers, developing indigenous industries, using policies, and addressing the issue at the global level. This will help the study to provide a more strategic and effective NEV supply chain solution in Australia today to accomplish the country's vision of achieving a sustainable, green future.

2. Australian NEV Impact

2.1. Immediate Effects

2.1.1. Production Halts and Delays

The recent shortage of semiconductors in the global market has resulted in massive stoppages and slowdowns for NEV manufacturers in Australia. Automotive semiconductors play a central role in vehicle functionality elements such as power rails, connectivity, comfort, and safety. The availability of these chips remains very low, making manufacturers either slow down their production line or completely halt production for some time [6]. Some manufacturers like Tesla, which assembles cars in Australia, have been affected by disruptions in manufacturing processes because of the lack of semiconductors. Through this disruption, the delivery of vehicles to the final consumers is congested, extending the global impact to manufacturers' set production goals, which affects the total supply chain.

Resource Dependence Theory (RDT) posits that organizations depend on external resources, which can create vulnerabilities and influence their strategic behavior [7, 8]. The theory suggests that Australian firms should seek to reduce dependence by diversifying suppliers, developing alternative resources, and fostering local production capabilities to mitigate risks associated with external dependencies [2].

For instance, the theory can be vital for Hyundai Australia, which has experienced some disruptions in the production of the Kona Electric and the Ioniq auto models [9, 10]. They have mentioned the difficulty that the firm has faced in sourcing sufficient quantities of semiconductors due to constrained supply in the market; this has led to a decline in the shipment of the firm's products to Australia and delayed orders to their customers [11, 12].

2.1.2. Reduced Inventory and Sales

Due to such production disruptions, NEV manufacturers and dealerships have seen their vehicle stock decrease. Since many cars have not been produced and are in circulation, they point to the fact that sales numbers have significantly reduced. For instance, several NEV dealers in Australia point out that they have recently sold far fewer models like the Hyundai Kona Electric and Nissan Leaf [13, 14]. This has made NEVs scarce and resulted in long waiting lists that force customers to settle for traditional ICE vehicles, dampening the future prospects of NEVs in the Australian market. This idea is supported by the fact that there is a world shortage of semiconductors, which implies that manufacturers cannot find similar products from other companies [15].

For example, Tesla Australia has been among the firms that are the worst affected by the scarcity of semiconductors; the electric car maker needs superior chips for the self-driving profile and battery control, among others. This problem has forced the company to shut down some crucial functions in its vehicles, some of which have to be temporarily halted, and it has also had to change the supply chain system to be able to deal with it.

2.2. Long-term Effects

2.2.1. Impact on Innovation and Development

The challenge of chips has greatly impacted the Australian NEV market and innovation in general. Sustaining existing production volumes has become the major corporate strategy over research on

new models and technologies. This shift in focus has slowed advancements in crucial areas such as battery efficiency, autonomous driving, and vehicle connectivity. As a result, Australia's NEV industry risks losing its competitive edge in the global market due to reduced innovation and technological progress [16].

2.2.2. Manufacturers, Suppliers, and Dealerships Financial Implications

The effects of the semiconductor shortage on a company's financial health are quite considerable. The manufacturers' costs have risen due to the extraordinary transportation of the available semiconductors and the reorganization of the production schedules. Due to erratic and volatile customer demand and supply and demand uncertainty, suppliers have often failed to achieve high profitability. Dealerships, on the other hand, have recorded low revenues since there have been low sales levels, and one has to cope with customer demand and anger. These pressures could have long-term impacts on the balance of the NEV supply chain in terms of possible bankruptcies of some of the small players within the market.

The Theory of Constraints (TOC) also focuses on identifying and managing the production process that limits the overall output and financial implications [17]. The semiconductor shortage is a significant constraint in the NEV supply chain, hindering production and sales. According to TOC, addressing this constraint through measures like increasing buffer stocks, enhancing supply chain visibility, and investing in local semiconductor production can help reduce negative financial implications [18].

2.2.3. Effect on Market Competition and Consumer Choice

The scarcity of semiconductors also affected the competition and consumer preferences in the Australian markets. While the shortage has impacted some new energy vehicle manufacturers, well-established NEV companies with better supply chain networks have handled the situation better [19]. This has shifted the power to some dominant players, resulting in limited customer choices. Secondly, due to shortages of semiconductors, the prices of NEVs have increased, and many people cannot afford them, which has affected the adoption curve of sustainable vehicles.

2.3. Broader Implications

2.3.1. Job Losses and Economic Downturns

As the production and financials among NEV manufacturers and suppliers slow down and struggle to overcome, it has cost Australians their jobs and monetary crises. Employers have scaled down their shift operations or shutdowns, leaving many laid off and earning less than they used to [20]. An additional area of influence has to do with the economic effect that is not only limited to auto manufacturing but also reaches the communities dependent on such employment. The impact of such job losses is in terms of reduced consumption, overall demand, and economic shrinkage.

2.3.2. Delays in Transitioning to Sustainable Energy Solutions

The semiconductor shortage has also hindered Australia's progress toward shifting towards a sustainable energy source. The overall use of NEVs has slowed mainly due to the limited market and high cost of the vehicles. Consequently, greenhouse gas emissions and fossil fuel consumption, which could be reduced through electric automobiles, have been postponed. This delay has negative implications for Australia's ability to align with climate change goals and emission reductions stipulated in international treaties and, thus, its position on the international stage and environmental goals.

The delays in transitioning call for the Supply Chain Resilience Theory (SCRT), which emphasizes the capacity of a supply chain to anticipate, prepare for, respond to, and recover from disruptions [21]. The semiconductor shortage highlights the need for resilient supply chains that can withstand and quickly recover from such shocks. Strategies derived from SCRT include diversifying supply sources,

investing in redundancy and flexibility, and implementing robust risk management practices, reducing delays in transitioning to sustainable energy solutions [11].

3. Supply Chain Vulnerabilities

3.1. Australian NEV Supply Chain

3.1.1. Key Suppliers and Their Dependencies Producers

Scrutiny of the production structure of the Australian NEV market reveals that most of the key NEV supply chain players are heavily integrated into the global semiconductor manufacturers. The industry is currently led by players from Taiwan, mainly through TSMC, and South Korea through Samsung, which are required for NEV systems [21]. These overseas suppliers form the backbone of Australian NEV manufacturers and importers as they supply semiconductors for battery management systems, power electronics, and infotainment systems. This leads to a vulnerability because the global supply chain threatens domestic production capacity whenever a disruption occurs.

3.1.2. Structural Weaknesses and Bottlenecks Specific

Several structural ailments and breaks cause increased vulnerability of the Australian NEV supply chain. Firstly, Australia has limited domestic production capability in the semiconductor industry, and thus, it has to import many of its semiconductors. Such reliance on overseas providers exposes the supply chain or the industry, in this case, to global disruptions, like the shortage of semiconductors [1]. Furthermore, the issues of the geographical location of the company in Australia hinder the reliability of the supply chain, and the time it takes to order spare parts is long since the company imports most of them. Besides, Australia's relatively small market for NEVs compared to markets such as China, the USA, and Europe have limited bargaining power for Australian manufacturers and importers to obtain priority access to the scarce semiconductor supplies.

3.2. Specific Vulnerabilities

3.2.1. Single-Source Dependencies

Among the key risks arising from the current semiconductor debacle, the most notable is the lack of supply diversification. Many Australian NEV manufacturers currently depend on fewer semiconductor vendors to fulfill their requirements. Being a single-source reliance, any mishap at the supplier's end, be it natural calamities, political unrest, or production setbacks, would slow down and, at times, stop the whole supply chain completely. The recent scarcity has brought to light the vulnerabilities posed by these dependencies, calling for diverse supply-sourcing models [14].

3.2.2. Lack of Local Semiconductor Production

One such factor is the fact that Australia cannot produce its semiconductors. Thus, without any local manufacture, Australia is a hundred percent exposed to the international market for semiconductors. Such reliance exposes the supply chain to fluctuations in the international market, changes in trade policies, and even geopolitical instabilities that may disrupt the supply lines [1]. There is no local semiconductor industry; therefore, Australian NEV manufacturers and importers are vulnerable to fluctuations in the global supply and demand market, which results in shortages and cost increments.

3.2.3. Limited Stockpiling and Inventory Strategies

Another weakness is that NEV manufacturers and importers in Australia use very little stockpiling and inventory management strategies. Adopting just-in-time manufacturing, where work in progress is only ordered as it is consumed, has given organizations very little inventory to deal with the disruptions in the supply chain. The microchip shortage has also exposed the dangers of holding low inventory stocks due to disruptions that left corporations rationing for critical supplies. This has only made the shortage worse since companies cannot have a buffer inventory, which has resulted in delays in production and a reduction in sales [12].

4. Mitigation and Future Strategies

4.1. Short-term Mitigation Strategies

4.1.1. Diversification of Suppliers

The immediate thing that Australian NEV manufacturers and importers can do as a short-term strategy is to extend their sources of supply. The problem of being overly reliant on single or multiple suppliers from one geographic location can be managed by sourcing products from multiple suppliers from various geographic locations. Manufacturers should build partnerships with multiple suppliers in different countries to effectively manage the effects of certain country disruptions [3]. For instance, in addition to obtaining materials from established leaders like TSMC and Samsung, companies can source from new semiconductor manufacturers that may reside in Japan, India, or Vietnam. Another example of diversification is the procurement of semiconductors from different suppliers to have a less vulnerable supply chain.

4.1.2. Increased Inventory and Buffer Stocks

The NEV manufacturers should consider the practices of having high inventories and ensuring that they have buffer stocks of the vital parts. One of the benefits is stock accumulation acting as a safety net for manufacturers, which means they can continue producing when supply is a problem [15]. This strategy entails determining to invest in larger inventories that will enable the firm to have a safety stock for contingencies while at the same time considering the cost of holding stock in anticipation of future demand. It enables manufacturers to have inventory management practices that use information on demand rate and the status of the supply chain in determining appropriate inventory levels to replenish.

4.1.3. Enhanced Supply Chain Visibility and Management

Optimizing supply chain visibility and control are the most effective ways to deal with short-term risks and incidents. Manufacturers can get a better outlook on risks and challenges by being connected with real-time locational identification, supply chain predictive modeling, and artificial intelligence [7]. Increased visibility is a better form of preemptive action that prevents issues of concern by redirecting shipments or modifying affected production schedules. Supply chain visibility can be improved to a deeper level with efficient integration with key supply chain partners consisting of suppliers and logistics providers that support the supply chain and can help to make it more versatile and receptive to change in the supply chain.

4.2. Long-term Solutions and Recommendations

4.2.1. Investment in Domestic Semiconductor Manufacturing

Having a solid local semiconductor production capacity is necessary to fix the dependence problem in the long term. It means the investment in semiconductor fabrication plants (fabs) within the country will help to deliver vital parts for the NEV industry more dependably and without risks [16]. This initiative would involve an expensive process of setting up the required infrastructure, technology, and human capital resources through a partnership between the government and the business world. Using incentive packages to persuade internationally reputable semiconductor corporations to open manufacturing companies in Australia also helps.

4.2.2. Government Incentives and Support

Establishing a strong supply chain closely linked to the industry requires the government's support to ensure its sustainable growth, development and survival. An example is giving tax credits, subsidies, or grants for semiconductor manufacturing; this gives potential investors a reason to invest within the country. Also, increases in R&D funding for both the NEV and semiconductor industries can promote innovation and preparedness for future competition [19]. Other initiatives such as government scholarships, internships, mentorships, and other human capital development programs that support

capability development in semiconductor training can also assist with workforce qualification. It is common for the government to create a synergy with the respective industrial sectors to bring long-term growth and stability to the countries [10].

4.2.3. Development of Alternative Technologies

The identified investment opportunities also include the development of new alternative technologies and materials to avoid strong dependence on traditional semiconductors. Investment in new materials like silicon carbide (SiC) or gallium nitride (GaN), which provide higher efficiency, power density, or thermal efficiency compared to silicon-based technology, may help expand the technological specialization of the NEV industry [6]. Also, there is an opportunity to turn to the development of other power electronics and control systems that can be free from limitations associated with the lack of semiconductor materials. Such breakthrough technologies can only be fostered and developed with the help of collaborations between the industry and academic institutions.

4.2.4. Strengthening International Trade Relationships

Protecting and enhancing the multilateral trade system and its related arrangements is crucial for supply chain sustainability. Australia can also enter into bilateral and multilateral trade agreements to help it get the necessary semiconductors, components, and raw materials [5]. Membership and interaction in the global semiconductor associations and consortiums can facilitate technology networking and acquisition of knowledge, the latest technologies, and standard industry practices. Trade negotiations to de-escalate trade disputes and towards open markets could also promote stability of the supply chain for semiconductors, which would, in turn, benefit the Australian NEV industry.

5. Conclusion

Due to the global shortage of semiconductors, numerous NEV manufacturers in Australia have been compelled to pause their production, leading to inadequate inventory levels and financial stress on producers, suppliers, and dealers. This disruption has exposed various risks, including reliance on a single supplier, absence of local fabrication of semiconductors, and adequate preparedness for stockpiling. These impacts have constrained sales and postponed NEV adoptions as future outcomes that may distort innovation, competition, and environmental objectives in Australia.

To avoid these risks, it is crucial to implement more short-term supply chain risk management tactics, including supply base diversification, building up inventory stocks, and integrating supply chain visibility solutions. In the long run, the key steps are to support domestic production of semiconductors, government subsidies, alternative technology development, and, more importantly, international trade relationships. Thus, the above-outlined steps would assist in creating a healthier future for NEV industries in Australia in terms of a sustainable supply chain.

That is why organizations must work on using foresight and provide change interventions in the future. There is also a need for the industry and government to use synergy in organizing their aims and establishing policies and events intended to promote sustainable industries. Therefore, by applying these tactics, the Australian government can protect the local NEV industry from future disruptions, encourage the use of renewable energy sources, and strengthen Australia's position in the global market. Continuation of the improvement of the supply chain's robustness will be necessary in mitigating risks that may arise in the future and in optimizing opportunities for the NEV market.

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