Examining the Socioeconomic Ramifications of the Shift from Combustion Engine to Electric Vehicle Industry on Labor Well-being in Thailand: An In-Depth Economic Welfare Analysis

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Abstract

This research article constitutes a review-oriented investigation that specifically examines the implications of the transition from internal combustion engines to electric vehicles (EVs) in Thailand on the labor market and worker well-being. The study systematically analyzes existing literature and reports exploring the historical evolution of the combustion engine industry, the emergence of EVs, and their impact on labor through an economic welfare assessment. The researchers highlight the imperative for government intervention and assistance in ensuring an equitable transition, underscoring the role of Chinese investments in advancing both the EV industry and workforce skills. The literature review reveals that Thailand's automotive sector is undergoing a transformative phase driven by the increasing global demand for EVs. While this shift presents new employment prospects in the EV sector, it also poses risks of job displacement and wage disparities in the conventional vehicle industry. In response to these challenges, the researchers propose a comprehensive approach involving collaboration among the government, private sector, educational institutions, and internal stakeholders. Key strategies encompass workforce retraining, social protection measures, labor policies, and targeted regional development to mitigate the adverse effects of the transition on workers. Significantly, the research paper accentuates the noteworthy role played by Chinese investments in Thailand's EV industry. These investments have strengthened manufacturing capabilities, expanded charging infrastructure, and facilitated research and development collaborations. When coupled with supportive government policies, Chinese investments are instrumental in expediting the transition to electric mobility in Thailand. This paper relies on a secondary literature review employing a systematic approach to synthesize and present the research findings.

Keywords: Electric vehicle, Labor market, Economic welfare analysis, Thailand, Government policy

Introduction

The global automotive industry is standing at the cusp of a transformative era, marked by the unprecedented shift from internal combustion engines to electric vehicles (EVs). This transition, driven by concerns for environmental sustainability, the urgency to mitigate climate change impacts, and a surge in technological advancements, is reshaping economies worldwide. Nations like Norway and China are leading in EV adoption through comprehensive policies and incentives (Zhang et al., 2014). Similarly, Thailand, a nation deeply intertwined with the automotive sector, is embracing strategic initiatives to lead in this transition. Key among these initiatives is the ambitious "30@30 Policy," aimed at making electric vehicles 30% of the nation's car production by 2023, and the supportive EV3.5 policy,

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both of which are integral to Thailand's vision for a sustainable automotive future (Thailand Ministry of Energy, 2021; Excise Department, 2023).

However, it is crucial to note that Thailand's move towards EV manufacturing is influenced by multiple factors, including economic imperatives and foreign investment pressures, rather than purely environmental concerns (Berkeley et al., 2017). The country faces significant challenges in enforcing environmental standards, as evidenced by ongoing PM 2.5 pollution issues. This paradox between the Thai government's environmental policy enforcement and the economic and environmental benefits of EVs highlights the complexity of Thailand's transition. Moreover, much of the EV manufacturing in Thailand is driven by foreign companies, which further emphasizes the external economic pressures shaping this shift (Schröder, 2021).

Thailand's automotive industry, a substantial contributor to its economic infrastructure, is undergoing a significant reorientation with the global EV evolution. This shift from combustion engine industry to the burgeoning EV sector holds profound implications for the labor market and the overarching economic welfare within the country. The labor force, an indispensable asset to the automotive sector, stands at the intersection of this industrial transformation, presenting a scenario riddled with both challenges and opportunities. Recognizing the need for a skilled workforce to support this transition, Thailand's 13th National Economic and Social Development Plan (NESDP 2023-2026) outlines strategic goals and measures aimed at enhancing labor capacities and readiness for the emerging EV industry (Thailand Ministry of Labor, 2023).

This research delves into the multiple dimensions of this industry shift and its subsequent impact on labor well-being in Thailand. An in-depth exploration of the historical and contemporary landscapes of the combustion engine industry in Thailand lays the foundation context for this study, while the emergence and growth trajectory of the electric vehicle, alongside forward-looking policies, and development plans, are analyzed to discern their role in reshaping labor market dynamics. The National Economic and Social Development Planning 2023-2026, in relation to the Ministry of Labor, specifically addresses the realm of EVs. With goals such as enhancing existing operators' ability to adapt to automotive production and fostering investment in vehicle technology, the plan sets forth a proactive blueprint for Thailand's labor force to thrive in this new industrial paradigm. Indicators such as the targeted increase of skilled workers in the EV sector and strategic sub-strategies for labor skill development embed the comprehensive approach being undertaken to ensure a smooth and inclusive transition (Thailand Ministry of Labor, 2023). Furthermore, the economic rationale for Thailand's transition toward EVs includes environmental imperatives and economic opportunities. With the global push towards sustainability, EVs offer a path to reduce greenhouse gas emissions and pollution, aligning with Thailand's commitments and paralleling initiatives in other nations. Economically, the transition presents an opportunity for Thailand to position itself as a leader in the burgeoning EV market, attracting foreign investment, fostering technological innovation, and creating high-quality jobs. This research embarks on an economic welfare analysis to offer insights into the nuances of the labor market shifts and their repercussions on labor welfare within the EV industry. Elements such as workforce development, social protection policies, and regional development initiatives are brought into the analytical purview to generalize the future perspectives of labor welfare in the electric industry in Thailand.

Literature review

The global transition from combustion engines to electric vehicles (EVs) represents a pivotal economic and socio-labor transformation. Countries worldwide, including Thailand, with significant automotive industries, are at various stages of this transition, facing unique challenges and opportunities. The development of the combustion engine industry in Thailand, considered a cornerstone of economic growth and employment, is now navigating the increasing environmental and global pressures driving a shift towards more sustainable alternatives (Kohpaiboon, 2006; Wonglimpiyarat, 2016).

In Thailand, the EV industry, although in its infancy, is characterized by rapid growth, driven by increasing consumer demand and significant foreign investments. This mirrors global trends where the EV market is expected to reshape the traditional automotive sector (Lee et al., 2020). However, the transition brings forth the challenges alongside opportunities, requiring comprehensive strategic approaches to adeptly navigate this transformation (Zhong et al., 2022). The impact on labor and economic welfare emerges as a central concern, with potential ramifications for employment in the combustion engine sector signaling job displacements and a pressing need for expansive workforce development initiatives (Kulkolkarn, 2019; Acemoglu & Restrepo, 2018). Moreover, the Thai government launched the Automotive Industry Master Plan (2002-2006) and the Automotive Industry Master Plan II (2007-2011), which aim to establish Thailand as a regional production and export hub for automobiles and automotive parts. By the 2010s, Thailand had become one of the largest automotive producers in Southeast Asia, with the combustion engine industry playing a significant role in the country's economic growth and development (Natsuda & Thoburn, 2013).

Government policies and strategic plans are pivotal in shaping and supporting this transition. Thailand's "30@30 Policy" aims to make EVs 30% of the nation's car production. The Excise Department's EV3.5 policy, a continuation and enhancement of this vision, outlines specific measures and incentives over a 4-year period (2024-2027) to propel Thailand as a regional EV production hub and to promote a low carbon society (Thailand Ministry of Energy, 2021; Excise Department, 2023). Additionally, understanding Thailand's approach within the broader context of global transitions provides valuable insights. Comparative studies from countries like Norway and China, which have led in EV adoption due to comprehensive policies and incentives, help contextualize Thailand's journey within the broader narrative of the global shift to electric mobility (Haugneland, 2017; Zhong et al., 2022).

Research Methods

The research examines the socio-economic impacts of Thailand's transition from combustion engine to electric vehicle industries with a particular focus on labor well-being. To capture the multi-dimensional nature of this transition required a nuanced qualitative approach underpinned by a systematic comparative analysis and thematic content analysis. This methodology is chosen for its robustness in uncovering the intricate dynamics of industrial shifts and their broader socio-economic implications. The systematic comparative analysis examines the EV transition policies of Thailand, Norway, and China to identify best practices and lessons that can be applied to the Thai context. This involves comparing policy frameworks, implementation strategies, and socio-economic outcomes across the three countries. By drawing on the experiences of these countries, this analysis aims to highlight effective strategies and potential pitfalls that Thailand may consider in its transition. Thematic

content analysis was applied to analyze qualitative data from secondary sources, including industry reports, government publications, and academic articles. This method involves categorizing data to identify recurring themes and patterns. The analysis focused on key aspects such as policy effectiveness, labor market impacts, and workforce development initiatives. By systematically analyzing the data, this study provides a comprehensive understanding of the socio-economic impacts of Thailand's transition to EVs. The cornerstone of our approach is a comprehensive collection of secondary data meticulously selected to ensure relevance, credibility, and diversity. This includes industry reports detailing employment trends and policy impacts, government publications outlining strategic initiatives and legal frameworks, and academic articles offering theoretical insights and empirical studies. Such selection criteria prioritize recent, authoritative sources directly discussing Thailand's EV transition and its socio-economic dimensions. By incorporating a diverse source of documents, this study aims to construct a multifaceted view of the transition, capturing its complexities and varied implications. Ethical considerations are paramount in such an approach. I adhere to strict research ethics, ensuring proper attribution of sources, respect for intellectual property rights, and presenting information with accuracy and integrity. Moreover, I acknowledge the limitations inherent in relying solely on secondary data, including potential biases and the currency of information. To mitigate these issues, I employ exacting selection criteria and engage in cross-referencing of sources. Additionally, while comparative analysis provides insights, the unique socio-economic and political context of Thailand requires careful consideration when applying lessons from other countries.

Overview of Combustion Industry in Thailand

A. History and development of the combustion engine industry

The history of the combustion engine industry in Thailand can be traced back to the early 1960s when the Thai government implemented the First National Economic and Social Development Plan (1961-1966) to promote domestic production of automobiles (Wonglimpiyarat, 2016). This plan aimed to reduce the country's reliance on imported vehicles and spur economic growth by fostering industrialization. Subsequent development plans continued to emphasize the importance of the automotive sector, leading to the establishment of a solid foundation for the industry. Over the years, the Thai government introduced several incentives to attract foreign direct investment (FDI) and foster the growth of the automotive industry. These incentives included tax breaks, tariff reductions, and preferential treatment for companies that set up manufacturing plants in the country (Kohpaiboon, 2006). As a result, Thailand attracted several major global automakers, which significantly contributed to the development of the combustion engine industry.

Throughout the 1990s and 2000s, the Thai automotive sector experienced rapid growth, driven by a combination of factors such as favorable government policies, a strategic location, an affordable and skilled labor force, and a robust supply chain of automotive parts manufacturers (Kohpaiboon, 2006). Moreover, the Thai government launched the Automotive Industry Master Plan (2002-2006) and the Automotive Industry Master Plan II (2007-2011), which aimed to establish Thailand as a regional production and export hub for automobiles and automotive parts (Economics, 2003). By the 2010s, Thailand had become one of the largest automotive producers in Southeast Asia, with the combustion engine industry playing a central role in the country's economic growth and development. The industry's success can be attributed to the strong partnerships between the public and private sectors, as well as the country's commitment to fostering a competitive and innovative automotive sector.

B. Employment trends in the combustion engine sector

The combustion engine sector has been a major contributor to employment in Thailand, providing a wide range of direct and indirect job opportunities (e.g., extensive automotive supply chain, logistics, mechanics, etc.) to the local population. As the industry has evolved and grown over the years, its impact on the Thai labor market has become increasingly significant. Moreover, the combustion industry has provided a changing dynamic whereby the global employment trend has shifted to increase labor to support the particular industry growth (Solomon & Krishna, 2011). The growth of the combustion engine industry has led to several spillover effects on the Thai economy, as the sector's success has positively influenced other industries (Lee et al., 2020). For example, the demand for high-quality infrastructure to facilitate transportation and logistics has created job opportunities in construction and engineering. Additionally, the increase in disposable income for workers in the automotive sector has boosted consumer spending in various other industries, leading to job creation in retail, hospitality, and other service sectors.

C. Key players and market share

Thailand's combustion engine industry has attracted several major global automakers, including Toyota, Honda, Nissan, Ford, and General Motors, among others (Schröder, 2021). These companies have established manufacturing plants and research and development centers across the country. Domestic automakers, such as Thai Rung and Mine Mobility, have also emerged, although with a smaller market share. Thailand's strategic location in Southeast Asia and its well-established automotive ecosystem has allowed the country to become a regional production hub, exporting a significant portion of its manufactured vehicles to neighboring countries and beyond.

Emergence and Growth of the Electric Vehicle Industry in Thailand

The global shift from combustion engine vehicles to electric vehicles is fueled by concerns around environmental sustainability, technological advancement, and government backing. This transition resonates strongly within Thailand’s automotive perspectives. However, it is important to address the paradox between the Thai government’s lack of enforcement of environmental standards and the positive economic and environmental benefits of EVs.

Acknowledging this change, Thailand is channeling investments into electrifying its vehicle industry, reflecting a strategic adaptation to the global automotive paradigm. Furthermore, Thailand’s population is showing a burgeoning awareness and concern for the environmental implications of conventional fossil fuel usage (Zhao et al., 2020). This transition in perception is catalyzing a heightened demand for electric vehicles, acknowledged for their minimal carbon footprint and economic operation. This shift is compelling automakers to diversify and broaden their electric vehicle portfolio, reflecting changing consumer preferences.

Concurrently, Thailand’s strategic geographical positioning, skilled labor force, and entrenched supply chains are drawing substantial foreign investment (Kohpaiboon, 2006). International automakers are forging alliances with local entities to institute electric vehicle manufacturing hubs. Such global-local partnerships are pivotal, driving technology exchange and enhancing the operational capacity for Thailand’s electric vehicle sector. This technological influx is a foundation for Thailand’s sustained and

competitive presence in the global electric vehicle arena. Beyond mere vehicle production, the Thai government's proactive stance is discernible in their push for a holistic electric vehicle ecosystem (Kohpaiboon, 2006). Encouraged investments are fortifying diverse segments including battery production, charging infrastructures, and ancillary services, solidifying the comprehensive electric vehicle network. This multifaceted development is instrumental for the seamless functioning and long-term stability of the electric vehicle industry within Thailand. However, the journey is not without its challenges. A crucial need for extensive infrastructure development, particularly in building charging stations, is prioritized to alleviate consumer apprehensions regarding electric vehicle range and to bolster widespread adoption. Additionally, the sector's expansion necessitates focused workforce development to meet the burgeoning demands of the industry, a strategy outlined in Thailand's National Economic and Social Development Plan (NESDP 2023-2027) (Thailand Ministry of Labor, 2021).

Notwithstanding these advancements, the journey is laden with challenges, notably the crucial need for extensive infrastructure development, especially in building charging stations. This is essential to ally consumer apprehensions around electric vehicle range and to bolster widespread electric vehicle adoption. The sector's expansion necessitates focused workforce development to meet the industry's burgeoning demands. Amongst these challenges, the electric vehicle shift presents ample opportunities for Thailand. The nation stands to attract further foreign investment, bolster employment, and stimulate innovation (Zhao et al., 2020). In essence, by capitalizing on its established automotive foundations and surmounting inherent challenges, Thailand is poised to emerge as a dominant force in the global electric vehicle landscape. This strategic transition not only augments Thailand's economic trajectory but also underscores its commitment to a sustainable and environmentally responsible future.

Economic Welfare Analysis: Impact on Labor Well-Being

The transition from the combustion engine industry to the electric vehicle industry in Thailand is a paradigm shift with profound implications for the labor market and workers' well-being. As Thailand embraces electric mobility, bolstered by strategic initiatives like the 30@30 Policy and EV3.5 plan, the labor market is poised for transformation (Thailand Ministry of Energy, 2021; Excise Department, 2023). New employment opportunities are anticipated to emerge in burgeoning sectors such as battery production, vehicle assembly, and charging infrastructure development. However, alongside these opportunities several challenges remain, notably the potential displacement of workers in the combustion engine sector as the demand for traditional vehicle production declines.

Furthermore, wage dynamics during this transition are complex, with potential wage stagnation or decline for low-skilled labor due to increased automation and capital-intensive production processes. In contrast, high-skilled workers with expertise in engineering, research and development, and advanced manufacturing may witness wage growth as their skills become increasingly valuable in the electric vehicle sector (Acemoglu & Restrepo, 2018).

Critical to this transition is the focus on skills development and training, as outlined in the 13th National Economic and Social Development Plan (NESDP 2023-2027). Workers will need to adapt and acquire new competencies in areas such as battery technology, electric powertrain systems, and advanced manufacturing techniques. Collaborative efforts between the government, educational institutions, and private sector stakeholders are paramount in developing effective workforce

development and training programs (Thailand Ministry of Labor, 2021). This approach is essential for maintaining competitiveness and facilitating a smooth transition in the labor market.

Moreover, the electric vehicle industry may have positive implications for job quality and working conditions. Workers in this sector could experience safer working environments and fewer health risks compared to the combustion engine sector, given the cleaner technologies and materials involved in EV production (Kulkolkarn, 2019). However, comprehensive research is necessary to fully understand the transition's implications on job quality and working conditions within the Thai context, ensuring that the shift not only promotes environmental sustainability but also enhances worker welfare.

Such a transition from the combustion engine industry to the electric vehicle industry in Thailand has substantial consequences for labor market dynamics and workers' well-being. Challenges such as potential job displacement and wage inequality coexist with opportunities for skills development, employment generation, and improved job quality. The role of strategic planning, policy intervention, and stakeholder collaboration becomes increasingly vital to ensure a just and equitable transition that benefits both the economy and the labor force. By aligning national strategies with labor market needs, Thailand can navigate this transition effectively, ensuring that it not only capitalizes on the economic opportunities presented by the electric vehicle industry but also safeguards and enhances the welfare of its workforce.

Government Policies and Support for a Just Transition

Understanding the nuances and impacts of various government policies from Thailand, Norway, and China is crucial in shaping an effective and just transition from the combustion engine industry to the electric vehicle industry. This in-depth analysis explores the effectiveness of specific initiatives, the challenges faced, and their broader implications.

A. Tax Incentives and Financial Support:

Thailand: The "30@30 Policy" and EV3.5 initiatives reflect Thailand's commitment to boosting EV adoption. However, the effectiveness of these policies is contingent upon comprehensive implementation and public acceptance. While incentives reduce the financial burden on consumers, the lack of direct purchase tax exemptions, compared to Norway's approach, might limit their impact. Ensuring that incentives are substantial enough to sway consumer preference and that they are well-publicized and accessible is crucial (Thailand Ministry of Energy, 2021; Excise Department, 2023).

Norway: Norway's exemption from purchase taxes and zero VAT on EV purchases have been highly effective, evidenced by the country's world-leading EV adoption rates. These policies significantly reduce the cost barrier for consumers, making EVs a financially viable option. However, such aggressive tax exemptions require substantial government support and may not be feasible for all countries considering their economic contexts (Haugneland et al., 2017).

China*:* China's subsidies and tax incentives have successfully spurred domestic EV production and adoption. Yet, this approach has faced challenges, including dependency on government support and market distortion concerns. As subsidies taper off, the long-term sustainability of China's EV market growth reliant on these incentives is under scrutiny. Balancing financial support with market-driven growth is a critical consideration for policy sustainability (Graham et al., 2021).

B. Charging Infrastructure Development:

Thailand: While Thailand is investing in its charging infrastructure, the scale and speed of development are crucial to match the growing number of EVs. Norway's success illustrates that extensive and accessible charging networks are key to consumer confidence. Thailand must ensure that infrastructure development keeps pace with vehicle sales to avoid bottlenecks and maintain momentum in EV adoption (Excise Department, 2023).

Norway: Norway's investment in a comprehensive charging network has effectively mitigated range anxiety and supported its high EV adoption rates. The challenge for Norway moving forward is to maintain and expand this infrastructure to accommodate an increasing number of EVs, ensuring it continues to meet consumer needs and supports further adoption (Mersky et al., 2016).

China: China's rapid expansion of its charging infrastructure has played a significant role in supporting its burgeoning EV market. However, challenges such as ensuring the quality, interoperability, and geographic distribution of charging stations are critical for meeting the diverse needs of consumers across urban and rural areas. Balancing speed of deployment with these quality considerations is vital (Li et al., 2016).

C. Workforce Development and Social Policies:

Thailand: Thailand recognizes the need for targeted workforce development as it transitions to an EV-dominant future. The government's initiatives, as outlined in the National Economic and Social Development Plan No. 13, emphasize upskilling and reskilling workers to meet the demands of the EV industry. The plan sets forth goals for increasing the number of workers skilled in EV technologies and related fields. However, implementing these initiatives across diverse regions and industries presents challenges, including ensuring equal access to training and addressing the needs of workers in rural or underserved areas. Additionally, Thailand must balance the rapid technological advancements in EVs with timely and relevant training programs (Thailand Ministry of Labor, 2023). Social protection measures are also vital to support workers potentially displaced by the industry transition, including unemployment benefits and job placement services.

Norway: Norway's approach to workforce development in the EV sector is informed by its comprehensive social welfare system and emphasis on lifelong learning. The government supports retraining programs and continuous education to help workers adapt to new technologies and industries. As a result, Norway has managed to maintain low unemployment rates and high labor market flexibility even as it leads the world in EV adoption. However, ongoing challenges include ensuring that the fast-paced growth of the EV market does not outpace the development of necessary skills and that all sectors of the workforce have opportunities for advancement and retraining. Norway's success in this area is partly due to strong collaboration between the government, educational institutions, and industry stakeholders, creating a cohesive strategy for workforce development (Mapis, 2022).

China: China's rapid expansion of its EV industry is accompanied by significant investments in workforce development and training. The government has implemented various programs to cultivate a skilled labor force capable of supporting the growing EV sector, from engineers and technicians to manufacturing workers. China's approach emphasizes both technical education and on-the-job training, often in partnership with leading EV companies. These initiatives are crucial for sustaining the

industry's growth and ensuring that Chinese workers can compete in the global market. However, China also faces challenges, including the need to provide support for workers transitioning from traditional automotive sectors to new roles in EV production and ensuring equitable access to training and development opportunities across its vast and diverse population (Warner, 1996).

Challenges and Barriers to EV Implementation in Thailand

Thailand faces several significant challenges and barriers in implementing EV manufacturing. The country's education system has a poor reputation, particularly regarding its ability to produce a workforce with the skills and critical thinking necessary for the modern economy. This presents a significant barrier to finding and training workers for more complex EV manufacturing tasks. The Thai government must invest in improving the equality of education and vocational training to ensure a skilled workforce capable of supporting the EV industry (Schröder, 2021). Furthermore, the Thai government is often perceived as being somewhat chaotic and ineffective in policy implementation. This vulnerability could impact the successful implementation of EV manufacturing policies. Ensuring effective governance, transparency, and accountability in policy execution is critical to overcoming this challenge. Additionally, Thailand's public social welfare system is weak, which could impact the care provided for displaced workers and the goal of creating upskill training programs. Strengthening social protection measures, including unemployment benefits, job placement services, and retraining programs, is essential to support workers affected by the transition (Kulkolkarn, 2019). By addressing these challenges, Thailand can create a more conducive environment for the successful implementation of EV manufacturing and ensure a just and equitable transition for its labor force.

Discussion and Conclusion

The transition from the combustion engine industry to the electric vehicle (EV) industry in Thailand marks a significant turning point with wide-ranging implications for the labor market and workers' well-being. This study has explored the historical development of the combustion engine industry, the emergence and rapid growth of the EV industry, and the multifaceted impact of this transition on labor welfare through an economic welfare analysis.

As Thailand stands on the brink of this transformative shift, it faces a dual scenario of opportunities and challenges. The global rise in demand for electric vehicles heralds a new era for Thailand's automotive industry, promising economic growth and technological advancement. However, this transition also brings with it potential job displacement and wage inequality, underscoring the need for proactive measures to ensure a just and equitable shift for all labor segments. Moreover, a multi-pronged approach involving government, private sector stakeholders, educational institutions, and international partners is essential. Implementing workforce development and training programs is crucial to address the evolving skills requirements in the automotive sector. Similarly, social protection measures and labor market policies must be established to support affected workers, while targeted regional development strategies and industrial diversification will help mitigate adverse effects on local labor markets and communities.

The role of Chinese investments in Thailand's EV industry is significant, contributing to manufacturing capabilities, charging infrastructure, and fostering R&D collaborations. These

investments, coupled with supportive government policies, can catalyze Thailand's transition to electric mobility. However, it is essential to consider these developments within the broader international context. A comparative analysis with countries like Norway, which has successfully navigated a similar transition through robust policies and incentives, and China, with its aggressive EV market expansion, offers valuable lessons for Thailand. These comparisons highlight the importance of tailored strategies that consider local economic, social, and infrastructural realities while drawing on global best practices.

In conclusion, Thailand's journey towards an electric vehicle-dominated future is paved with both promises and challenges. By thoughtfully addressing the complexities of this transition, Thailand can foster an environment conducive to economic growth, innovation, and enhanced labor welfare. Future research should continue to monitor this transition, comparing Thailand's progress with other nations and evaluating the long-term effectiveness of policy interventions. Such an ongoing analysis will be crucial in understanding the evolving landscape of the EV industry and its socio-economic impacts, guiding policymakers and stakeholders towards a sustainable and equitable automotive future.

References

Acemoglu, D., & Restrepo, P. (2018). The race between man and machine: Implications of technology for growth, factor shares, and employment. *American economic review*, *108*(6), 1488-1542.

Berkeley, N., Bailey, D., Jones, A., & Jarvis, D. (2017). Assessing the transition towards Battery Electric Vehicles: A Multi-Level Perspective on drivers of, and barriers to, take up. *Transportation Research Part A: Policy and Practice*, *106*, 320-332. https://doi.org/10.1016/j.tra.2017.10.004

Economics, O. o. I. (2003). *Automotive Industry Master Plan 2002-2006*. Thailand

Excise Department. (2023, December 19). *Excise Department drives EV3.5 Electric Vehicle Policy, Pushing Thailand To Be a Center for EV Vehicle Production in the Region to Promote a Low Carbon Society*. https://media.thaigov.go.th/uploads/document/142/2023/12/pdf/Doc_20231219171444000000.pdf [in Thai]

Graham, J. D., Belton, K. B., & Xia, S. (2021). How China beat the US in electric vehicle manufacturing. *Issues in Science and Technology*, *37*(2), 72-79.

Haugneland, P., Lorentzen, E., Bu, C., & Hauge, E. (2017). Put a price on carbon to fund EV incentives–Norwegian EV policy success. EVS30 Symposium. Stuttgart, Germany.

Kohpaiboon, A. (2006). Foreign direct investment and technology spillover: A cross-industry analysis of Thai manufacturing. *World Development*, *34*(3), 541-556.

Kulkolkarn, K. (2019). *Impact of the Transition to Electrical Vehicles on Workers in Automotive Parts Manufacturing in Thailand*. Bangkok: Friedrich Ebert Stiftung Thailand Office.

Lee, K., Wong, C. Y., Intarakumnerd, P., & Limapornvanich, C. (2020). Is the Fourth Industrial Revolution a window of opportunity for upgrading or reinforcing the middle-income trap? Asian model of development in Southeast Asia. *Journal of Economic Policy Reform*, *23*(4), 408-425. https://doi.org/10.1080/17487870.2019.1565411

Li, Y., Davis, C., Lukszo, Z., & Weijnen, M. (2016). Electric vehicle charging in China's power system: Energy, economic and environmental trade-offs and policy implications. *Applied energy*, *173*, 535-554. https://doi.org/10.1016/j.apenergy.2016.04.040

Mapis, C. B. M. (2022). *The Green Shift in Norway: exploring the impact on industry workers.* [Master's Thesis, Norwegian University of Life Sciences]. https://nmbu.brage.unit.no/nmbu-xmlui/handle/11250/3034036

Mersky, A. C., Sprei, F., Samaras, C., & Qian, Z. S. (2016). Effectiveness of incentives on electric vehicle adoption in Norway. *Transportation Research Part D: Transport and Environment*, *46*, 56-68. https://doi.org/10.1016/j.trd.2016.03.011

Ministry of Energy. (2021, October 22). *Guidelines for promoting electric vehicles*. EPPO. https://www.eppo.go.th/index.php/en/component/k2/item/17415-ev-charging-221064-04 [in Thai]

Ministry of Labor. (2023, January). *Strategic plan, milestone 3 Connection to the National Economic and Social Development No. 13: In Relation to Ministry of Labor*. https://std.mol.go.th/wp-content/uploads/sites/30/2022/09/หมุดหมายที่-3-ไทยเป็นฐานการผลิตยานยนต์ไฟฟ้าที่สำคัญของโลก-1.pdf [in Thai]

Natsuda, K., & Thoburn, J. (2013). Industrial policy and the development of the automotive industry in Thailand. *Journal of the Asia Pacific Economy*, *18*(3), 413-437. https://doi.org/10.1080/13547860.2012.742690

Schröder, M. (2021). Electric vehicle and electric vehicle component production in Thailand, in Schröder, M., F. Iwasaki ans H. Kobayashi (eds.) *Promotion of Electromobility in ASEAN: State, Carmakers, and International Production Networks.* ERIA Research Project Report FY2021 no.03, Jarkarta: ERIA.

Solomon, B. D., & Krishna, K. (2011). The coming sustainable energy transition: History, strategies, and outlook. *Energy Policy*, *39*(11), 7422-7431. https://doi.org/10.1016/j.enpol.2011.09.009

Warner, M. (1996). Human resources in the People's Republic of China: The 'three systems' reforms. *Human Resource Management Journal*, *6*(2), 32-43. https://doi.org/10.1111/j.1748-8583.1996.tb00402.x

Wonglimpiyarat, J. (2016). Towards the Detroit of Asia: Empirical research insights of Thailand's OEM strategy. *The Journal of High Technology Management Research*, *27*(1), 78-87. https://doi.org/10.1016/j.hitech.2016.04.007

Zhang, X., Xie, J., Rao, R., & Liang, Y. (2014). Policy incentives for the adoption of electric vehicles across countries. *Sustainability*, *6*(11), 8056-8078. https://doi.org/10.3390/su6118056

Zhao, X., Ye, Y., Ma, J., Shi, P., & Chen, H. (2020). Construction of electric vehicle driving cycle for studying electric vehicle energy consumption and equivalent emissions. *Environmental Science and Pollution Research*, *27*, 37395-37409. https://doi.org/10.1007/s11356-020-09094-4

Zhong, J., Traiwannakij, S., Su, G., Rakthin, C., Siriwatthanakrit, R., Mascarinas, A. M., Liu, M., & Poomsook, P. (2022). Chinese Electric Vehicles in the Thailand Market: Opportunities and Challences. *RMUTK Journal of Liberal Arts*, *4*(2), 131-143. https://so02.tci-thaijo.org/index.php/larts-journal/article/view/258772