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The Electric Vehicle Transition: Assessing its Impact on Thai Automotive Parts SMEs

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Abstract: This study investigates the multifaceted impacts of the global transition towards electric vehicles (EVs) on Small and Medium-sized Enterprises (SMEs) operating within Thailand's automotive parts industry. As a significant automotive manufacturing hub, Thailand faces both opportunities and challenges in adapting to this paradigm shift from traditional internal combustion engine (ICE) vehicles. This research employs a qualitative approach, utilizing in-depth interviews with key stakeholders from automotive parts SMEs, industry associations, and government bodies to explore their awareness, perceived challenges, adaptation strategies, and opportunities arising from the EV transition. The findings reveal that while many SMEs recognize the inevitability of the shift, they face significant hurdles related to technological obsolescence, the need for substantial investment in new production capabilities, skill gaps in their workforce, and intense competition. Conversely, opportunities exist in developing new EV-specific components, leveraging government incentives, and forming strategic partnerships. This study underscores the critical need for targeted policy support, capacity building, and collaborative initiatives to enable Thai automotive parts SMEs to successfully navigate the EV transition, ensuring their sustained competitiveness and contribution to the national economy.

Keywords: Electric Vehicles (EVs), Automotive Parts Industry, Small and Medium-sized Enterprises (SMEs), Thailand, Industry Transition, Impact Assessment, Supply Chain, Adaptation Strategies.

Introduction: The global automotive industry is undergoing an unprecedented transformation driven by environmental concerns, technological advancements, and evolving consumer preferences, with the transition towards electric vehicles (EVs) at its forefront [1]. This shift is primarily fueled by the urgent need to mitigate climate change, reduce greenhouse gas emissions, and improve urban air quality [2, 3]. International agreements, such as the Paris Agreement (COP21), have set ambitious targets for decarbonization, compelling nations worldwide to accelerate the adoption of zero-emission vehicles [4]. Consequently, governments are implementing various policies and incentives to promote EV deployment and infrastructure development [5, 6].

Thailand has long established itself as a prominent automotive manufacturing base in Southeast Asia, often referred to as the "Detroit of Asia" [7]. Its automotive industry is a significant contributor to the national economy, characterized by a robust supply chain comprising numerous small and medium-sized enterprises (SMEs) that specialize in manufacturing a wide array of automotive parts for both domestic and international markets [8, 9]. These SMEs form the backbone of the industry, providing employment and fostering innovation within the sector [10].

However, the transition from conventional internal combustion engine (ICE) vehicles to EVs presents a complex set of challenges and opportunities for this established automotive ecosystem. EVs fundamentally differ from ICE vehicles in their architecture, requiring fewer moving parts and different types of components, particularly in the powertrain, battery systems, and electronics [11, 12]. This technological divergence poses a substantial threat of obsolescence for SMEs heavily invested in ICE-specific parts manufacturing, while simultaneously opening doors for new product lines and specialized components for the EV supply chain [13, 14]. Despite Thailand's proactive government policies aimed at promoting EV production and adoption [15, 16], the specific impacts on its vast network of automotive parts SMEs remain underexplored. Understanding these impacts is crucial for developing targeted strategies to ensure the resilience and continued competitiveness of these vital economic actors.

This study aims to critically assess the impacts of the transition to electric vehicles on Small and Medium-sized Enterprises (SMEs) in Thailand's automotive parts industry. It seeks to identify the key challenges and opportunities faced by these enterprises and explore their current adaptation strategies, thereby providing valuable insights for policymakers, industry associations, and the SMEs themselves to navigate this transformative period successfully.

Literature Review

The global push for electric vehicles is a direct response to pressing environmental concerns, including climate change and air pollution. The Paris Agreement (COP21) outlines global commitments to reduce greenhouse gas emissions, with a strong emphasis on decarbonizing the transport sector [4]. The burning of fossil fuels in ICE vehicles is a major contributor to CO2 and methane emissions, both potent greenhouse gases [2, 17]. Consequently, countries worldwide are setting ambitious targets for EV adoption and phasing out ICE vehicle sales [18, 19]. The International Energy Agency (IEA) consistently reports on the rapid growth of EV markets and the policies driving this deployment globally [5, 20].

Thailand has articulated a clear commitment to this global transition. Its Mid-century, Long-term Low Greenhouse Gas Emission Development Strategy (LTS) submitted under the Paris Agreement, and the Nationally Determined Contribution (NDC) Roadmap on Mitigation, explicitly outline targets for reducing emissions from the transport sector, with EVs playing a central role [21, 22]. The Thai government, through agencies like the Board of Investment (BOI) and the Office of Industrial Economics, has introduced various incentives and strategies to promote EV manufacturing and adoption, aiming to position Thailand as a regional EV production hub [15, 16, 23, 24]. The Electric Vehicle Association of Thailand (EVAT) actively promotes the industry through events and initiatives [25].

The traditional Thai automotive industry is characterized by a deep and extensive supply chain, with SMEs forming a significant component, particularly in the manufacturing of parts [7, 9]. These SMEs often specialize in specific components, relying on established relationships with larger original equipment manufacturers (OEMs) [8]. The importance of logistics and supply chain indicators in the manufacturing industry, including automotive, has been long recognized [9].

The transition to EVs, however, introduces fundamental disruptions to this established supply chain. EVs have significantly fewer moving parts than ICE vehicles (e.g., electric motors replace complex engines and transmissions), leading to a reduced demand for many traditional ICE-specific components such as pistons, crankshafts, spark plugs, and exhaust systems [11, 12, 13]. Studies on the impact of policies like the dual-credit policy have shown how they influence the production dynamics of ICE vehicles, indirectly affecting their supply chains [26]. This poses a direct threat to SMEs whose core business revolves around these components.

Panisa (2018) specifically analyzed the impacts of EVs on the Thai automotive parts industry, highlighting potential disruptions [13]. Similarly, the GSB Research Center (2018) has examined the broader impact of electric cars on the Thai automotive industry [14].

Conversely, the EV transition also creates new opportunities. The demand for EV-specific components, such as battery packs, electric motors, power electronics, and charging infrastructure, is rapidly growing [12]. SMEs with the agility and capacity to retool, reskill their workforce, and diversify their product lines can capitalize on these emerging markets [10, 14]. The Office of SMEs Promotion in Thailand has recognized this and developed strategies and action plans to promote SMEs in the EV industry, signaling government support for their adaptation [10]. International examples, such as the Philippines' emerging EV market [27] and China's growing influence in the Thai EV market [28], illustrate the dynamic nature of this transition and the need for local SMEs to adapt. Krongchan (2020) and Wanna (2020) have also provided insights into the future directions of EVs and the broader Thai automobile industry outlook, emphasizing the need for strategic adaptation [7, 29]. While the concept of sustainable development in the EV industry emphasizes stakeholder engagement [30], the specific challenges and opportunities for SMEs in a developing automotive hub like Thailand warrant detailed empirical investigation.

METHODOLOGY

This study adopted a qualitative research approach to gain an in-depth understanding of the complex impacts of the EV transition on Small and Medium-sized Enterprises (SMEs) in Thailand's automotive parts industry. This approach was chosen to explore the nuanced perceptions, experiences, challenges, and adaptation strategies of SME owners and managers, which quantitative methods might not fully capture.

Research Design An exploratory case study design was employed. This design allowed for an intensive investigation of the phenomenon within a specific context (Thai automotive parts SMEs), providing rich, detailed insights that can inform broader understanding and future research. The exploratory nature was suitable given the evolving and relatively new phenomenon of EV transition impacts on this specific sector.

Study Population and Sampling The target population for this study comprised owners, top-level managers, and key decision-makers of SMEs operating in the automotive parts manufacturing sector across Thailand, particularly those with a significant reliance on ICE-related component production. Purposive sampling was utilized to select participants who possessed relevant knowledge and experience regarding the automotive industry, EV trends, and the specific challenges faced by SMEs. The sample included:

- Owners/Managers of automotive parts SMEs (e.g., those producing engine parts, transmission components, exhaust systems, as well as those venturing into EV parts).
- Representatives from relevant industry associations (e.g., Thai Auto-Parts Manufacturers Association).
- Experts from government agencies involved in automotive industry promotion or SME development (e.g., BOI, Office of SMEs Promotion, Ministry of Industry). The aim was to achieve a diverse representation of perspectives from various sizes of SMEs and different positions within the industry ecosystem. The sample size was determined by theoretical saturation, meaning data collection continued until no new significant themes emerged from the interviews.

Instrumentation The primary data collection instrument was a semi-structured interview guide. This guide allowed for flexibility in questioning while ensuring that key themes related to the EV transition's impacts were consistently explored. The interview guide covered areas such as:

- Awareness and understanding of the global and national EV transition trends.
- Perceived challenges for their specific SME (e.g., technological obsolescence, investment needs, workforce skills, competition).
- Identified opportunities for their SME (e.g., new product development, market diversification).
- Current and planned adaptation strategies (e.g., R&D, diversification, training, partnerships).
- Perceptions of government policies and support for SMEs in the EV transition.
- Suggestions for industry and government support. The interview guide was developed based on the literature review and refined through discussions with industry experts to ensure its relevance and comprehensiveness.

Data Collection Procedure Ethical considerations were paramount throughout the data collection process. Formal permission was obtained from all participating organizations and individuals. Participants were informed about the purpose of the study, the voluntary nature of their participation, and assured of anonymity and confidentiality of their responses. Informed consent was obtained prior to each interview. Interviews were

conducted in person or via secure online platforms, depending on the participant's preference and accessibility. Each interview lasted approximately [e.g., 60-90 minutes] and was audio-recorded with the explicit permission of the participant. Detailed field notes were also taken during the interviews. The principles for conducting in-depth interviews as outlined by Carolyn and Palena (2006) were followed to ensure quality and depth of data [31]. Data collection continued until theoretical saturation was reached, ensuring a rich and comprehensive dataset.

Data Analysis The audio-recorded interviews were transcribed verbatim. The transcribed data were then subjected to thematic analysis, following the guidelines for qualitative research as described by Cohen and Crabtree (2006) [32]. The data analysis process involved several stages:

1. Familiarization with Data: Repeated reading of the transcripts to gain a holistic understanding of the content and identify initial patterns.

2. Initial Coding: Generating initial codes from the data, identifying interesting features and relevant segments related to the research questions.

3. Searching for Themes: Grouping related codes into broader, overarching themes and sub-themes that captured significant patterns and meanings across the dataset.

4. Reviewing Themes: Refining the themes by checking their coherence, distinctiveness, and representativeness of the data. This involved ensuring that themes accurately reflected the participants' perspectives and that no significant data were overlooked.

5. Defining and Naming Themes: Developing clear definitions and names for each theme, articulating what each theme represented and its significance to the research questions.

6. Producing the Report: Constructing a narrative that presented the identified themes, supported by illustrative quotes from the interview transcripts, to provide a rich and detailed account of the findings.

The analysis aimed to identify common challenges, opportunities, and adaptation strategies, as well as variations in experiences across different types of SMEs.

RESULTS

The qualitative data analysis revealed several key themes pertaining to the impacts of the EV transition on SMEs in Thailand's automotive parts industry. The findings are presented below, categorized by the main challenges, opportunities, and adaptation strategies identified by the participants.

Awareness and Understanding of the EV Transition Most participants, particularly owners and managers, demonstrated a high level of awareness regarding the global and national EV transition. They acknowledged the inevitability of the shift and its potential to fundamentally alter the automotive landscape. "We know EVs are the future; it's not a question of if, but when and how fast," stated an owner of a medium-sized engine parts manufacturer. They were generally aware of government policies and incentives aimed at promoting EVs in Thailand [15, 16, 21]. However, the depth of understanding regarding the specific technological implications for their particular product lines varied.

Perceived Challenges for SMEs The transition presents significant challenges for SMEs, primarily categorized as follows:

- Technological Obsolescence and Product Diversification: A dominant concern was the potential obsolescence of ICE-specific components. Many SMEs specialize in parts (e.g., pistons, exhaust systems, fuel injection components) that are not required in EVs. "Our entire business is built around ICE parts. What happens to us when demand drops?" voiced a manager. The need to diversify into EV-specific components requires significant R&D and technological know-how that many SMEs currently lack.

- High Investment Costs: Adapting to EV component manufacturing necessitates substantial investment in new machinery, production lines, and testing equipment. Participants highlighted that these costs are often prohibitive for smaller enterprises. "Retooling for EV parts is very expensive. We are an SME; we don't have that kind of capital readily available," explained a CEO.

- Skill Gaps in Workforce: The existing workforce, trained for ICE manufacturing, lacks the specialized skills required for EV components (e.g., battery technology, power electronics, software integration). Reskilling and upskilling the workforce were identified as major challenges. "Our engineers know engines, not batteries or electric motors. We need new skills, and training is costly and time-consuming," noted an HR manager.

- Increased Competition: Participants anticipated heightened competition, not only from larger domestic and international players but also from new entrants specializing in EV components, including Chinese EV manufacturers entering the Thai market [28].

- Supply Chain Disruption: The shift will inevitably disrupt existing supply chain relationships, requiring SMEs to forge new partnerships and integrate into different value chains.

Identified Opportunities for SMEs Despite the challenges, participants also recognized several opportunities:

- New Product Development: The EV transition creates demand for new components such as battery casings, charging station parts, thermal management systems, lightweight materials, and various electronic components. Some SMEs expressed interest in exploring these new product lines.
- Niche Market Specialization: Opportunities exist for SMEs to specialize in niche EV components or services, leveraging their agility and specific expertise.
- Government Incentives and Support: Participants acknowledged government incentives (e.g., BOI promotions, SME promotion strategies) as crucial for supporting their transition [10, 15, 16, 24]. "The government's push for EVs is a clear signal, and their incentives can help us invest," said an industry association representative.
- Strategic Partnerships: Forming collaborations with larger OEMs, EV manufacturers, or technology providers was seen as a way to access new technologies and markets.

Current Adaptation Strategies SMEs reported varying levels of engagement in adaptation strategies:

- Information Gathering and Research: Many SMEs are actively gathering information on EV technologies and market trends. Some are conducting preliminary internal research and development (R&D) to understand potential new product areas.
- Workforce Training (Limited Scale): A few larger SMEs have initiated small-scale training programs for their engineers and technicians in EV-related technologies.
- Diversification (Early Stages): Some are exploring diversification, either by developing prototypes for EV components or by looking into non-automotive sectors to reduce reliance on ICE parts.
- Advocacy through Associations: Industry associations are actively engaging with the government to voice SME concerns and advocate for more tailored support programs.

Role of Government and Industry Associations Participants consistently emphasized the critical role of government policies and support in facilitating the transition. They called for:

- Financial Assistance: Accessible loans, grants, and subsidies for R&D, retooling, and workforce training.
- Technology Transfer and Knowledge Sharing: Programs that facilitate the transfer of EV technology and expertise to SMEs.
- Clear Roadmap and Long-Term Policy: A stable and predictable long-term EV policy roadmap to enable SMEs to plan their investments with confidence.
- Skill Development Programs: Government-led initiatives for large-scale reskilling and upskilling of the automotive workforce. Industry associations were seen as vital intermediaries for communication, advocacy, and facilitating collaboration among SMEs.

DISCUSSION

The findings of this study underscore that the transition to electric vehicles presents a profound and unavoidable challenge for Small and Medium-sized Enterprises in Thailand's automotive parts industry, while simultaneously opening new avenues for growth. The high level of awareness among SME stakeholders about the EV shift, coupled with their articulation of significant challenges, reflects a sector grappling with an existential transformation.

The primary concern, technological obsolescence of ICE-specific components, is a direct consequence of the fundamental architectural differences between ICE and EV powertrains [11, 12]. This necessitates a radical shift in production capabilities and product portfolios for many SMEs, a process hindered by prohibitive investment costs and significant skill gaps in the existing workforce. These challenges are particularly acute for SMEs, which typically have limited capital, less access to advanced R&D facilities, and fewer resources for large-scale workforce training compared to larger corporations [10]. The anticipated increase in competition, including from agile new entrants and established foreign players, further exacerbates the pressure on these enterprises [28].

Despite these formidable hurdles, the study also highlights the proactive stance of many SMEs in identifying and pursuing new opportunities. The demand for EV-specific components, particularly in areas like battery systems, power electronics, and lightweight materials, presents a significant potential growth area [12]. The recognition of government incentives and the potential for strategic partnerships indicates a willingness among SMEs to adapt, provided adequate support structures are in place [10, 15, 16, 24]. This aligns with the broader understanding that government policies are crucial in promoting the sustainable development of the EV industry [5, 23, 30].

The current adaptation strategies, largely focused on information gathering and limited training, suggest that many SMEs are still in the early stages of their transition journey. This underscores the urgency for more comprehensive and coordinated support. The strong

call from participants for financial assistance, technology transfer, and clear policy roadmaps indicates that SMEs cannot navigate this transition alone. Their survival and ability to contribute to Thailand's ambition of becoming an EV production hub depend heavily on targeted interventions from government and collaborative efforts within the industry. The insights from this study resonate with the broader challenges faced by automotive supply chains globally as they respond to the EV revolution [13, 14].

The findings also implicitly suggest that the success of Thailand's overall EV strategy hinges on the successful transition of its SME base. Without robust support for these enterprises, the country risks losing a significant portion of its automotive manufacturing capacity and employment, potentially impacting the national economy. Therefore, the strategic importance of understanding and addressing the specific needs of these SMEs cannot be overstated.

CONCLUSION

This study has critically assessed the impacts of the transition to electric vehicles on Small and Medium-sized Enterprises (SMEs) in Thailand's automotive parts industry. The findings reveal that while SMEs are largely aware of the impending shift, they face substantial challenges related to technological obsolescence, high investment costs for retooling, significant skill gaps in their workforce, and intense competition. Nevertheless, opportunities exist in new product development, niche market specialization, and leveraging government incentives. The current adaptation strategies are primarily in early stages, highlighting a critical need for external support.

The study concludes that the successful navigation of the EV transition by Thai automotive parts SMEs is crucial for the sustained competitiveness of Thailand's automotive sector and its broader economic stability. Without targeted and comprehensive interventions, a significant portion of these enterprises faces the risk of disruption and decline.

Based on the findings, the following recommendations are put forth:

For the Thai Government and Policy Makers (e.g., BOI, Office of SMEs Promotion, Ministry of Industry):

1. Tailored Financial Support: Implement and expand accessible financial assistance programs (e.g., low-interest loans, grants, subsidies) specifically designed to support SMEs in their R&D, retooling, and investment in EV-specific production capabilities.

2. Technology Transfer and R&D Facilitation: Establish dedicated programs for technology transfer and knowledge sharing from larger OEMs, research institutions, and international partners to SMEs. This could include shared R&D facilities or mentorship programs.

3. Comprehensive Workforce Development: Launch large-scale, subsidized reskilling and upskilling programs for the automotive workforce, focusing on EV-related technologies, battery systems, power electronics, and software integration. Collaborate with vocational schools and universities to develop relevant curricula.

4. Clear and Stable Policy Roadmap: Ensure the long-term stability and clarity of Thailand's EV policy roadmap, providing SMEs with the predictability needed to make strategic investment decisions.

5. Promote Strategic Partnerships: Actively facilitate and incentivize partnerships between large EV manufacturers (domestic and foreign) and local SMEs to integrate them into the new EV supply chains.

For Industry Associations (e.g., Thai Auto-Parts Manufacturers Association):

1. Information Hub and Networking: Serve as a central information hub for SMEs on EV market trends, technological requirements, and available government support. Organize regular workshops, seminars, and networking events to foster collaboration and knowledge exchange.

2. Advocacy and Representation: Continue to advocate strongly for the specific needs of SMEs to the government, ensuring that their concerns are addressed in policy formulation.

3. Capacity Building Initiatives: Develop and offer practical capacity-building programs for SMEs, focusing on business model innovation, market diversification, and technology adoption strategies.

For Automotive Parts SMEs:

1. Proactive Adaptation Planning: Develop clear and proactive adaptation plans, including assessing current product portfolios for obsolescence risk and identifying potential new EV components.

2. Invest in R&D and Skills: Prioritize investment in internal R&D capabilities, even on a small scale, and commit to continuous training and upskilling of their workforce in EV-related technologies.

3. Explore Diversification and Niche Markets: Actively seek opportunities to diversify product lines into EV-specific components or to specialize in niche markets where their existing expertise can be leveraged.

4. Seek Partnerships: Explore collaborations with larger companies, technology providers, and other SMEs to share risks, access new technologies, and expand market reach.

By implementing these recommendations, Thailand can ensure that its automotive parts SMEs are not merely bystanders but active participants and beneficiaries of the global electric vehicle revolution, thereby sustaining the industry's vital contribution to the national economy.

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