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IJIE

Journal homepage: http://penerbit.uthm.edu.my/ojs/index.php/ijie
ISSN : 2229-838X e-ISSN : 2600-7916

The International Journal of Integrated Engineering

SWOT Analysis for Electric Vehicles (EVs) in Thailand

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DOI: https://doi.org/10.30880/ijie.2021.13.07.003
Received 21 October 2020; Accepted 23 March 2021; Available online 30 September 2021

Abstract: Nowadays, transport activities are one of the major contributors to greenhouse gas (GHG) emission. It also causes air pollutants in major cities around the world as particulate matter (PM), carbon monoxide (CO) and carbon dioxide (CO_2). Thai government has implemented numerous policies in reducing GHG emission of which Electric Vehicles are an interesting option. Electric vehicles (EVs) are interesting as a result of new technology they deploy, which can reduce GHG emission and friendly to the environment. This study, therefore aims to investigate EVs factors and their important by using SWOT analysis. We analyzed the strength, weaknesses, opportunities and threats related to EVs adoption in Thailand. We also established strategies for EVs adoption, via competition and attractive investment to entice local and international investors, gather and share information on countries that adopted EVs, encourage communities in discussion about EVs technology, smart grid designation, deploying well trained technicians, as well as EVs supporting policies and promotion. The result showed that policies on EVs in Thailand are concentrated on providing support to only manufacturers, entrepreneurs and importing car companies. While, the consumers support' policies are given lesser importance. These findings are important for the relevant authorities in Thailand in developing appropriate EVs policy for sustainable transportation.

Keywords: Transport, electric vehicles, SWOT, Thailand, policy

1. Introduction

Transport activities are one of the major contributors to GHG emission and cause air pollution in major cities. In 2017, Thailand's final energy consumption of was 80,752 ktoe. The transport sector took the chunk of this consumption constituting about 40.1%, followed by industrial at 35.2%, residential at 13.3%, commercial at 8.1% and agriculture at 3.3% [1]. The transport activity can be divided into roadways, airway, waterways and railways at 77.05%, 18.23%, 4.50% and 0.22%, respectively of the total transport activity. In terms of fuel type usage diesel constituted the highest with 43% followed by gasoline, jet fuel, natural gas, LPG and fuel oil at 25%, 17%, 7%, 5% and 3%, respectively [1]. Biodiesel, ethanol, natural gas, hydrogen and electricity are used as alternative fuel for vehicles. This could reduce fossil fuel consumption, thereby reducing theCO_2 emission in transport sector. Electric vehicles have been considered as alternative vehicles to internal combustion engines vehicles (ICEVs) as it reduces air pollution such as GHG emission and particulate matter ($PM_{2.5}$, PM_{10}) and provide a solution for sustainable transport [2]. Thai government is interested in EVs technology and launched policies to promote EVs in 2015 which marked the beginning of EVs in Thailand. However, the adoption EVs is quite low at 0.32% of the total number of registered vehicles (i.e. 123,967 EVs compared to 38.2 million cars registered with the Department of Land Transportation) [3].

A strategic planning process is required for successful EVs policies and planning. This process involves the utilization of a simple but powerful tool called SWOT. The SWOT stands for strengths, weaknesses, opportunities and threats. SWOT analysis has two dimensions, internal and external. The internal dimensions include factors from strengths and weakness while external dimensions include factors associated with opportunities and threats [4].

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This study aims to investigate EVs factors and their importance by using SWOT and TOWS. The Thailand EVs policies are described in next section. Methodology section showed the SWOT and TOWS analysis. In the final section, the results and discussions will be presented.

1.1 Electric vehicles (EVs)

Nowadays, internal combustion engine vehicles are developing engine technologies as it pertains to their energy efficiency levels, energy recovery system as well as higher emission standard [5]. On the other hand, an alternative vehicles technology was developed referred to as EVs which have potential to reduce fossil fuel usage, friendly to the environment, less pollution, efficient in the consumption of energy [6] and can support electricity grid through smart grid f9or example vehicle to grid (V2G) [7-9], grid to vehicle (G2V) [7-8], vehicle to building (V2B) [10] and vehicle to home (V2H) [10]. Electricity vehicles (EVs) including battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and hybrid electric vehicles (HEVs).

1.2 Thailand EVs policy

Several policies on EVs have been implemented, serving as basis for the long term EVs adoption in Thailand. These policies are formulated by several Ministries but have one goal which is to ensure successful EVs adoption in Thailand. As stated previously, Thailand launched EVs policies in 2015 and have developed an EVs adoption roadmap in order to reform efficiency in the use of energy, increase energy security, as well as alternative energy usage, reduce oil import from abroad and environmental consciousness. Ministry of Energy plays a key role in collaboration with Ministry of Finance, Ministry of Natural Resources and Environment, Ministry of Science and Technology, Ministry of Industry, Ministry of Transport, Ministry of Education, Office of the National Economics and Social Development Board (NESDB), The Board of Investment of Thailand (BOI), office of Energy Regulatory Commission (ERC), Electricity Generating Authority of Thailand (EGAT), Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) to formulate and implement policies on EVs. All these institutions agreed to promote EVs in public transport using buses in the first stage and then in the second stage, extend and promote personal EVs. Below are described the implemented policies in Thailand as table 1.

Table 1 - Electric vehicles policy in Thailand

Ministry/ Department	Policy
National Science and Technology Development Agency (NSTDA)	Thailand would be an ASEAN BEV hub by promoting EVs in 4 key areas including [11] - Electric buses, with the capacity to produce 1,000 buses per year in Thailand. - Modified electric vehicles, promoting research and development of prototype modified electric vehicles and distribute to vehicle modification entrepreneurs. - Personal EVs, which as a start requires policies to promote imported EVs for intensive usage. Then the automotive industry will adapt to market condition with government support to promote investment in Thailand. - Supporting research and development of EVs parts and equipment such as electrical dispensing heads, charging stations, batteries and motors. These require the setting up of Thailand EVs' standard and guidelines for researchers and developers.
Ministry of Energy	Provided Energy Efficient plan (EEP2015) which aimed to preserve overall energy consumption at 51,700 ktoe which transportation sector took 30,213 ktoe. This plan has a goal of reaching a total EVs of 1.2 million vehicles by 2036 [12]. EEP2018 was updated to preserved overall energy consumption at 49,064 ktoe which transportation sector took 17,682 ktoe [13]. This updated plan promoted EVs charging station mapping installation covering community areas, gas station, shopping malls, commercial building, office building and main road between cities. Public and private sectors were allowed to apply funding from Energy Conservation And Promotion Fund Office for the purpose of sufficient number of charging stations and created confidence among EVs' users and

	stimulated EVs market widespread.
Energy Policy and Planning Office (EPPO)	Made an energy plan for EVs promotion in Thailand which is divided into three stages Stage 1: Preparation of EVs adoption (2016-2017). At this stage the focus was on piloting public electric buses as it has potential to benefit more people and development of infrastructure to support the promotion of future EVs. Moreover, this stage provided system grid, charging station and planning for future policy, law, preparation of staffs in EVs automotive industry and support research and development in EVs. Stage 2: Extend public electric buses and preparation of personal EVs (2018-2020). This stage provided more support for public infrastructure due to increasing public electric buses. The standard of charging station was determined and permission requested for service electric charging station. In addition, this stage studied and set measurement to motivate private sector to invest in development of charging station. Electricity price and service rates were measured for EVs and charging station. Stage 3: Promoting personal EVs (2021 onwards). The electricity infrastructure would be developed to support the increase amount of personal EVs as EV smart charging. Furthermore, Thailand electricity demand will be managed with EVs as vehicle to grid (V2G) [14]. EPPO and Energy Conservation and Promotion Fund Office set up a project to support charging station investment. This project aimed to construct 100 charging stations in three years by assigning EVAT as a handler.
Office of Energy Regulatory Commission (ERC)	Responded to study and defined electricity tariff for EVs, studied rules and regulation of licensing of EVs charging stations and prepared safety standards for setting up charging stations. [15]
Thai Industrial Standards Institute (TISI)	Established industry standard products related to EVs by referred to the UN regulation and European Union's regulation related to EVs for example UN regulation No. 100 Revision 2 Uniform provision concerning the approval of vehicles with regard to specific requirements for the electric powertrain.
Customs department and BOI	Provided EVs investment in Thailand by creating tax incentives for investors, customs deduction for imported EVs and EVs' parts and equipment. BOI attracted car makers' investment in EV manufacturing through investment incentive and strategic location of Thailand. BOI approved several projects of all types of EVs which were produced in country including HEVs, PHEVs, BEVs from car makers.
The Excise Department	Took the responsibility for the determination of EVs excise tax and Eco car promoting policies.
Bangkok Mass Transit Authority (BMTA)	Planned the provision of 200 public electric buses.
Office of Industrial Economics (OIE)	Discussed with entrepreneurs with regard to the framework and guidelines to promote EVs production in Thailand. The EVs production goal is 1.25 million car which equal to 50% of total car production in 2035 and 100% in 2040.
EGAT, MEA and PEA; three major electricity authority	EGAT did as following: - Provided pilot demonstration using public electric minibus and built charging stations for visitors at EGAT learning center, headquarters. - Provided pilot project by using smart grid for EV demand management. - A Project studied and developed standards and high

	efficiency criteria to support No.5 labeling for electric vehicles and charging stations. Label No.5 use to indicate the level of electricity consumption and some basic information of electrical appliances such as performance and cost per year. MEA set up four charging stations to support pilot public electric buses of BMTA. PEA projected a pilot electric public buses and set up four charging stations for tourist convenience between Suvarnabhumi airport to Pattaya route. [16] Three major electricity authority and ministry of energy studied and planned a developing electrical infrastructure to support EVs through development of electrical connection and interoperability, determined price and service, implemented suitable energy consumption standards for EVs as well as any regulations related to the operation of the three major electricity authority.
Department of Land Transport (DLT)	Updated the DLT Announcement for registration of EVs. DLT also provided a study to prepare the draft safety requirements for electric cars and electric motorcycles as international standards. Moreover, DLT proposed guidelines, regulations and procedures for checking the condition and equipment for inspection Electric car and electric motorcycles suitable for Thailand.
Electric Vehicles Association of Thailand (EVAT)	Create a platform for discussions on EVs between universities, researchers and private sectors as it pertains to EVs. [17]
Petroleum Authority of Thailand (PTT)	Electric bus pilot project was demonstrated through shuttle staffs from head office to BTS Mo-chit skytrain.

2. Methodology

SWOT analysis was used to indicate the key internal and external factors of the EVs in Thailand. The relevant SWOT factors for analysis considered by review of scientific literature e.g. [18], [19], [20], [21]. The matching of internal and external factors are done to create strategic matrix for analysis framework or TOWS. The TOWS matrix includes opportunities - strengths (O-S), threats - strengths (T-S), opportunities - weaknesses (O-W) and threats - weaknesses- (T-W) [21].

In this study, the analysis stages were as follows:

a) Identification of the strengths, weaknesses, opportunities and threats.

b) Comparison between internal and external factors as stated above.

	Helpful	Harmful
Internal factor	Strengths	Weaknesses
External factor	Opportunities	Threats

Fig. 1 - SWOT analysis

3. Results and Discussion

3.1 Strengths, Weaknesses, Opportunities, Threats

We were able to identify 6 possible strengths, 5 possible weaknesses, 7 potential opportunities and 5 potential threats for EV adoption in Thailand. All factors are shown in Table 1.

The strengths are positive internal factors. We found that EVs are environmentally friendly and reduce GHG emission. EVs use battery as a major energy source for the engine, thus zero emission from its tailpipe. However, the production of this energy maybe CO_2 intensive especially when the source of electricity emanates from fossil fuel or other renewable energy sources. According to the Office of Energy Efficiency and Renewable Energy, US department of energy, claimed EVs convert about 59-62% of electric energy from battery to power at the wheels while ICEVs

convert about 17-21% of energy stored gasoline to power at the wheels. Therefore, in terms of power efficiency EVs generate three times as much as power as ICEVs. In terms of operating cost, EVs are relatively cheaper than ICEVs as EVs require only electric charging and the price of electricity is stable compared to fossil fuel. In addition, EV engines have less complexity and need no oil or lubricant compared to ICEVs. EVs utilize electric motor and have simple speed transmission that can result to low maintenance, increase safety, quick and quiet engine. On the other hand, ICEV engines have many mechanical components which require schedule maintenance for example oil changes, spark plugs and drive belt.

The weaknesses are negative internal factors. We found that performance limit e.g. range or distance limitation are the major obstacles which directly affect purchase decision. Charging time is another factor which take 5 - 8 hours and causes inconvenience to EV users. In addition, EVs especially BEV banks on the battery as the main source of power. The battery lifetime is at eight-years less or more depend on the usage and treatment. Both cold and hot temperatures have adverse effects on the battery life. Some EV company offer warranty of their EV battery at five or eight years. Thus, EV owners have to replace battery every eight year. The current EV charging infrastructure in Thailand stood at 1,200 stations around the country and are available only in Bangkok and few tourist cities which include Hua-hin, Chiang-mai and Pattaya. This is inconvenient to EV users and affect the purchasing decision. The high cost of EVs over ICEVs is also an obstacle for the low purchasing power of potential customers. In addition, the availability of limited EV model in the market (i.e. two or three models) from each car dealer resulting into limitation of users' choice.

The opportunities are positive external factors. We note that the sustainable transport is a global trend which focus on social, environmental and climate impacts especially the issue of energy supply source in transport sector. Higher fossil fuel prices will drive adoption of EVs faster and make people gain more interest in EVs. We also expect EVs to become more popular, more available and more competitive within the industry which would lead to reducing the price of EVs compared to ICEVs. Developing new EV technology requires research and study of available supporting grants for ICEVs or EVs by companies or government. In addition, we expect that the increasing EVs' users will also share their experiences, problems and discussion with users or potential users who might be interested in EVs through EVs user community group such as blog, social media and web board.

The threats refer to negative external factors. It is noted that large scale investment is a prerequisite for development of EVs' infrastructure as the technology is at a developing state in Thailand. The availability of infrastructure can drive EV adoption as users do not have to worry about where to charge during long distance trips. Challenges as regard to the grid infrastructure are often faced as most EV users are expected to charge in the evening after working hour, which can peak the demand. In 2019, the highest electricity demand of Thailand is recorded at 30,120.2 MW in April at 8.29 pm. Therefore, charging EVs in the evening will significantly increase electricity demand in the future and might cause the problem provided there is no sufficient grid management system. Competition issues with ICEVs market make EVs difficult to penetrate as a result of price and limitation of car model. The ICEV prices are relatively cheaper compared to EVs with ICEVs infrastructures well established. Moreover, the future of EVs is uncertain as it is new technology and requires designation and development of technical standards. In addition, the lack of adequate nationwide technicians and mechanics of EVs to support after sale service is an obstacle. Current technicians and mechanics provide maintenance and repair services for ICEVs and not EVs.

Table 2 - Overview of SWOT factors

	Strengths		**Weaknesses**
S1	Environmental friendly	W1	Performance limit (range, charging time)
S2	High efficient engine	W2	High price of EVs
S3	Low operating cost (No fuel or gas cost)	W3	Battery life and battery replacement
S4	Low maintenance	W4	Inconsistence infrastructure
S5	Zero tailpipe emission	W5	Limit consumers' choice
S5	Safety to drive		
S6	Quiet and quick		
	Opportunities		**Threats**
O1	Global trend of sustainable transport	T1	Large scale investments are require for development of EVs infrastructure.
O2	Increasing fossil fuel price	T2	Grid infrastructure challenge
O3	Reduction of EVs price compared to ICEVs	T3	Competition with ICEVs market
O4	Growing consumers' interest	T4	Uncertainty of EVs future (standards, technical)
O5	EV social network (web board, social media)	T5	Lack of nationwide technicians and mechanics of EVS
O6	Research grant for EVs and new technology		
O7	EVs industry competition		

3.2 TOWS Matrix

A comparison of opportunities and strengths (O-S) can describe how opportunities may be capitalized upon in the face of the prevailing strengths. Favoring factors for EVs adoption in Thailand are the global trend for sustainable transport and competition among EV companies which could render EV technology widely available and reducing cost of EVs. The government policies should promote and support EVs manufacturers, EVs entrepreneurs and customers which would facilitate fast adoption of EVs.

Opportunities and weaknesses (O-W) comparison, explain show weaknesses can trigger opportunities to be exploited. With the availability of sustainable transport and research grant EV technological development would eliminate the barriers to EV penetration i.e. performance limit, charging time, battery life and EV models. The increase in EV users might lead to building a communities or network of experience sharing and discussions.

Threats and strengths (T-S) identifies how strengths may defend and counter the treats. A smart grid infrastructure management could be beneficial to the community as EV battery could be used as electricity storage to support the grid during peak hours as in the case of V2G, V2B and V2H. The electricity grid should be designed to support EV connection.

Threats and weaknesses (T-W) serve as the defend strategy to ensure that weaknesses do not serve as threats. The EV companies should collaborate in terms of technology transfer, create, and standardize parts or components as well as distribute trained technicians and mechanics around the country. The adoption of EVs cannot happen if companies are left to do it alone. Thus, government should implement policy to support EV companies and consumers through promotion, incentives, subsides and other benefits for EV users.

4. Conclusion

The result showed the analysis of EV adoption in Thailand using SWOT and TOWS. The adoption of EVs and development of charging infrastructure in Thailand required a collaborative effort amongst manufacturers, entrepreneurs, government as well as universities. Thai government focused on supporting EV manufacturers, importers by using tax incentives and innovative funding. In Thailand, the distribution of EVs is limited in urban area and some touristic cities. The following are the key recommendations that could lead to the establishment of a strategy for EVs adoption, promote competition and attract investment as means to entice the local and international investors, as well as gathering and information sharing with adopted EVs countries, encourage communities in discussion about EV technology, smart grid designation, deploying well trained technicians, EVs supporting policies and promotion.

Acknowledgement

Thomas Brudermann (University of Graz) is thanked for his constructive comments and feedback to this paper. This work was supported by Scholarship Awards for Thai Ph.D. students under Thailand's Education Hub for Southern Region of ASEAN Countries and Overseas Thesis Research Scholarship.

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