EXPLORING TÜRKİYE'S POTENTIAL IN E-MOBILITY WITH PATENT PERSPECTIVE

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ETHICAL DECLARATION

I hereby declare that I am the sole author of this thesis and that I have conducted my work in accordance with academic rules and ethical behaviour at every stage from the planning of the thesis to its defence. I confirm that I have cited all ideas, information and findings that are not specific to my study, as required by the code of ethical behaviour, and that all statements not cited are my own.

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ABSTRACT

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Master's Program in Sustainable Energy

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It is a well-established fact that electric vehicles (EVs) contribute less to overall air pollution. This thesis focuses on the development of Türkiye's e-mobility sector, highlighting the role of climate change mitigation technologies and emphasizing the significance of patents. The aim is to understand how e-mobility impacts Türkiye's economy and its position in the global e-mobility ecosystem, investigating best practices, patent importance, and the potential of local companies. The six chapters of the thesis provide recommendations for Türkiye's sustainable e-mobility technology development by examining the overall sustainable e-mobility technology development in Türkiye and selected countries with the best e-mobility practices. By emphasizing collaboration among science, technology, and innovation stakeholders, the thesis identifies challenges in research, technology, and human resources, underscoring the importance of sustainable capability creation, intellectual property development, and collaboration. Key priority areas include ecosystem and network development, value-

added production, human resource development, and strengthening the innovation and entrepreneurship ecosystem. The thesis highlights the essential role of product and process innovations for internationalization in the e-mobility sector, emphasizing the importance of result-oriented studies and application-oriented R&D organizations for SMEs. In addition, the thesis recommends raising awareness of grants and funds, improving access to finance, and fostering collaboration with investors to enhance growth opportunities for small companies. It emphasizes the necessity of improving Türkiye's investment environment, underlining the importance of clear key target indicators and comprehensive planning involving all ecosystem actors to research and develop newer technologies.

Keywords: patents, sustainability, e-mobility, EVs, Espacenet, ecosystem analysis.

ÖZET

TÜRKİYE'NİN E-MOBİLİTE POTANSİYELİNİN PATENT PERSPEKTİFİYLE DEĞERLENDİRİLMESİ

Seyhan, Elif

Sürdürülebilir Enerji Yüksek Lisans Programı

Tez Danışmanı: Prof. Dr. Muhittin Hakan DEMİR

Ocak, 2024

Birçok yerde kanıtlanmış bir gerçektir ki, elektrikli araçlar genel hava kirliliğine daha az katkı sağlamaktadır. Bu tez, Türkiye'nin e-mobilite sektörünün gelişimini, iklim değişikliği azaltma teknolojilerine, patentlerin rolünü vurgulayarak, odaklanmaktadır. Tez, e-mobilitenin Türkiye ekonomisinde ve küresel e-mobilite ekosistemindeki konumunu anlamayı, bu konuda en iyi uygulamaları olan ülkeleri, patentlerin önemini ve yerel şirketlerin potansiyelini araştırmayı amaçlamaktadır. Tezin altı bölümü, genel olarak, Türkiye'nin ve seçilen örnek emobilite ülkelerinin sürdürülebilir e-mobilite teknolojisi gelişimini inceleyerek Türkiye için öneriler sunmaktadır. Bilim, teknoloji ve inovasyon paydaşları arasındaki işbirliğini vurgulayan bu tez; araştırma, teknoloji ve insan kaynaklarında karşılaşılan zorlukları belirlemekte ve sürdürülebilir yetenek oluşturmanın, fikri mülkiyet geliştirmenin ve işbirliğinin önemini vurgulamaktadır. Ana öncelikli alanlar, ekosistem ve ağ geliştirmesi, katma değerli üretim, insan kaynakları geliştirmesi, inovasyon ve girişimcilik ekosisteminin güçlendirilmesini içermektedir. Tez, e-mobilite sektöründeki uluslararasılaşma için ürün ve süreç

yeniliklerinin hayati rolünü vurgulayarak, sonuç odaklı çalışmaların ve KOBİ'ler için uygulamaya yönelik Ar-Ge kuruluşlarının önemini vurgulamaktadır. Küçük şirketler için büyüme fırsatlarını artırmak için tez, hibe ve fonlara dikkat çekme, finans erişimini iyileştirme ve yatırımcılarla işbirliğini teşvik etmeyi önermektedir. Tez, Türkiye'nin yatırım ortamını iyileştirmenin gerekliliğini vurgulayarak, yeni teknolojilerin araştırma ve geliştirilmesi için tüm ekosistem aktörlerini içeren açık hedef göstergeler ve kapsamlı planlamayı önemsemektedir.

Anahtar Kelimeler: patentler, sürdürülebilirlik, e-mobilite, Elektrikli Araçlar, Espacenet, ekosistem analizi.

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LIST OF ABBREVIATIONS

CPC	Corporate Patent Classification
e-mobility	Electric Mobility
EVs	Electric Vehicles
ICT	Information and Communication Technology
IP	Intellectual Property
IPC	International Patent Classification
OEM	Original equipment manufacturer
R&D	Research and Development
SMEs	Small and medium-sized enterprises
WEF	World Economic Forum

CHAPTER 1: INTRODUCTION

E-mobility is becoming more popular and is expected to continue growing. This growing tendency is mainly because electric vehicles help us shift away from fossil fuels that produce CO2, reducing greenhouse gas emissions and air pollution. So, what are the definitions of e-mobility and EVs, and what are the main differences between these e-mobility and EVs that are mentioned so much everywhere? E-mobility means, in a general way, electrifying the way we move (Melissa, 2023). EVs are gaining popularity, with registrations growing from 3.7 million units in 2017 to 11.8 million in 2021 (Melissa, 2023). It is not just about electric cars; e-mobility includes e-buses, car sharing, e-scooters, e-bikes, and more. The growth of e-mobility should also involve developing various transportation options and infrastructure, revolutionizing how people choose their mode of transportation.

Climate change is a big challenge globally, and finding solutions is crucial. Patents are vital in developing technologies that can help tackle climate issues (Oyebanji et al., 2022). This thesis focuses on e-mobility ecosystem in Türkiye by concentrating mostly on the e-mobility patents. A perspective on climate change mitigation technologies related to transportation (e-mobility), contribution level to the regional economy, and the current status of the e-mobility sectoral strength in its involvement in the global value chain were examined in this thesis.

This thesis also tries to understand Türkiye’s e-mobility ecosystem by concentrating on the best practices regarding the e-mobility sector, e-mobility patents, and the potential of domestic e-mobility companies. Firstly, understanding why patents matter helps us see how they encourage new ideas, protect intellectual property, and help share technology. Thus, the thesis aims to uncover how patents impact the development of technologies that combat climate change. Secondly, the thesis aims to look into Türkiye's potential for investing in climate-change mitigation technologies related to transportation by exploring the pros and cons. Hence, the thesis aims to understand the challenges and opportunities Türkiye faces in becoming a better version of sustainable transportation innovations. Thirdly, the thesis aims to make recommendations from the perspective gained during the thesis by concentrating on patents to contribute to literature for strategic investments in technologies that align with the nation's goals for sustainable development.

With the research questions below, an attempt was made to develop an understanding of Türkiye's role in the world of e-mobility patents:

1. Why are patents important, and how do they contribute to the development of climate-change mitigation technologies?

2. Is Türkiye suitable to invest in climate change mitigation technologies related to mobility by considering the cases in terms of Y02T10/00, Y02T30/00, and Y02T90/00?

3. What can be suggested for Türkiye?

This thesis consists of six chapters.

Chapter 1 sets up the thesis's topic, purpose, and relevance. Additionally, it explains the research questions.

Chapter 2 describes relevant research with the thesis topic the literature review. The indicators used to design an ecosystem analysis index are presented in Chapter 5. Chapter 2 also outlines how the thesis is carried out.

Chapter 3 illustrates the methodology to construct Türkiye's e-mobility ecosystem from the patent perspective. It also discloses the countries that are part of the comparison tables. Furthermore, the thesis provides an online capability survey guide; for the development of the thesis, a capability survey for the e-mobility sector is developed with the e-mobility companies in Türkiye. A capability matrix is the map developed for the e-mobility sector in Türkiye, considering the fields of activity, products and services of all companies operating in the sector. Thus, the survey aims to map the skills activities and gather the required information considering e-mobility companies' capacity in Türkiye.

Chapter 4 presents the findings and analysis of the capability survey results under six sub-headings. The analysis was designed to determine e-mobility companies' capabilities and the e-mobility sector's patent environment in Türkiye. Chapter 4 will try to reach the manufacturing and service providers operating in the e-mobility sector and draw a simple picture of what level Türkiye is in this regard and what level it can be reached. After doing this, the thesis will look at the patents of leading countries in

this field, such as Germany, Norway, and Spain, and try to help them shed light on Türkiye.

Chapter 5 introduces the research questions in detail by categorizing the comparison countries. For the e-mobility sector, an international pre-study was needed to get a sectoral outlook. Therefore, the chapter is initiated by the definition and importance of intellectual property rights/patents. Furthermore, this chapter includes the e-mobility patent ecosystem analysis using Türkiye and selected countries with a comparison table of international IP Espacenet patent levels of countries selected.

Chapter 6 is the conclusion part of the thesis. It provides a final evaluation of Türkiye's e-mobility ecosystem. It concludes the discussion by suggesting recommendations for future research in the Turkish e-mobility ecosystem literature by considering the thesis results.

The main output of this thesis is the e-mobility technology levels analysis of the comparison countries and Türkiye's capability in this regard, which will serve as the basis for formulating the suggestion development process. This thesis reveals the results of the e-mobility technology analysis conducted on the e-mobility sector to identify sectoral capabilities, contribution to the region, the current level of sectoral competitive advantages and disadvantages in its involvement in the global e-mobility ecosystem, and the state of intellectual property and public-private partnerships.

CHAPTER 2: LITERATURE REVIEW/THEORETICAL FRAMEWORK

The literature review noted that questions were directed to consumers on climate-related patents for e-mobility. On the other side, in this thesis, EV Manufacturers, Charging Infrastructure Providers, Battery Manufacturers, Mobility Service Providers, Component and Technology Suppliers, Electric Bike and Scooter Manufacturers, and Energy Providers under e-mobility service sector and e-mobility manufacturing sector 2 main headings have been chosen as the main focus. The reason for choosing all e-mobility sector value chain suppliers is to map Türkiye's e-mobility sector, as no existing literature on this specific subject has been identified.

As mentioned in the previous chapter, clean energy technologies play a crucial role in mitigating climate change, and the transportation sector, particularly e-mobility, holds great potential for reducing greenhouse gas emissions. Analyzing patent data by considering the comparison countries' current status provides valuable insights into technology trends and innovation in this field. This literature review examines relevant studies that utilize patent classification codes to see what has been done until now to analyze clean energy technology trends.

Analyzing patents is important. Regarding this, a study explores the effects of climate-related patents on financial markets. The study, in which Hege et al. utilize econometric calculations, highlights the methodological advantage of patent analysis and finds that companies with positive shocks of climate-related patent grants experience significant cumulative abnormal returns and a reduction in the implied cost of capital, indicating the financial market's response to corporate climate. Other than this kind of study, in the literature, it was found that carbon tax and its relation to patents have also been investigated action (Hege, Pougetz, and Zhangx, 2022). Moore, Brehm, and Gruhl (2022) examined the impact of a carbon tax on innovations in clean technologies within the transport sector. The study employs patent data and the synthetic control method to estimate the local effect of the Swedish carbon tax reform. At the end of the study, it was found that the carbon tax had positive and economically significant effects on the invention of clean transport technologies, indicating that carbon pricing can stimulate clean innovation and drive the transition to a

decarbonized transport sector. Carbon tax's positive effects on the invention of clean transport technologies tell us that looking at patents may help us understand many things in the e-mobility field. While patents encompass a wide range of content, there is a scarcity of specific studies in the literature that focus on patents within the realm of e-mobility.

Nevertheless, as exemplified by a particular study, comparative patent analysis has been employed to identify global research trends. For instance, this approach was applied to investigate patenting trends in technologies such as battery storage, hydrogen, and bioenergy (Baumann et al., 2021). This thesis examined patent indicators compared with patenting activities across different countries.

In the literature, as mentioned above, there are different approaches to analyzing the patent data, like "Analysis of patent documents with utility mining: a case study of wind energy technology," which presents a novel approach based on utility mining to analyze associations among wind energy technologies. Using patent data, Altuntaş and Gök (2020) identify technology classes associated with wind energy. The results highlight strong associations between certain technologies, indicating potential future development.

Studies in the literature concentrate on specific countries, such as China. According to Altenburg, Corrocher, and Malerba (2022), China is leapfrogging ahead in some domains, such as electric buses and lithium batteries, and rapidly catching up in others, including passenger vehicles, driven by ambitious green transformation policies. The study examined China's efforts to catch up and compete in the electric vehicle industry. By combining patent data and qualitative analyses, this study assesses China's technological capabilities and competitiveness in electromobility. In addition to China's example, Brazil also conducted a patent analysis study on technologies used in agricultural machinery engines that contribute to reducing atmospheric emissions. This study analyzes patent filings in Brazil from 2006 to 2017 related to technologies aiming to reduce pollutant emissions from agricultural machinery engines, investigates the profile of manufacturers in the Brazilian market for agricultural machinery technologies and identifies countries excelling in developing technologies to reduce pollutant emissions (Silveira et al., 2021).

Corporate Patent Classification (CPC) codes are important for analysis.

"Technological evolution of wind energy with social network analysis" study by Altuntaş, and Gök (2020) examines wind energy technologies using social network analysis based on patent information. The relationships among sub-technologies within wind energy using CPC codes were examined thanks to this study. As a result, the study emphasized the significance of wind motors and technologies related to energy conversion or management systems in reducing greenhouse gas emissions (Altuntaş, and Gök, 2020).

In the literature review, the effects of the decisions taken by the country on patents were also examined, as well as the results according to patents. "Does increasing carbon emissions lead to accelerated eco-innovation? Empirical evidence from China" is one example of this kind of literature. It investigates the relationship between increasing carbon emissions and eco-innovation in China. The study utilizes Y02 patents related to technologies mitigating or adapting to climate change and panel data from 30 Chinese provinces (Wang et al., 2019). The research establishes a new theoretical framework and finds that increasing carbon emissions led to accelerated eco-innovation. It also identifies a positive impact of carbon emissions on environmental regulation, which mediates the relationship between carbon emissions and eco-innovation (Wang et al., 2019).

The "Knowledge for a warmer world: A patent analysis of climate change adaptation technologies" study analyzes climate change adaptation technologies (CCATs) in US patents. In the study, Hötte Jee (2022) explores historical patterns and drivers of innovation in CCATs, scientific and technological requirements for their development, and potential technological synergies with mitigation. The research reveals slow innovation in CCATs compared to mitigation technologies. It identifies two main clusters: science-intensive CCATs in agriculture, health, and monitoring technologies and engineering-intensive CCATs in coastal, water, and infrastructure technologies. The study suggests harnessing technological synergies between adaptation and mitigation to achieve both goals effectively (Hötte, and Jee, 2022).

The literature review mostly concentrated on the significance of patents in developing green technologies since the aim was to find studies if selected countries' patent trends could be an example for Türkiye. One of the findings was that the thesis investigated how patents impacted firms' incentives and strategies in green innovation and

discussed the possibility of establishing a European accelerated examination for green patent applications (Xiangning, 2020). In his research, Xiangning emphasizes the advantages of fast-gained patents for European innovators and highlights the benefits of accelerating green patent applications to facilitate the pace of green transformation (2020). Similarly, Urbaniec, Tomala, and Martinez (2021) discuss eco-innovation and the measurement of technological eco-innovation using patent data in their study. They emphasize the importance of green technologies in reducing negative environmental impacts and improving resource efficiency. Significantly, the study analyzes trends in environment-related patents from 2000 to 2017 in countries such as China, Korea, Japan, the United States, and Germany. The research highlights significant progress in environmental technologies, particularly those related to energy generation, transmission, and distribution, closely linked to international environmental policies. The study contributes to the literature on measuring eco-innovation output (Urbaniec, Tomala, and Martinez, 2021).

A study named "Green Innovation Regarding Electromobility in Germany and China: Who and How to Get Involved?" focuses on green innovation in the context of electromobility in Germany and China (Zhao, 2018). This study was considered in the literature review chapter because green innovation regarding electromobility in Germany is a part of this thesis. The study examines the involvement of different actors and utilizes patent analysis to compare the development, collaboration, and diffusion of e-mobility technologies between the two countries. The findings indicate Germany's irreplaceable position in inventive activities, while China is more concerned about emerging technologies in electric and hybrid vehicles (Zhao, 2018).

A critical scientific research review on climate change mitigation in the transport sector presented by Schwanen, Banister, and Anable (2011) identifies prevailing research methodologies. It explores the dominant focus on improvements in transport technologies, pricing, infrastructure, and behavioral change. Although the study was realized in 2011, it is important because it argues for a deeper engagement with theoretical insights from the social sciences to enhance understanding of transport mitigation (Schwanen, Banister, and Anable, 2011). The critical scientific research review advocates for a more pluralistic approach by arguing that combining different theoretical perspectives and engaging in interdisciplinary discussions will lead to richer and more nuanced understandings of effective climate change mitigation in

transportation. Therefore, it is obvious that a cannot be concluded Türkiye just by looking at the patent trends of the countries chosen. However, doing so can create a basis for combining different theoretical perspectives and participating in cross-disciplinary discussions.

By sharing a large patent dataset from 1995 to 2017 and covering major climate mitigation technologies, "Global Trends in the Innovation and Diffusion of Climate Change Mitigation Technologies" discusses global trends in the innovation and diffusion of climate change mitigation technologies (Probst et al., 2021). The study reveals an initial growth in low-carbon patenting rates until 2013, followed by a decline, possibly influenced by declining fossil fuel prices and reduced public funding for green research and development. The concentration of innovation is highlighted, with Germany, Japan, and the US accounting for most global inventions (Probst et al., 2021). Zhang and Fujimori (2020) underline that transport electrification alone may not contribute to climate change mitigation unless fossil-fuel power plants are replaced. However, transport electrification and sustainable shared socioeconomic pathways can facilitate a low-carbon transition. The study also highlights the potential of electric vehicles to reduce the mitigation cost associated with climate stabilization targets (Zhang, and Fujimori, 2020). Therefore, a good patent level may not be the most powerful demonstration of a good e-mobility transition for climate-related actions. It needs to be combined with fossil fuel power plant replacement. A good analysis of the relationship between cities, mobility, and climate change is needed in this respect. In his paper, Banister (2011) argues for reducing energy use and emissions in the transportation sector, particularly in urban areas, to achieve carbon reduction targets. He proposes the concept of sustainable mobility as an alternative approach that focuses on reducing the need to travel within cities. His paper highlights the importance of combining economic, planning, and technological innovations to transition to low-carbon transport futures. In the detailed empirical evidence from 12 European countries, Georgatzi, Stamboulis, and Vetsikas (2019) examines the determinants of CO2 emissions in the transport sector in 12 European countries from 1994 to 2014. The study investigates the impact of environmental policy stringency, climate change mitigation technologies related to transportation, infrastructure investments, and the share of value added by the transport sector on CO2 emissions. The research emphasizes the importance of policies and technological innovation in

achieving a low-carbon economy (Georgatzi, Stamboulis, and Vetsikas, 2019).

According to the systematic review of Kanga, Weia, Liue, Hana, Yua, and Wanga (2020) the literature on energy systems and climate change mitigation was provided. Their study categorizes research based on the energy process, time scale, geographic location, energy technology, and end-use sector. They emphasized the need for more research in underrepresented regions and highlighted the importance of cost-benefit analysis, renewable generation, and the impact of climate change on electricity production in 2020. This shows us that there are still not enough studies in this area.

In the literature, the most similar study content with this thesis was found in "The Road Ahead for e-mobility" report that addresses the road ahead for e-mobility, focusing on mass-market readiness, consumer perceptions, OEM's (original equipment manufacturer) readiness, and business case improvement for EVs. The report acknowledges the growth of EV sales and provides recommendations for OEMs to enhance the consumer experience and drive EV adoption (Tschiesner et al., 2020). However, in this study, it was not found that a direct study was conducted on OEMs.

This literature review highlights various studies that employ patent analysis and classification codes to analyze clean energy technology trends. The selected studies provide insights into the impact of climate-related patents on financial markets, the effectiveness of carbon taxes in driving clean innovation, and the identification of patenting trends across different countries. They also demonstrate the utility of patent data in identifying associations among technologies and assessing technological capabilities and competitiveness in specific sectors. By leveraging patent analysis, researchers gain valuable insights into clean energy technology trends, facilitating informed decision-making and policy formulation to promote climate change mitigation efforts in the transportation sector.

Analyzing clean energy technology trends related to transportation (e-mobility) using patent classification codes provides valuable insights into innovation and climate change mitigation efforts. The reviewed studies shed light on the relationship between carbon emissions and eco-innovation, the slow innovation in climate change adaptation technologies, the significance of patents in driving green technologies, the measurement of technological eco-innovation using patent data, and the role of patents in analyzing global trends in climate change mitigation technologies. Additionally, the

studies explore the potential of transport electrification, the need for sustainable mobility approaches, and the determinants of CO2 emissions in the transport sector. Moreover, the literature review highlights the importance of policies, technological innovation, and the role of energy systems in achieving a low-carbon economy. Finally, it recognizes the need for more research in underrepresented regions and emphasizes the role of manufacturing and services sectors in driving the adoption of electric vehicles.

CHAPTER 3: METHODOLOGY

The methodology selection was the first step of the thesis. Following the methodology selection, the countries to list patents and compare with Türkiye were identified. A literature review was conducted to see what had been done on the topics to be analyzed in the thesis and to create a framework accordingly. Then, online surveys with related companies in Türkiye were held. Prepared and presented tools were conducted, and gathered data was processed for each heading identified in the analysis process.

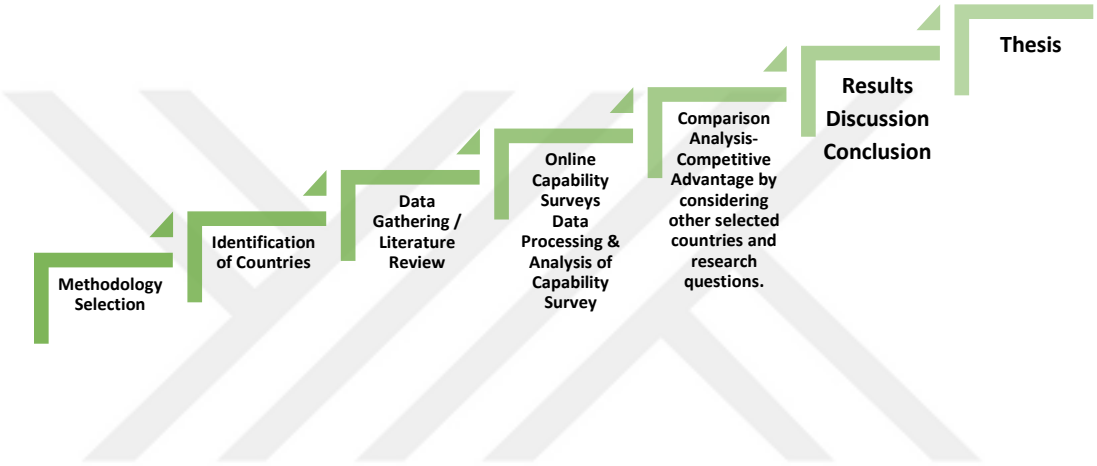


Figure 1. Methodology

3.1. Identification of Countries:

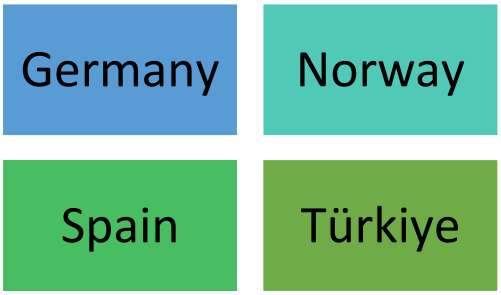


Figure 2. Selected Countries

Choosing Germany, Norway, and Spain as reference countries for e-mobility-related patents with Türkiye has been identified for several reasons. Each country offering unique characteristics and insights for such a comparative analysis according to the desk research. Here are the reasons for selecting these specific countries:

Germany is known for its strong automotive industry, including electric vehicle (EV) manufacturers like Volkswagen, BMW, and Mercedes-Benz. Germany likely has many patents in the e-mobility sector due to its leadership in the automotive industry (Markets and Markets, 2023). Moreover, particularly in cities like Berlin and Munich, Germany is considered an innovation hub for e-mobility and clean energy technologies

(Johnsen et al., 2019). The country's focus on research and development makes it a prime candidate for comparison with Türkiye.

Norway is recognized as one of the world's leaders in adopting electric mobility. The government offers substantial incentives for EV buyers, leading to a high penetration rate of electric vehicles (OECD, 2022). This could result in a high number of patents related to e-mobility technologies. Furthermore, Norway's unique market dynamics and high EV adoption rate may provide insights into the types of e-mobility technologies in demand and the innovations arising (Békés et al., 2023).

Spain has been making significant strides in its transition to clean energy sources, including e-mobility. The country's commitment to reducing carbon emissions and promoting electric transportation may lead to many patents in this field (International Energy Agency, 2021).

Comparing Türkiye with countries like Germany, Norway, and Spain allows us to assess different approaches to e-mobility development. Germany may focus on traditional automotive manufacturing (Sovacool et al., 2019), while Norway could highlight policies that drive consumer adoption (Asgarian et al., 2023). Therefore, understanding the regional variation in e-mobility patents can be valuable. Each of these countries represents a different region within Europe, which can lead to variations in patent trends, technology focus, and market dynamics (Hunkin and Krell, 2022).

In addition to regional variation with different approaches, the availability of patent data and comprehensive information for these countries is another important reason (Haščič, Silva and Johnstone, 2015). It is important to have access to reliable data to conduct a meaningful comparison. There are also differences in government policies and regulations related to e-mobility, which can greatly impact patent activity (Hunkin and Krell, 2022). These countries likely have varying policies that influence patent trends.

The size of the e-mobility market in each country may be a factor (Carlino and Kerr, 2014). Larger markets tend to attract more innovation and patent activity. In addition, investigating the levels of research and development investments in e-mobility by both the private sector and government can offer insights into patent trends (OECD and Appelt, 2015).

Overall, by comparing Türkiye to these countries regarding e-mobility patents, a comprehensive view can be gained of how different factors, such as market dynamics, government policies, and industry strengths, influence innovation in this critical sector. This analysis can provide valuable insights for policymakers, researchers, and businesses involved in e-mobility.

3.2. Data Gathering / Desk Research:

A questionnaire for an online survey was prepared to have a better understanding of the capabilities of the companies in Türkiye. In addition, desk research with the existing resources, industry-related reports and publications, and statistical databases were used to analyze the comparative advantages and weaknesses of the countries.

3.3. Data Processing & Analysis:

In the data processing phase, the data gathered from questionnaires was classified, and reviewing and validating actions were carried out. For the quantitative study, the data was finalized by calculating aggregated statistics from online questionnaires and capability matrices were prepared by using the result of the survey. In the analysis phase, formats, graphs, and tables were designed to visualize the results.

3.4. Online Capability Survey:

The capability survey for the e-mobility sector was prepared to identify the infrastructure that underpins the companies' capabilities. This survey is the baseline of the analysis. The capability survey has been evaluated under the major headings below.

1. Company Profile and Operations:

- ***Objective:*** To comprehend the company's background, scale, and operational experience.
- ***Evaluation Criteria:***
    - Company description and industry tenure.
    - Employee count and revenue range.
    - Market share evaluation.

2. Charging Infrastructure:

- ***Objective:*** To gauge the company's commitment to developing and expanding charging networks.
- ***Evaluation Criteria:***
    - Number and distribution of charging stations.
    - Types of charging stations offered.
    - Supported charging protocols.

3. Collaborations and Partnerships:

- ***Objective:*** To assess the company's network and collaborative efforts within the industry.
- ***Evaluation Criteria:***
    - Existence and nature of collaborations with listed organizations.
    - Partnerships for expanding charging infrastructure.

4. After-Sales Services and Customer Support:

- ***Objective:*** To understand the commitment to customer satisfaction and product support.
- ***Evaluation Criteria:***
    - After-sales services for e-mobility products.
    - Presence of service centers and repair facilities.

5. Intellectual Property and Innovation:

- ***Objective:*** To measure the company's innovation, involvement in patent activities, and its stance in legal matters.
- ***Evaluation Criteria:***
    - Presence and nature of patent/utility model applications.
    - Collaboration in patent disputes or legal processes.

6. Financial and Strategic Considerations:

- ***Objective:*** To evaluate the company's financial decisions and strategic priorities.
- ***Evaluation Criteria:***
    - Factors considered in allocating financial resources to e-mobility ventures.
    - Recommendations for sector development.

7. Overall Comparative Analysis:

- ***Objective:*** To place the company within the context of the broader e-mobility sector in Türkiye.
- ***Evaluation Criteria:***
    - Identification of strengths and unique contributions.

By systematically analyzing company responses based on these criteria, a comprehensive understanding of the e-mobility sector in Türkiye will be derived. This evaluation serves as a valuable tool for stakeholders, investors, and policymakers, providing insights into the industry's capabilities, strengths, and potential areas of improvement. Furthermore, it facilitates the identification of companies that are driving innovation, collaboration, and sustainable growth in the dynamic landscape of Turkish e-mobility.

Table 1. Detailed Capability Survey Plan

Capability Survey	
1.	**Preparation of Methodology**
1.1.	Questionnaire
1.2.	Capability Survey Chapter Format
2.	**Company Selection**
2.1.	List of Potential Companies
2.2.	Meeting with Thesis Advisor
2.3.	Updating the List

Table 2. (Continued)

3.	**Sending Survey to Companies**
3.1.	E-mails
3.2.	Using social media such as LinkedIn
3.3.	Calling People with Contact Numbers
4.	**Preparation of the Chapter**
4.1.	Capability Survey Chapter

Survey Guide

The capability analysis survey has been targeted to be sent to the company owner or the highest-level manager in management. E-mailing and social media accounts have been used to disseminate online capability surveys. The first communication with potential survey participants has been realized via e-mail by sending the survey as an attachment. When an adequate and fast communication could not be achieved via e-mail, LinkedIn has been used as the second step. A short introduction text that consists of the purpose of the activity has been sent to all companies via e-mail and LinkedIn messages.

Table 3. The Survey Questions for Manufacturing Sector Representatives

1. Company Name	
2. City	
3. Name Surname of the Company Representative	
4. Title of the Company Representative	
5. Phone Number of the Company Representative	
6. Email Address of the Company Representative	
1. How would you describe your company or organization?	Manufacturing/Service/Other
2. Please select the management process that applies to your company.	Strategic Management/Research and Development (R&D) Management/Operational Management/Customer Relationship Management (CRM)/Sustainability and

Table 4 (Continued).

	Environmental Management/Financial Management/Risk Management/None/Other
3. How long has your company been operating in the e-mobility sector in Türkiye?	0-5 years/5-10 years/10-20 years/more than 20 years
4. What is the number of employees in your company?	1-10/11-50 employees/51-250 employees/251-500 employees/501-1000 employees/more than 1000 employees
5. What is your company's revenue range?	0-10 million TL/10-100 million TL/100-500 million TL/Over 500 million TL/Other
6. How do you evaluate the market share size of your company?	Market leader - has the highest share in the market/Market pioneer - innovator, one of the first players/We have an average market share/Still trying to gain market share/Other.
7. What electric vehicles are included in your product range? If you produce a different type of electric vehicle or wish to provide details, you can specify in the "Other" section.	Automobile/Scooter/Bicycle/No electric vehicle with our product range. /Other
8. In which types of vehicles are your battery technologies used?	Hybrid Vehicles/Electric Vehicles/Fuel Cell Vehicles/Other
9. Do you manufacture your batteries or source them externally?	We produce it ourselves./We supply it from outside./We produce jointly with external services.
10. What is the capacity of this battery technology, and consequently, how long is the charging time?	0-20 kWh/20 kWh/50 kWh/100 kWh/200 kWh/500 kWh 0-30 min/30 min - 1 hr/1 - 4 hr/4 - 8 hr/8 - 12 hr

Table 2 (Continued).

11. What is this battery technology's average (half-load) range?	Lithium-Ion (Li-Ion): 150-370 km/Lithium-Polymer (Li-Po): 200-450 km/Nickel-Cadmium (Ni-Cd): 80-200 km/Nickel-Metal Hydride (Ni-MH)): 250-500 km/Supercharger (like Tesla): 350-600+ km/Others
12. Which of the following features are present in your e-mobility products? If not, can you explain in the "Other" section?	Fast Charging Technology/Long Range Batteries/Autonomous Driving Capabilities/E-mobility Integration/Connected Vehicle Technology/Other
13. Which necessary safety and environmental standards in Türkiye do your vehicles comply with?	Turkish Highway Traffic Regulation (KTY)/Emission Standards Automobile Safety/Seat Belt and Airbag Standards/Fuel Efficiency and Environmental Certificates/Homologation and Type Approval (Electric Vehicles with Plate / Electric Vehicles Without Plate)
14. Do you collaborate or partner with any organizations listed below? If so, you can indicate the reason for the collaboration.	R&D studies/Project/Developing patent portfolio/Technology or product development/Commercial/Our reason for collaboration or partnership is not found here. (We have collaborations or partnerships with Turkish Government Institutions/Municipalities/Local Companies/International Companies/Research Institutions/Universities/Institutions/organizations other than those listed here. /We do not have collaborations or partnerships with institutions/organizations.)
15. Do you have any patent/utility model applications related to e-	Yes/No

Table 2 (Continued).

mobility?	
16. Has your company purchased patents related to e-mobility from other companies or individuals?	Yes/No
17. Is your company actively conducting R&D to produce new e-mobility-related patents?	Yes/No
18. How does your company's patent portfolio size and scope compare to other domestic e-mobility companies?	Very good/Good/Medium/Low
19. Are there specific domestic e-mobility companies against which your company is particularly strong in terms of its patent portfolio?	Yes/No
20. Has your company been involved in patent disputes or legal processes related to e-mobility in Türkiye?	Yes/No
21. Has your company licensed its e-mobility-related patents to other companies?	Yes/No
22. What factors do you consider when allocating financial resources to e-mobility ventures?	Market Potential/Technology and Innovation/Sustainability/Team Capabilities/Competitive Analysis/Customer Preference/Financial Performance/Legal and Regulatory Compliance/Risk Assessment/Strategic Alignment/Other

Table 2 (Continued).

23. Do you have any recommendations for developing the e-mobility sector in Türkiye?	Open Ended

Table 5. The Survey Questions for Service Sector Representatives

1. Company Name	
2. City	
3. Name Surname of the Company Representative	
4. Title of the Company Representative	
5. Phone Number of the Company Representative	
6. Email Address of the Company Representative	
1. How would you describe your company or organization?	Manufacturing/Service/Other
2. Please select the management process that applies to your company.	Strategic Management/Research and Development (R&D) Management/Operational Management/Customer Relationship Management (CRM)/Sustainability and Environmental Management/Financial Management/Risk Management/None/Other
3. How long has your company been operating in the e-mobility sector in Türkiye?	0-5 years/5-10 years/10-20 years/more than 20 years
4. What is the number of employees in your company?	1-10/11-50 employees/51-250 employees/251-500 employees/501-1000 employees/more than 1000 employees
5. What is your company's revenue range?	0-10 million TL/10-100 million TL/100-500 million TL/Over 500 million TL/Other

Table 3 (Continued).

6. How do you evaluate the market share size of your company?	Market leader - has the highest share in the market/Market pioneer - innovator, one of the first players/We have an average market share/Still trying to gain market share/Other.
7. How many charging stations do you have nationwide in Türkiye?	Open Ended
8. In which cities are your charging stations located?	Open Ended
9. What types of charging stations do you offer?	Fast chargers/Slow chargers/Other
10. Could you select the charging protocols supported by your charging infrastructure?	CCS (Combined Charging System)/CHAdeMO/Tesla Supercharger/AC Charging (Alternating Current)/DC Fast Charge/Other
11. Do you collaborate or partner with any organizations listed below? If so, you can indicate the reason for the collaboration.	Expanding the charging infrastructure/E-mobility projects/Developing the patent portfolio/R&D studies/Technology or product development/Commercial Our reason for cooperation or partnership is not here. (Turkish Government Institutions/Municipalities/Local Companies/International Companies/Research Institutions/Universities/ We do not have any collaboration or partnership with any institution/organization.)
12. What after-sales services do you provide for your e-mobility products?	Technical Support/Maintenance and Repair Services/Warranty Services/Software Updates/Charging Infrastructure Services/Other

Table 3 (Continued).

13. Do you have service centers or authorized repair facilities in different regions of Türkiye?	Yes/No
14. What is your response time to customer complaints or issues?	Response Within 24 Hours/Response Within 48 Hours/Response Within 72 Hours/Response During Working Hours on Weekdays/Varies Depending on the Situation/Immediate Response in Emergencies/We manage our response time in accordance with a specific policy or approach. /Other
15. Do you have any patent/utility model applications related to e-mobility?	Yes/No
16. Has your company purchased patents related to e-mobility from other companies or individuals?	Yes/No
17. Is your company actively conducting R&D to produce new e-mobility-related patents?	Yes/No
18. How does your company's patent portfolio size and scope compare to other domestic e-mobility companies?	Very good/Good/Medium/Low
19. Are there specific domestic e-mobility companies against which your company is particularly strong regarding its patent portfolio?	Yes/No
20. Has your company been involved in patent disputes or legal processes related to e-mobility in Türkiye?	Yes/No
21. Has your company licensed its e-mobility-related patents to other	Yes/No

Table 3 (Continued).

companies?	
22. What factors do you consider when allocating financial resources to e-mobility ventures?	Market Potential/Technology and Innovation/Sustainability/Team Capabilities/Competitive Analysis/Customer Preference/Financial Performance/Legal and Regulatory Compliance/Risk Assessment/Strategic Alignment/Other
23. Do you have any recommendations for the development of the e-mobility sector in Türkiye?	Open Ended

Summary of Analysis

Limitations

During the thesis writing period, five factors affecting limitations have been identified.

Lack of Industrial Data: The e-mobility industry is an emerging sector that has seen rapid growth over the past decades. This sector encompasses companies categorized under various coding systems, making it exceedingly challenging to collect data using conventional research methods. For example, obtaining employment data for the e-mobility sector from national and international sources is very difficult.

Technological infrastructure: Obtaining technical infrastructure data at the machine and equipment level through open-source channels has limitations. Nonetheless, in the survey, there are some questions to assess the technological proficiency in this area and to develop a comprehensive understanding of the technological level.

The scale of the Capability Survey: It was aimed for a more extensive approach in creating the capability survey compared to other national and international examples. Consequently, adapting the "Alignment of E-mobility" capabilities to other sectors in different countries proved more complex. As a result, certain areas of activities cannot be readily compared.

Complexity in obtaining data for surveys: Frequently, companies lack

comprehensive access to management data concerning various aspects, necessitating them to frequently make intricate approximations regarding their manufacturing processes, capabilities, and numerical data.

Lack of Motivation for Filling out a Survey: The sector's significance and potential are on the rise, causing companies within it to be quite busy with limited available time. For this reason, companies face many demands such as information, interviews, surveys, etc. Due to the intensity of demand, companies become bored, and motivation to participate in such activities decreases. Therefore, an effective communication language has been created for the survey.

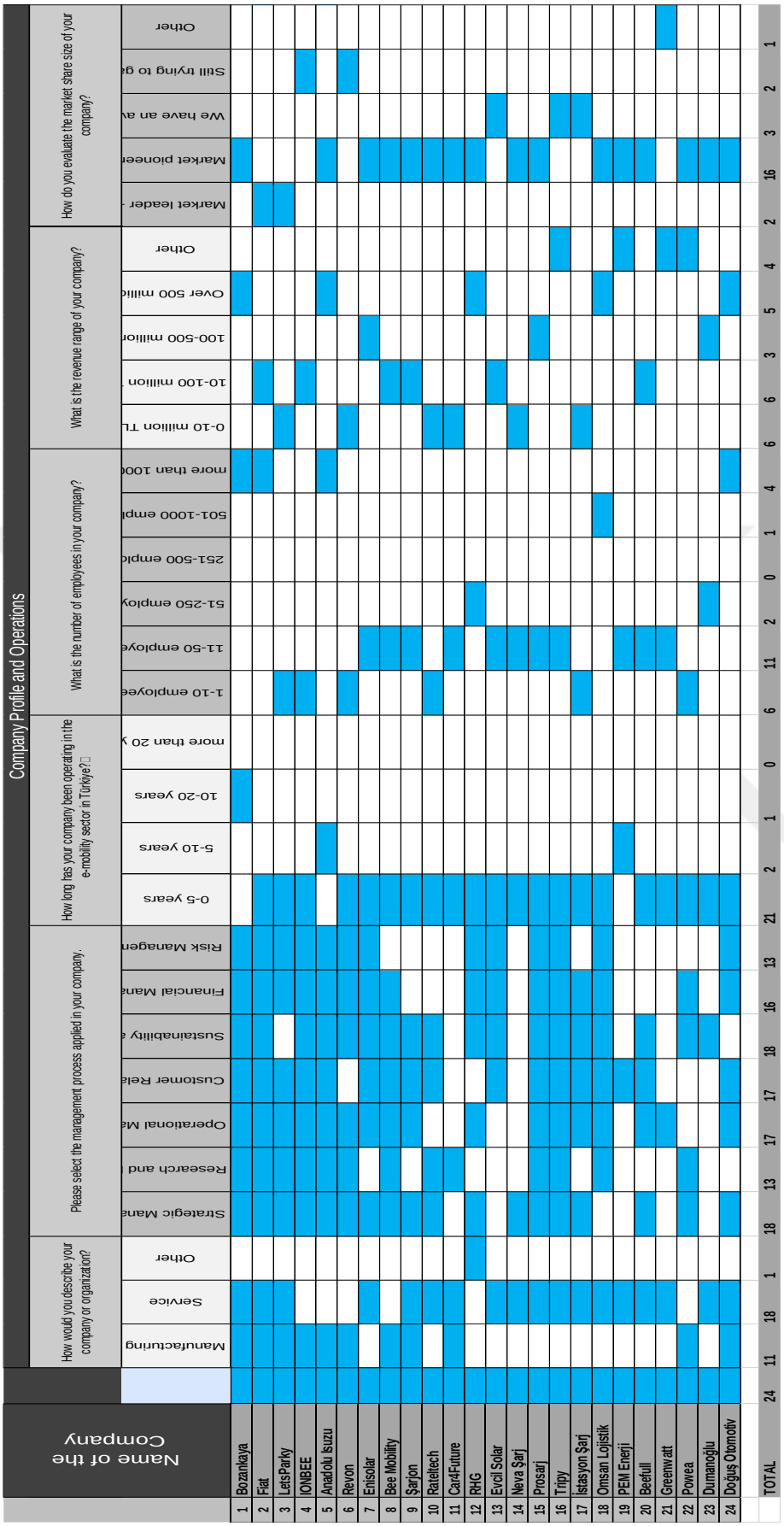
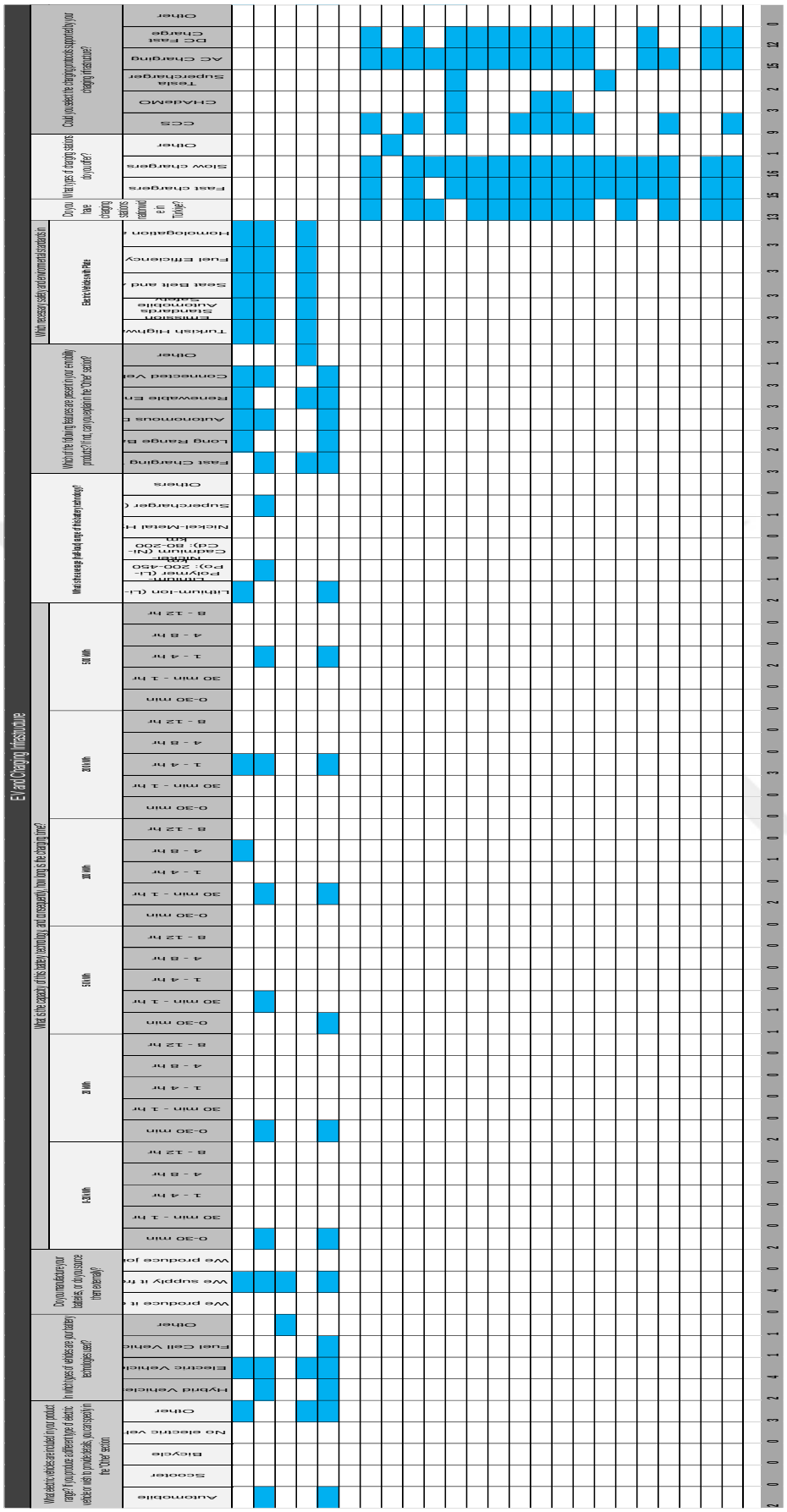


Figure 3. Capability Survey Matrix



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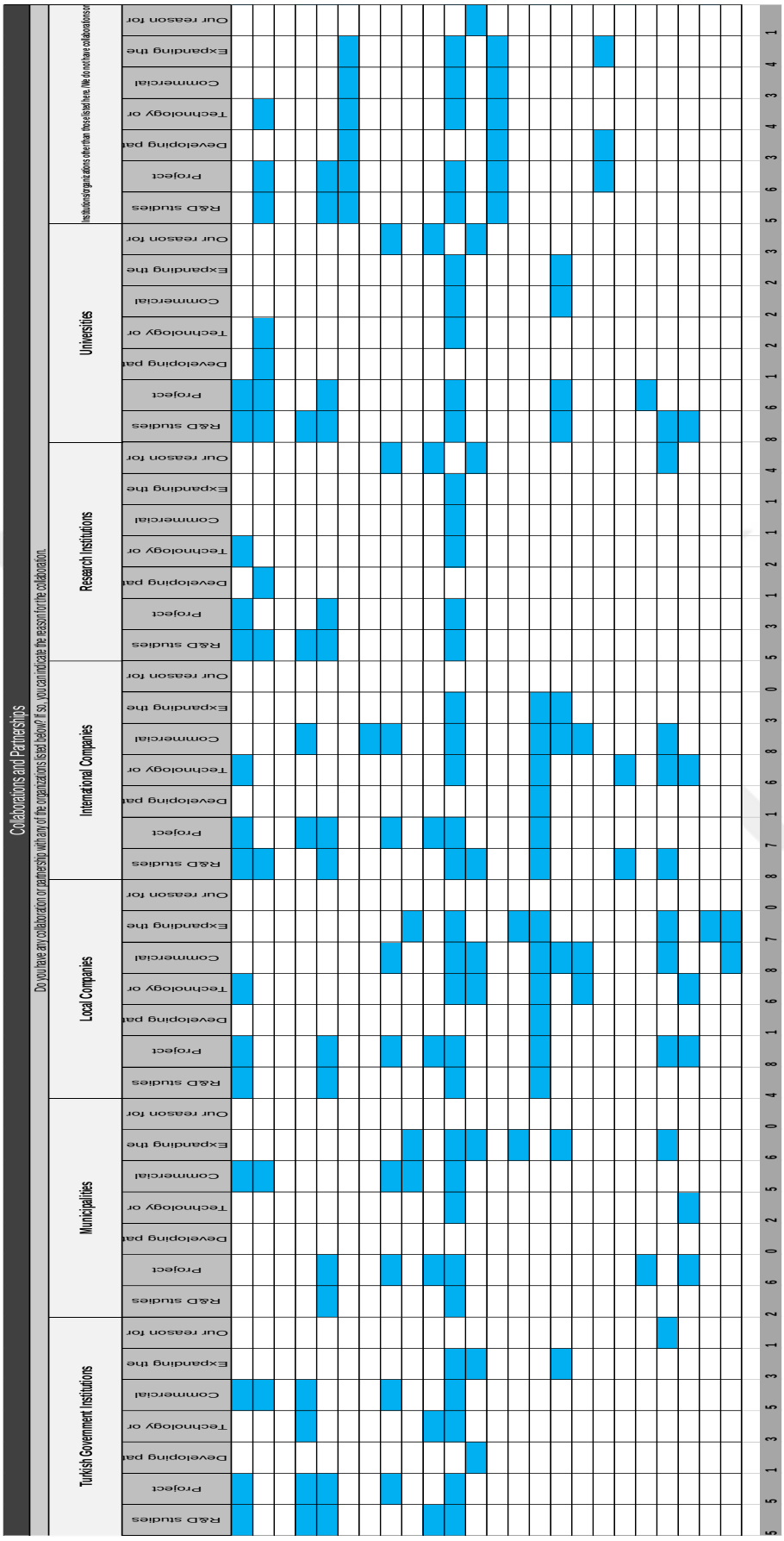

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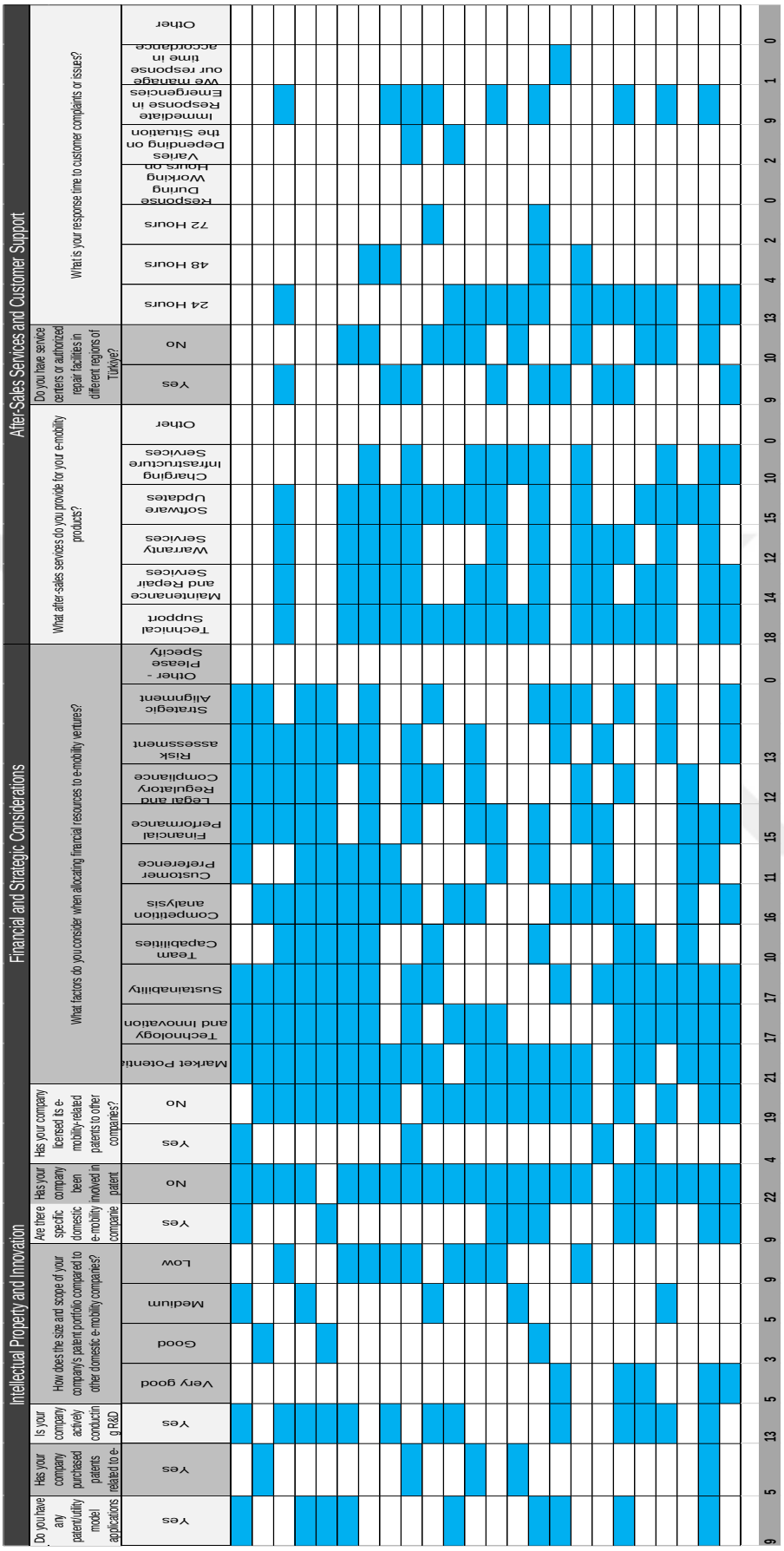


Figure 3 (Continued).

CHAPTER 4: CAPABILITY SURVEY MATRIX FINDINGS

4.1. Company Profile and Operations

The Survey has been designed as a basic-level digital self-assessment tool. Google Forms' capability survey tool is an online tool that allows e-mobility manufacturing and service sector representatives to assess their business performance against expected standards. The tool typically requires the sector representative to input quantitative and/or qualitative information into an online interface. Thus, this online survey has been used to identify the infrastructure that underpins the core competencies of each company. Twenty-six core competencies under 6 headings were defined for e-mobility manufacturing and service sectors. Even though there are slight sector-specific differences between each sector, common headings/areas where core competencies are defined are “Company Profile and Operations,” “EV and Charging Infrastructure,” “Collaborations and Partnerships,” “Intellectual Property and Innovation,” “Financial and Strategic Considerations,” and “After-Sales Services and Customer Support.

Two separate forms with 23 questions have been prepared for both manufacturing and service companies active in the e-mobility sector to see Turkish companies' capabilities. Twenty-four companies filled out the e-mobility capability analysis survey, and the results were analyzed using MS Excel. The distribution of the capability analysis survey with 24 companies is presented below.

Table 6. Number of E-mobility Companies filling out the Survey

Number of E-mobility Companies Filling out the Survey	
Manufacturing Sector	5
Service Sector	13
Manufacturing & Service Sector	6
Total:	***24***

While identifying the companies to be sent the capability analysis survey according to the purposeful sampling methodology, it is observed that the companies operating in

the e-mobility industry in Türkiye are concentrated in the service sector more than the manufacturing sector. In this respect, 131 companies have been identified; 100 operate in the service sector, 13 are in manufacturing, and 18 are in the manufacturing and service sectors.

Please note that all capability matrices in Excel format can be found in Appendix 1. In addition, all responses collected from the companies/institutions in Excel format can also be found in Appendix 1.

Table 7. List of companies to which the survey was sent.

Company	Category
ARIEN SOLAR ENERJİ	Service
AZİMUT SOLAR	Service
BEEFULL	Service
BORUSAN ENBW ENERJI	Service
CAR4FUTURE	Service
DRK SOLAR	Service
ELECTROOP	Service
ENISOLAR	Service
EŞARJ	Service
FONS SOLAR	Service
GAGE OTOMOTİV	Service
G-CHARGE (GERSAN)	Service
HIS SOLAR	Service
LUMHOUSE ENERJI	Service
MARTI	Service
MOBILIZ	Service
OMSAN	Service
PEM ENERJI	Service
SANKO ENERJI	Service
ŞARJON	Service
SCOOTABLE	Service
SHARZ	Service
SMART ENERGY	Service
SMART SOLAR AR-GE ENERJİ	Service
SOLAR3GW	Service
SOLARBABA	Service

Table 5 (Continued).

SOLARTECHNİK	Service
SOLARVIS	Service
SUNSIS	Service
SUNTEK	Service
VOLTRUN	Service
EN YAKIT	Service
PETROL OFİSİ	Service
CW ENERJİ	Service
GREEN SCİENCE	Service
ŞARJET	Service
ARMATEC	Service
RHG ENERTÜRK	Service
ASTOR ENERJİ	Service
ISOMER	Service
STL SOLAR Enerji	Service
WHITE ROSE MOTOR	Service
GREEN WATT	Service
DUMANOGLU ENERJI SWAPP	Service
VIZYONEKS	Service
TORA	Service
AKSA SARJ	Service
MITHRA POD	Service
ÖZKA – PLECO	Service
EVTECH ŞARJ	Service
FASTGO	Service
CARBONAGE	Service
ANTTECH – PETROO	Service
EVCİL MÜHENDİSLİK	Service
GIOEV ŞARJ	Service
VİTALEN ENERJİ	Service
ERC SİSTEM	Service
İSTASYON ŞARJ – ESTASYON	Service
EFAMODA – CAZADOR	Service
FORM ELEKTRİK – EPSIS	Service
MONOKON ELEKTRİK	Service
PROSARJ – GETASOLAR	Service
SOLARPARK - ACIKELAUTOSARJ	Service

Table 5 (Continued).

PIRIM GIDA	Service
SOLARSARJET ENERJI - CLIXOLAR	Service
360 Enerji	Service
MCZ TEKNOLOJI – ALASKA	Service
TUNCMATIK	Service
BAKIRCI MOBILITY - B-CHARGE	Service
FZY ENERGY	Service
NEVA SARJ	Service
INTERDATA	Service
RST CHARGEPOINT	Service
MANAS – MYCHARGE	Service
ATAY GÜÇ – ECOBOX	Service
SARJPLUS	Service
BLADECO	Service
BOLGEM PLUS	Service
VOLNET – VOLTI	Service
PROMASTER -TECH CARE PROMASTER	Service
IMAJ DESIGN - DESIGN & NETWORK IMAJ	Service
ISPIRLI	Service
TRIPY MOBILITY – WAYGO	Service
ZEBRA ELECTRONICS	Service
VOLTGO SARJ – VOLTPO	Service
ARENYA	Service
ARTAS - AVRUPA KENTENERJI	Service
AYDEM PLUS – OTOWATT	Service
KONYA ELEKTRIKLI ARACLAR - KARBON NOTR KONYA	Service
ZEPLIN TURIZM – ZEPLINCAR	Service
AYHAN TEKNOLOJI - AOSTeknoloji	Service
FORSEL	Service
FORTIS	Service
GOSARJ – DYNOPOWER	Service
MIONTI – TOGER	Service
BETA ENERJI	Service
Aküder	Service
POWER SOLAR ENERJİ	Service

Table 5 (Continued).

POWEA	Service
TOGER	Service
ANADOLU ISUZU	Manufacturing
ASPILSAN ENERJI	Manufacturing
EGE FREN	Manufacturing
FEMSAN ELECTRIC MOTORS	Manufacturing
IONBEE	Manufacturing
KARSAN	Manufacturing
TOGG	Manufacturing
VOLT MOTOR	Manufacturing
ZOOP	Manufacturing
WAT	Manufacturing
FIAT	Manufacturing
PROGRESS	Manufacturing
MEGASAN	Manufacturing
BEEMOBS (E-GARAJ)	Manufacturing & Service
BOZANKAYA	Manufacturing & Service
ELDOR ENERJI	Manufacturing & Service
ESA ROHR TEKNİK	Manufacturing & Service
GÜRSAŞ ELEKTROMEKANIK	Manufacturing & Service
HPT HARTNER	Manufacturing & Service
KALYON	Manufacturing & Service
KODECO	Manufacturing & Service
MGM ELEKTRİK	Manufacturing & Service
POWER ELEKTRONIK	Manufacturing & Service
SIEMENS	Manufacturing & Service
SOLGEO	Manufacturing & Service
SOLIMPEKS	Manufacturing & Service
SOLIS	Manufacturing & Service
SUNRA	Manufacturing & Service
ZES	Manufacturing & Service
LET’S PARKY	Manufacturing & Service
REVON	Manufacturing &Service

Location

The target group of this survey consists of companies operating in the e-mobility sector in Türkiye. The distribution of the 24 companies that filled out the survey by location is shown in the figure below. Ten companies are located in Ankara, 6 in Istanbul, 5 in Izmir, 1 in Bursa, 1 in Adana, 1 in Kocaeli and 1 in Nevsehir out of the 24 companies filled the survey.

Figure 4. Location of the companies participating in the survey (Source: paintmaps.com, 2024)

Age

When the companies participating in the survey, it is seen that the number of companies established in the last 5 years is quite high. Most companies established in the last 5 years operate in the e-mobility service sector.

Scale

When the company size is analyzed according to the number of employees, it is seen that most companies participating in the survey are micro (https://www.kosgeb.gov.tr/site/tr/genel/detay/8807/kobi-tanimi-guncellendi) and small-scale companies.

Economical Size of the Sample Group

20 of the 24 companies shared their revenue range data. Most companies participating in the survey are micro- and medium-sized, and large-sized companies have followed them. Moreover, 67% of the respondents evaluate themselves as “market pioneers,” while 13% are “an average,” 8% are “market leaders,” and “still trying to gain market share” in terms of their market share size.

The e-mobility service sector seems dominant over the manufacturing sector in Türkiye. According to the “Company Profile and Operations” heading questions, it is observed that “Strategic Management” and “Sustainability and Environmental Management” capabilities appear to be the strength of 75%, followed by “Operational Management “ and “Customer Relationship Management (CRM)” management competencies with 71%, “Financial Management” are relatively less, while “Research and Development (R&D) Management” and “Risk Management” have the least presence among companies participating in the survey.

Notably, the competencies filled in terms of "Financial Management" are equal to the average of the total competencies.

Table 8. Management Process Competence Ratios

Management Process	**Service & Manufacturing Companies**
Strategic Management	75%
Research and Development (R&D) Management	54%
Operational Management	71%
Customer Relationship Management (CRM)	71%
Sustainability and Environmental Management	75%
Financial Management	67%
Risk Management	54%

4.2. Charging Infrastructure

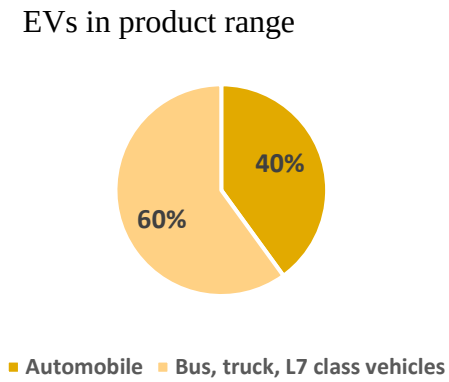


Figure 5. EVs in the product range

The survey aimed to be filled in by manufacturing companies that produce electric bicycles, scooters, etc. However, only automobiles, buses, trucks, and L7-class vehicles were selected as product ranges.

All respondents stated that they supply their batteries from outside instead of producing them.

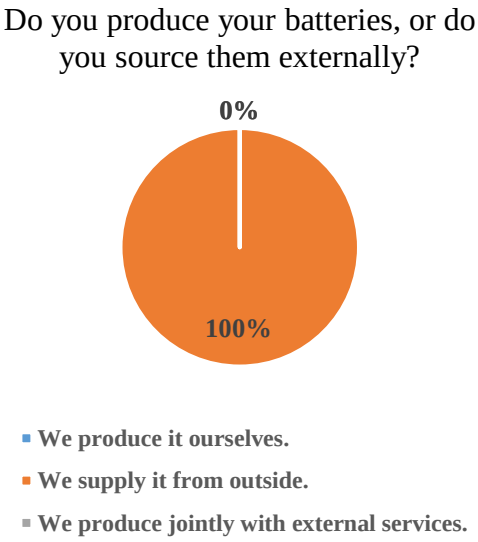
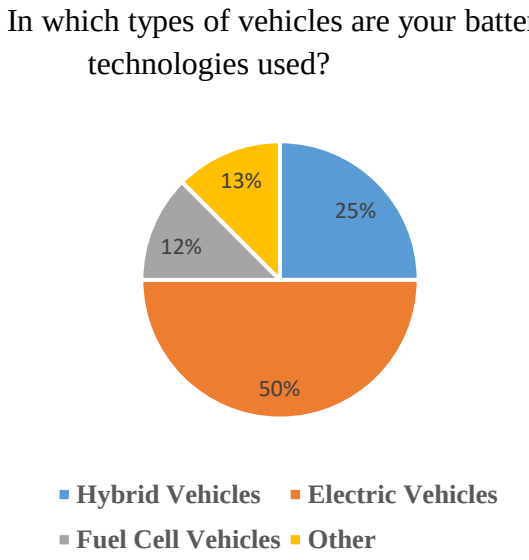


Figure 6. Production base of batteries.



Moreover, manufacturers responded that their battery technologies are used in Hybrid Vehicles, Electric Vehicles, and Fuel Cell Vehicles by 25%, 50%, and 25% respectively.

Figure 7. Type of Vehicle Battery Technologies Used in

Regarding "EV and Charging Infrastructure," battery technology and charging time companies participated in the survey, as stated below.

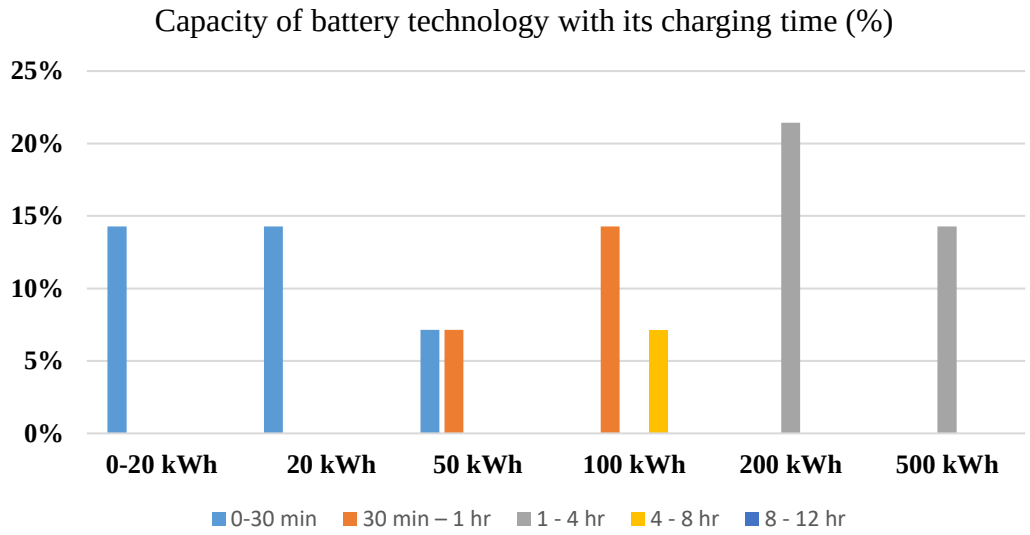


Figure 8. Respondent companies' battery capacities and their charging time

Distribution of Charging Time Across Battery Capacities:

The majority of respondents (14%) indicated that battery capacities ranging from 0-20 kWh can be charged within 0-30 minutes. Additionally, 4% mentioned the same for 20 kWh batteries, and 7% for 50 kWh batteries. On the other side, a noteworthy

percentage (14%) highlighted that the charging time of 0-20 kWh batteries extends to 30 minutes to 1 hour, while 7% mentioned the same for 50 kWh batteries. Finally, a significant proportion of responses (21%) indicated that batteries with capacities of 100 kWh and 200 kWh typically require 1-4 hours for charging.

Charging times exceeding 4 hours become more prominent for higher capacity batteries (100 kWh, 200 kWh, and 500 kWh). Notably, 21% of respondents mentioned a charging time of 1-4 hours for 100 kWh batteries. The data suggests that a significant portion of respondents focuses on battery capacities of up to 50 kWh, with faster charging times being a priority. This has implications for charging infrastructure planning, emphasizing the need for widespread availability of fast-charging stations to accommodate the charging preferences of these lower-capacity batteries. The absence of responses for longer charging times may indicate that the industry is currently prioritizing the development of faster-charging technologies for smaller to mid-range capacity batteries. This aligns with the broader trend in the e-mobility sector to enhance convenience and reduce charging times for electric vehicles.

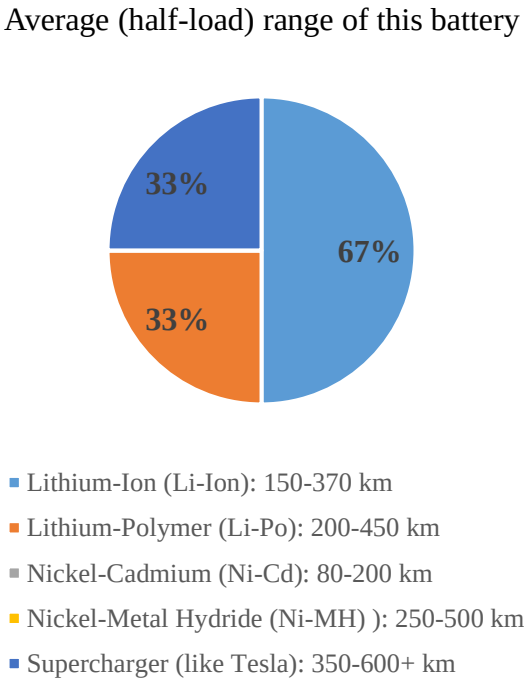


Figure 9. Average range of respondents' batteries

According to the Figure 7, the majority of respondents (67%) stated Lithium-Ion (Li-Ion) batteries, with an average range of 150-370 km at half-load. This aligns with the current industry trend, as Li-Ion batteries are widely used in electric vehicles due to

their high energy density, lightweight nature, and relatively long driving ranges. Lithium-Polymer (Li-Po) batteries are another popular choice, representing 33% of the responses. Vehicles equipped with Li-Po batteries have an average range of 200-450 km at half-load. Li-Po batteries share similarities with Li-Ion batteries but offer some flexibility in design and packaging. Nickel-Cadmium (Ni-Cd) and Nickel-Metal Hydride (Ni-MH) batteries both have a reported average range of 0%, indicating that these technologies are not widely used among the surveyed respondents. This aligns with the industry trend as newer lithium-based technologies have become more popular due to their improved energy density and other performance characteristics.

Supercharger technology, as exemplified by Tesla, is highlighted in the table with a reported range of 350-600+ km at half-load. This technology has gained attention for its ability to provide high-speed charging, contributing to longer driving ranges and addressing range anxiety concerns. It is notable that 33% of respondents stated this technology are used by their companies.

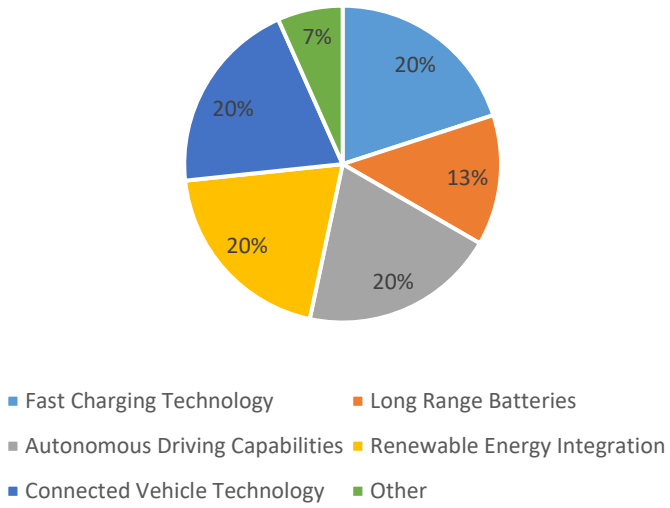


Figure 10. Features are presented in the e-mobility products of respondents

A notable percentage (20%) of e-mobility companies with charging infrastructure reported the presence of fast charging technology in their products. This indicates a recognition of the importance of efficient charging solutions, aligning with the industry trend to enhance charging speed and convenience for electric vehicle users.

While not as predominant as fast charging, 13% of respondents indicated the presence of long-range batteries in their e-mobility products. This suggests that a portion of

companies prioritizes maximizing the driving range of electric vehicles, addressing one of the key concerns of consumers regarding range anxiety.

An equal percentage (20%) of companies mentioned the incorporation of autonomous driving capabilities in their e-mobility products. This highlights the growing interest and investment in autonomous vehicle technologies within the e-mobility sector, potentially paving the way for advancements in smart and self-driving electric vehicles.

Another 20% of respondents reported the integration of renewable energy solutions into their e-mobility products. This indicates a commitment to sustainability and aligns with the broader industry goals of reducing environmental impact by incorporating cleaner energy sources into electric vehicle ecosystems.

The presence of connected vehicle technology was reported by 20% of companies, emphasizing the importance of connectivity features in enhancing the overall user experience. Connected technologies may include features like remote monitoring, over-the-air updates, and vehicle-to-grid communication.

The "Other" category, representing 7% of responses, suggests that some companies have unique features or innovations in their e-mobility products that were not explicitly listed in the survey options. Further exploration of the responses in this category would provide insights into specific, diverse features or technologies adopted by a subset of companies.

The survey responses reflect a diverse set of features present in e-mobility products among companies with charging infrastructure. Fast charging technology, autonomous driving capabilities, renewable energy integration, and connected vehicle technology are all prominent aspects, showcasing a holistic approach to addressing various aspects of electric vehicle development. The "Other" category indicates additional innovation and uniqueness within the industry, highlighting the dynamic nature of the e-mobility sector.

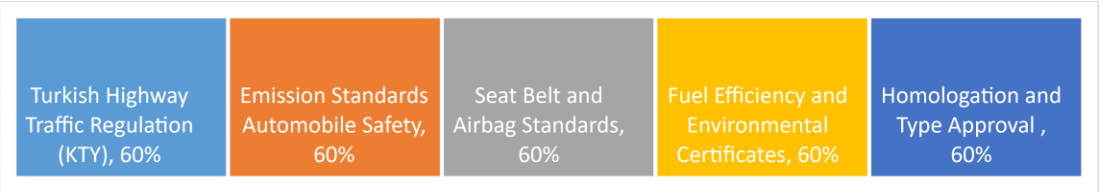


Figure 11.Safety and environmental standards that vehicles have

According to Figure 9, a significant number (60%) of company representatives mentioned that they comply with the Turkish Highway Traffic Regulation (KTY). This shows a dedication to following local traffic rules, ensuring the safe and legal operation of their e-mobility vehicles on Turkish roads. Another 60% of respondents stated that they adhere to emission standards and automobile safety regulations, reflecting a focus on environmental responsibility and vehicle safety in line with global efforts to reduce emissions and enhance vehicle safety features. Additionally, 60% of companies noted their compliance with seat belt and airbag standards, emphasizing their commitment to ensuring the safety of passengers and drivers. Meeting these safety standards is crucial for minimizing the impact of accidents and protecting occupants in case of a collision. A significant portion (60%) of companies highlighted their adherence to fuel efficiency and environmental certificates, indicating their dedication to promoting fuel efficiency and meeting environmental standards to reduce the ecological footprint of e-mobility vehicles. Moreover, 60% of companies stated their compliance with homologation and type approval standards, showing their commitment to meeting regulatory requirements for vehicle design, production, and safety. Compliance with these standards is essential for obtaining approval to sell or operate vehicles in Türkiye. The survey responses reveal a widespread commitment among e-mobility companies with charging infrastructure in Türkiye to comply with various safety and environmental standards. The inclusion of Turkish Highway Traffic Regulation, emission standards, automobile safety features, seat belt and airbag standards, and fuel efficiency and environmental certificates underscores a comprehensive approach to regulatory compliance. This commitment is crucial for ensuring the safe and environmentally responsible operation of e-mobility vehicles within the Turkish market.

Distribution of provinces where the companies participating in the survey have charging stations are as follows:

Figure 12.Cities in Türkiye with Charging Stations (Source: file:///C:/Users/Eseyhan/Downloads/Cities%20with%20Charging%20Stations.pdf)

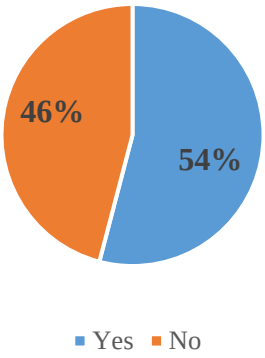


Figure 13. Respondent companies who have charging stations in Turkiye

According to the survey findings, 28 cities were explicitly identified as having charging stations. However, some respondents provided numerical figures, such as 15 or 54, or expressed comprehensive service coverage in all 81 provinces without specifying the exact number of cities. Consequently, not all cities could be individually highlighted on the map. Nevertheless, it is evident from the responses that charging stations are present in a minimum of 54 cities across Türkiye. Therefore, outcomes reveal a noteworthy statistic in Türkiye's 81 official cities, with 54 cities identified as hosting charging stations.

According to the Figure 12, a majority of e-mobility company representatives (56%) reported offering fast chargers. This aligns with the growing demand for rapid charging solutions, catering to users who seek quick turnaround times during their charging sessions. An even higher percentage (64%) mentioned providing slow

chargers. This reflects a recognition of the diverse charging needs of electric vehicle users, including scenarios where slower charging may be sufficient, such as overnight charging at home. In addition to fast chargers and slow chargers, a small percentage (4%) of respondents fell into the "Other" category, suggesting that some companies may offer unique or specialized charging solutions beyond the conventional fast or slow chargers. Further exploration of this category could unveil innovative charging technologies or services.

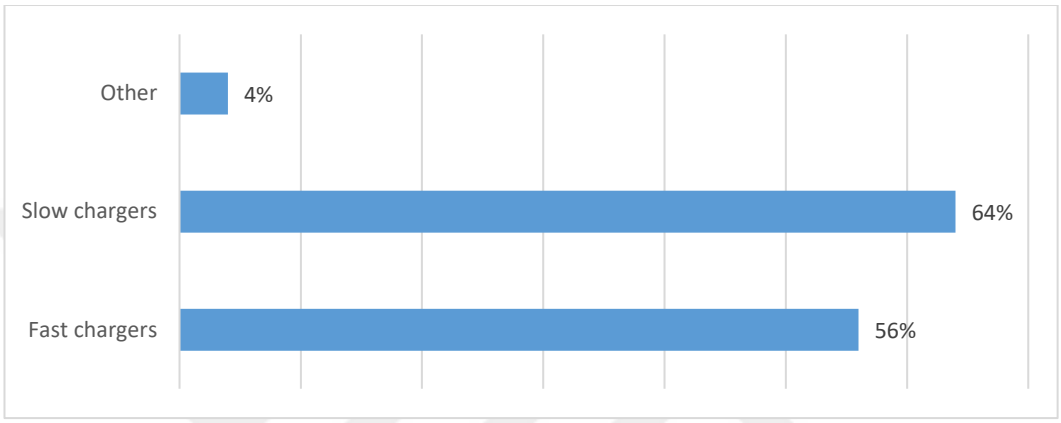


Figure 14. Types of charging stations

According to the Figure 13, a considerable percentage of e-mobility company representatives (22%) reported supporting the Combined Charging System (CCS). This suggests a commitment to a widely adopted charging standard, aligning with the industry trend and facilitating interoperability for a broad range of electric vehicles.

A smaller percentage (7%) of respondents indicated support for the CHAdeMO charging protocol. While less prevalent than CCS, the presence of CHAdeMO support may cater to specific electric vehicle models and user preferences, reflecting a diverse approach to charging infrastructure.

Some respondents (5%) reported supporting the Tesla Supercharger protocol. This indicates a consideration for Tesla electric vehicles and their unique charging infrastructure, showcasing a willingness to cater to a variety of electric vehicle users.

The majority of respondents (37%) mentioned support for AC (Alternating Current) charging. AC charging is essential for accommodating a wide range of electric vehicles and is commonly found in various charging scenarios, including home charging and public charging stations.

Nearly one-third of respondents (29%) stated support for DC (Direct Current) Fast Charging. This emphasizes a commitment to providing high-speed charging options, suitable for users who prioritize quick charging sessions, such as those on long journeys.

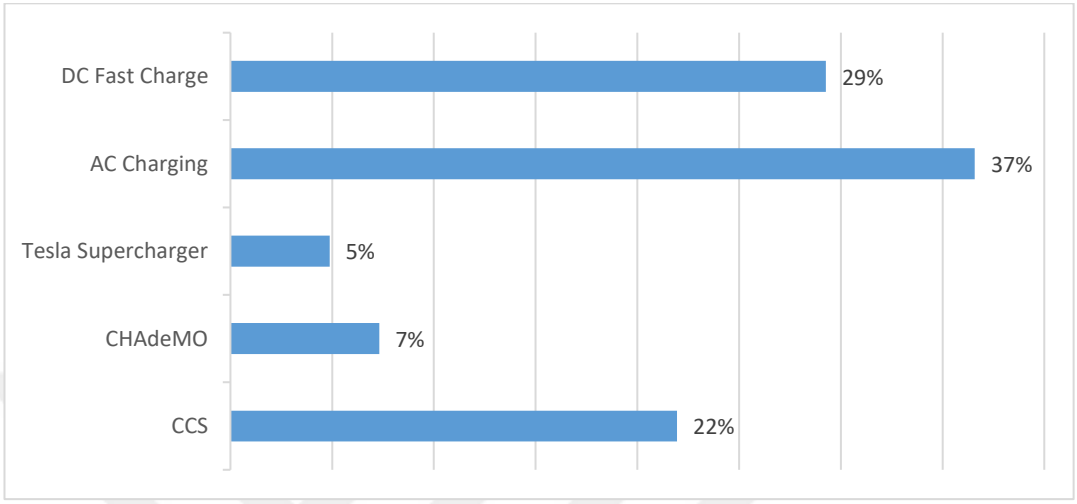


Figure 15. Charging protocols of respondent companies' charging infrastructure.

The survey responses from e-mobility company representatives demonstrate a diversified approach to charging infrastructure. While there is a prevalent focus on supporting widely adopted standards such as CCS, companies also acknowledge the importance of accommodating various protocols like CHAdeMO and Tesla Supercharger to cater to different electric vehicle users.

The emphasis on both AC and DC charging options, along with the availability of both fast and slow chargers, reflects a holistic strategy. This approach ensures flexibility in meeting the charging needs of a broad spectrum of electric vehicle users, aligning with the goal of providing comprehensive and accessible charging infrastructure in the e-mobility sector.

4.3. Collaborations and Partnerships

In the survey, respondents revealed extensive collaboration and partnerships with various organizations, presenting a diverse network across sectors. Creating R&D networks is crucial for sustainable capability creation within the competitive environment. Therefore, relations with other companies are as important as institutions (Vimalnath et al., 2023). The engagements primarily focus on Research and Development (R&D) studies, projects, commercial ventures, and the expansion of

charging infrastructure.

Respondents indicated robust collaboration with Turkish Government Institutions, particularly in R&D studies, projects, and commercial ventures. These partnerships signify a strategic alignment with governmental priorities and initiatives.

Engagements with municipalities were predominantly centered around projects and commercial ventures. Additionally, a notable emphasis was placed on collaborations to expand the charging infrastructure, reflecting a shared commitment to sustainable development.

Collaboration with local companies emerged as multifaceted, encompassing projects, technology/product development, commercial initiatives, and the expansion of charging infrastructure. These partnerships signify a strong commitment to fostering innovation and driving economic growth within the local business ecosystem.

Partnerships with research institutions were primarily oriented towards R&D studies, underscoring a commitment to staying at the forefront of technological advancements and fostering a culture of continuous innovation.

Respondents reported active partnerships with universities, particularly in R&D studies and projects. These collaborations underscore the importance of knowledge exchange and the development of a skilled workforce for mutual benefit.

Noteworthy collaborations were identified with institutions and organizations beyond the specified categories. These partnerships focused on R&D studies and projects, highlighting the diverse range of institutions contributing to the research and development landscape.

The comprehensive analysis of collaboration and partnership trends reveals a strategic and diversified approach to engaging with various institutions. The commitment to R&D, project development, and commercial ventures signifies a proactive stance in contributing to technological innovation, economic growth, and sustainable development. The findings presented in this report provide valuable insights into the collaborative landscape, which can inform future strategic decisions and foster continued growth in the relevant domains.

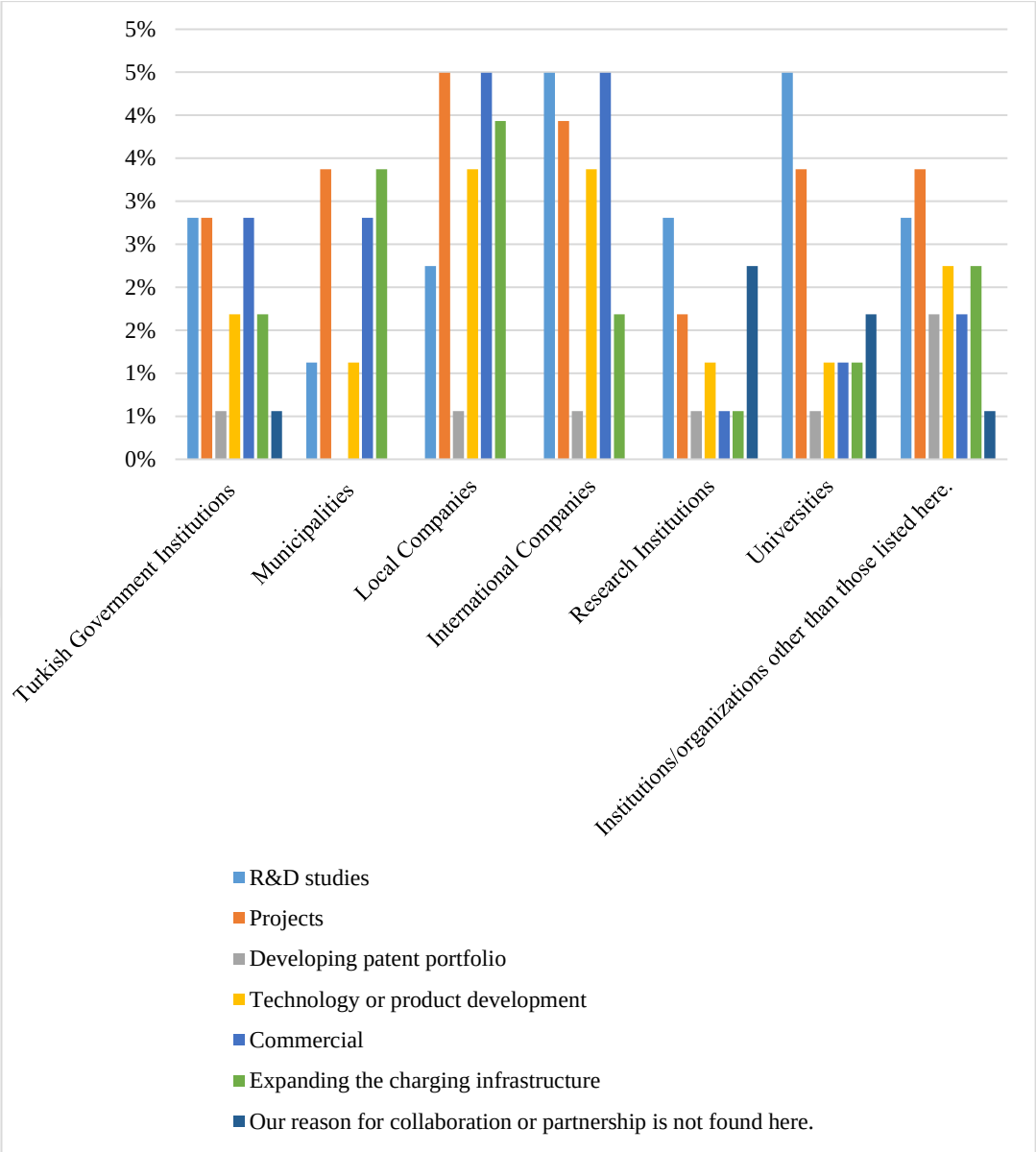


Figure 16. Collaboration or partnership with organizations & reasons

Collaboration or partnership with organizations are the main tools for many European companies to develop a competitive edge. Increased networking and communication are necessities for innovation and R&D-based product development. In today's world, high-technology enterprises must focus on corporate collaboration and take advantage of R&D networks. For e-mobility sub-sectors, product differentiation, new product development activities, the creation of diversification on products and services, and design capability are the main tools to reduce the competitive rivalry in the industry.

In the survey, 24 companies were asked about the existence of international relations or partnerships. Please note that the question is prepared in such a way as to allow

multiple selections. 4% of the respondents have an international commercial partnership, and 4% have an international project partnership. The share of respondents with joint technology or product development studies is 14%, and the percentage of those running joint R&D studies is as limited as 21%. 13% of the companies indicated that they collaborate with Universities. Within the survey, it was observed that companies need to establish fruitful collaboration and partnerships. Moreover, even if the level of cooperation was satisfactory, considering the result of the domestic patent search in Chapter 4.5, result-oriented R&D project development activities are needed in the sector. The development of intellectual property or know-how as an indicator of R&D and technology improvement could only be achieved by building sustainable and mutually beneficial relationships and fostering innovation between sectoral actors within the ecosystem (Vimalnath et al., 2023).

4.4 After-Sales Services and Customer Support

Based on the service provider company respondents in the survey, the commitment to customer satisfaction and product support for e-mobility products by looking at the after-sales services for e-mobility products seems to open improvements. There is a solid foundation for customer support, but strategic enhancements in specific areas could improve customer satisfaction and support for e-mobility products.

Regarding the percentage distribution of after-sales service categories, technical support has 75%; this demonstrates the high percentage indicating a strong commitment to providing technical support, which is crucial for customer satisfaction. Software updates have 63%, which is a relatively good score, indicating a commitment to keeping the e-mobility products up to date with the latest software enhancements. Maintenance and repair services follow software updates with 58%. This means that while there is a provision for maintenance and repair services, there is room for improvement, and efforts can be made to enhance this aspect. Moreover, warranty services have an average percentage of 50%. This mid-range score suggests a warranty service, but it may not be as comprehensive or appealing to customers compared to competitors. Finally, the lower score, 42%, of charging infrastructure services suggests there might be opportunities to improve or expand charging infrastructure services to meet customer needs better. While there are positive aspects, there are also opportunities for improvement in maintenance and repair services, warranty services,

and charging infrastructure services. You may find the chart of the percentage distribution of after-sales service categories below.

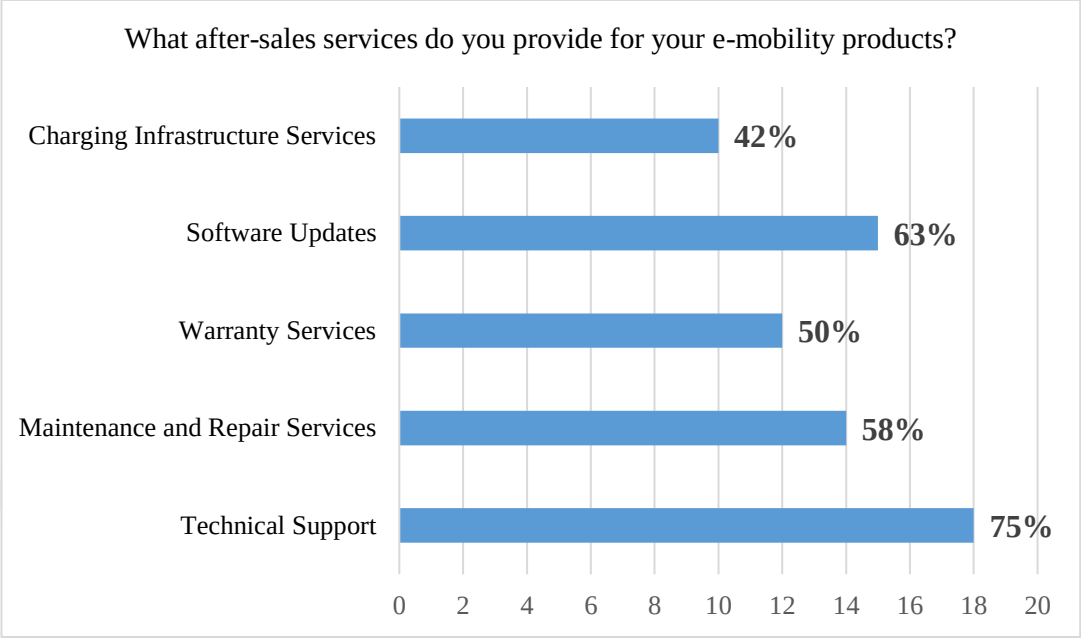


Figure 17. Percentage distribution of after-sales service categories

Furthermore, according to the service provider respondents, the presence of service centers and repair facilities ratio is 47%. This is positive, but efforts can be made to increase coverage or accessibility by at least 50%. You may find the bar chart of the service center ratio of service sector companies in the survey below.

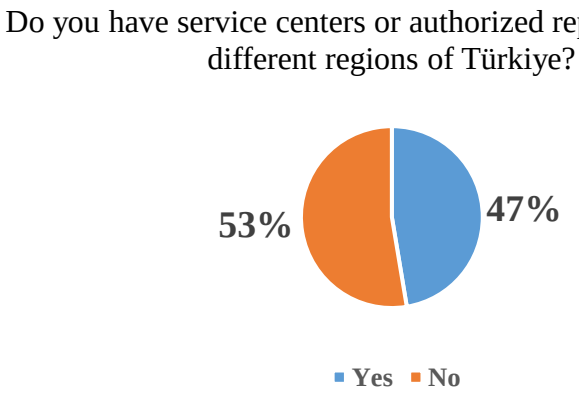


Figure 18. Service Center Ratio of Service Sector Companies in the Survey

Regarding the response time of e-mobility service providers, most responses indicate a commitment to prompt customer service, with a significant percentage offering a

response within 24 hours and immediate responses in emergencies. The respondent companies seem to focus strongly on immediate response in emergencies, but there could be more clarity on the specific policy or approach for managing response times. You may find the chart for the response time of e-mobility service providers in the survey below.

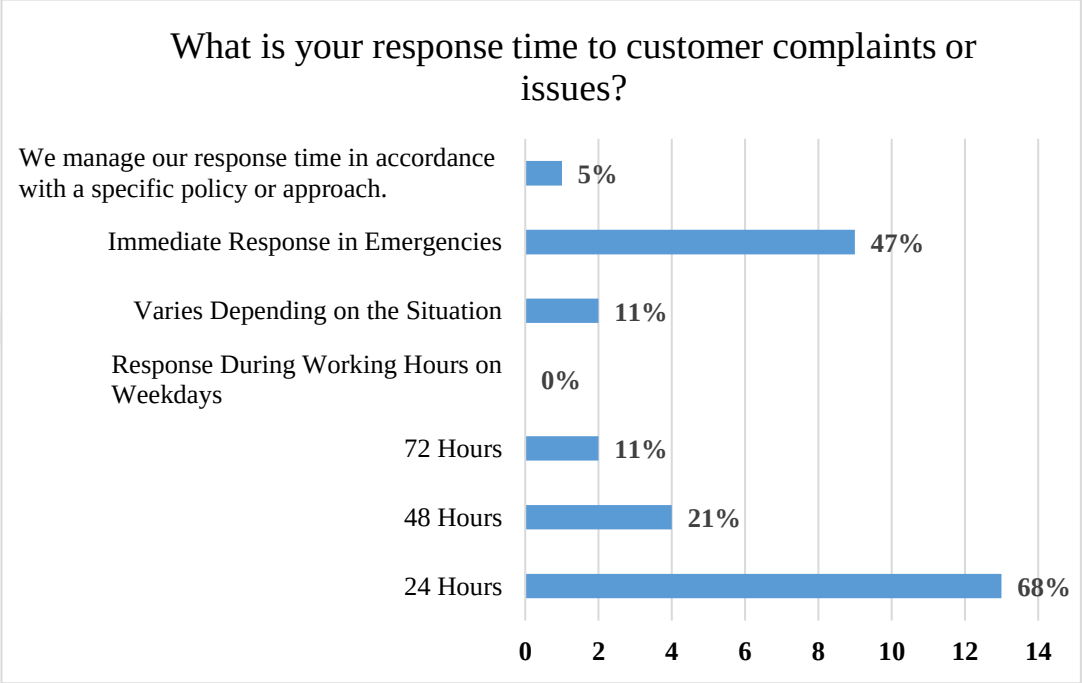


Figure 19. Response time of E-mobility Service Providers

4.5. Intellectual Property and Innovation

The survey results provide an overview of the current state of Türkiye's e-mobility sector, with a particular focus on intellectual property (IP) and innovation. The findings reveal both strengths and areas for improvement within the industry.

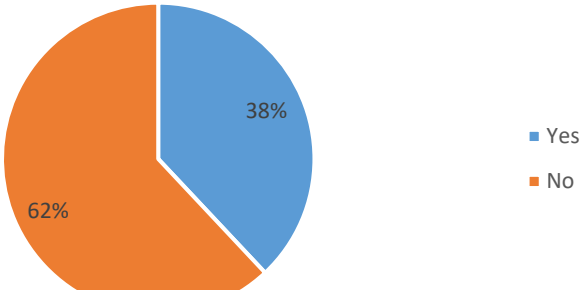


Figure 20. Patent/utility model applications related to e-mobility

The acknowledgment by only 38% of respondents regarding the existence of patent or utility model applications related to e-mobility

implies a notable deficiency in the creation and safeguarding of intellectual property within the sector. This signals that many companies may not have established exclusive rights to their innovations, potentially hindering their competitive edge in the global landscape. Consequently, there is a pressing need for enhanced discourse on intellectual property ownership within Türkiye, aimed at identifying and implementing strategies to augment available options and fortify the nation's position in the international arena.

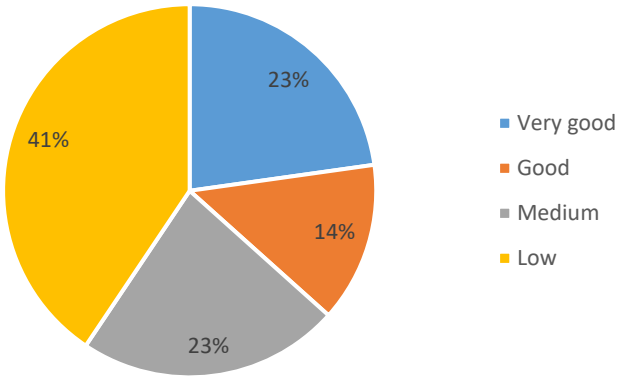


Figure 21. Size and scope comparison of respondent companies' patent portfolio compared to other e-mobility companies

The distribution of responses—Very Good (23%), Good (14%), Medium (23%), Low (41%)—when assessing the size and scope of patent portfolios indicates a diversified landscape. The prevalence of patent portfolio comparison responses in the "Low" category suggests that many companies may need to prioritize and strengthen their patent portfolios to align with industry averages and global standards.

The affirmative response from 41% of participants regarding specific strengths against other domestic e-mobility companies regarding patent portfolios underscores a subset of companies that have successfully differentiated themselves through robust intellectual property. This signifies potential leaders in innovation within the sector, although it highlights a need for broader adoption of such practices.

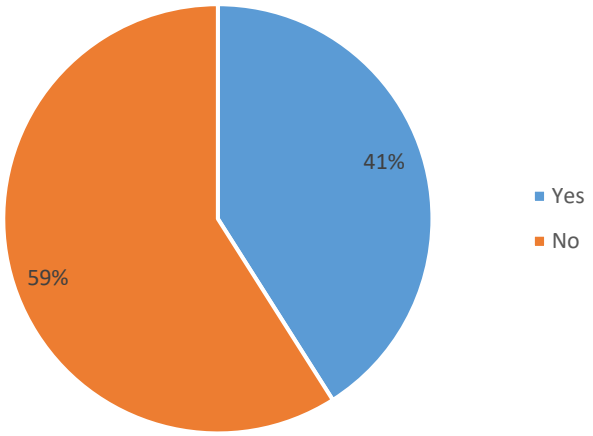


Figure 22. The dominant power of the companies over other domestic e-mobility companies in terms of patent portfolio

Has your company been involved in patent disputes or legal processes related to e-mobility in Türkiye?	**No - 92%** **No response – 8%**

The overwhelmingly negative response (92%) and no response from the rest of the respondents to involvement in patent disputes or legal processes related to e-mobility in Türkiye is a positive signal. This suggests a relatively stable legal environment and a lack of contentious issues within the sector, fostering an atmosphere conducive to innovation without legal impediments.

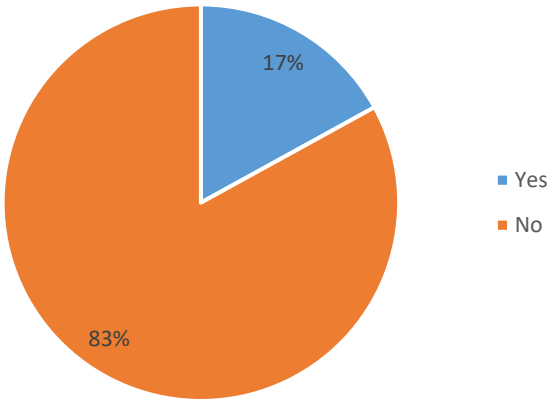


Figure 23. Licensed e-mobility-related patents ratio to other companies

While a majority (83%) have not licensed their e-mobility-related patents to other companies, the 17% who have participated in such activities indicate a willingness among certain entities to collaborate and share intellectual property. This may indicate a collaborative culture that promotes the advancement of

technology within the sector, albeit with opportunities for increased collaboration across the industry.

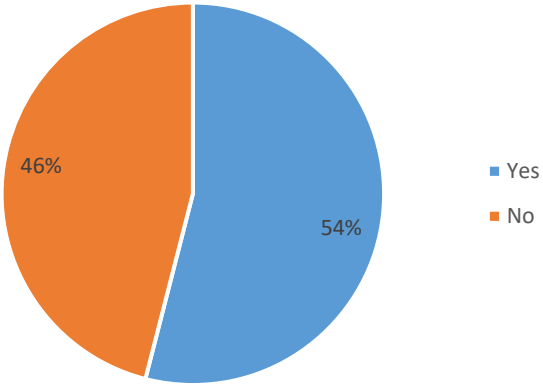


Figure 24. R&D activities ratio to produce new e-mobility-related patents

The surprising revelation that 54% of respondents are actively conducting research and development (R&D) activities to produce new e-mobility-related patents is a positive indicator. This demonstrates a significant commitment to ongoing innovation, potentially closing the previously identified gap in intellectual property ownership and positioning the sector for future advancements.

To sum up, the analysis of survey responses unveils a nuanced landscape for intellectual property and innovation within Türkiye's e-mobility sector. While there are notable strengths, such as specific companies showcasing robust patent portfolios and a substantial percentage actively engaged in R&D, there is also room for improvement. Strategies to enhance IP ownership, strengthen patent portfolios, and foster collaboration could elevate the sector's competitive standing and fuel continued innovation in the dynamic field of e-mobility. In addition, since patents play a crucial role in fostering innovation, attracting investment, and establishing a competitive edge in the e-mobility sector in Türkiye, the lack of significant patent disputes indicates a relatively stable environment, and the involvement in licensing suggests a collaborative approach towards advancing climate change mitigation technologies.

4.6. Financial and Strategic Considerations

The survey respondents demonstrate a comprehensive and strategic approach to their investment decisions, with a notable emphasis on market potential, scoring a high 88%. This focus suggests a keen awareness of the dynamic e-mobility sector and a

commitment to making informed choices. A positive 71% is assigned to both technology and innovation, reflecting the survey respondent's recognition of the importance of staying at the forefront of technological advancements by aligning with industry trends. Sustainability receives an equally high score of 71%, showcasing a forward-thinking perspective in response to the growing importance of environmental considerations. However, there is an opportunity for improvement in team capabilities, marked at 42%, indicating a potential need to enhance and better communicate the team's strengths in driving e-mobility ventures. Recognizing the competitive landscape is evident with a solid 67% for competition analysis, a crucial factor for well-informed decision-making. While customer preferences are considered at 46%, there is room for improvement in understanding and effectively catering to customer needs. Financial performance scored 63%, leaving room for further insights into specific resource allocation criteria. Legal and regulatory compliance is acknowledged with a moderate 50%, suggesting an awareness of the essential nature of adherence to legal standards. Balanced scores of 54% for risk assessment and 50% for strategic alignment indicate a recognition of the importance of managing risks and aligning e-mobility ventures with broader survey respondent goals. In harmony, these evaluations highlight the survey respondents' strategic strengths and areas for refinement, forming a holistic picture of their financial and strategic considerations in the e-mobility sector.

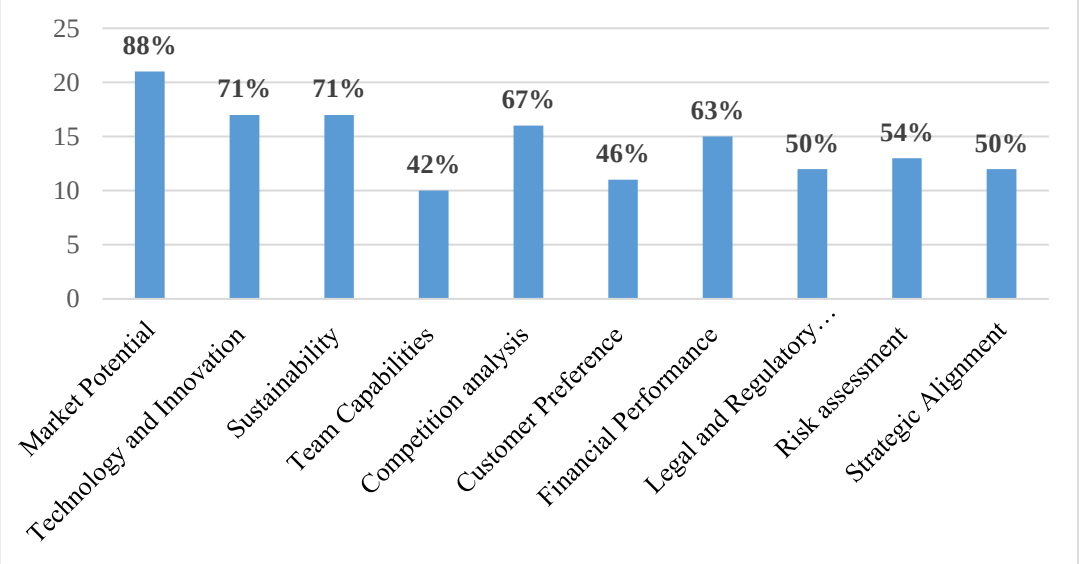


Figure 25. What factors do you consider when allocating financial resources to e-mobility ventures?

The survey respondents emphasize market potential, technology, and sustainability,

aligning seamlessly with prevailing industry trends. The survey respondents have the potential to enhance team capabilities and deepen their understanding of customer preferences to fortify their competitive position. More clarity on the financial performance metrics considered in resource allocation could provide a more nuanced perspective. Additionally, ensuring a robust legal and regulatory compliance framework is imperative to mitigate risks associated with e-mobility ventures effectively. To maximize synergies with broader organizational goals, a continuous process of assessment and refinement of strategic alignment is advised. In summation, the survey respondents showcase a robust focus on pivotal factors guiding the allocation of financial resources to e-mobility ventures. Opportunities for improvement in specific areas are identified, presenting avenues to optimize strategic priorities and propel the sector's development. The elements work cohesively, forming a dynamic and harmonious strategy for further enhancement.

7. Overall Comparative Analysis

The comprehensive analysis of the capability survey results for both manufacturing and service provider sectors in the Türkiye e-mobility landscape reveals valuable insights into the strengths and opportunities within the industry. The survey, designed as a digital self-assessment tool, engaged 24 companies, primarily concentrated in the service sector, with a notable presence in Ankara, Istanbul, and Izmir. Most of these companies were established in the last five years, reflecting a recent surge in e-mobility ventures, and were mostly micro and small-scale enterprises.

Regarding market potential, technology, and sustainability, the survey respondents demonstrate a strategic focus, scoring high percentages of 88%, 71%, and 71%, respectively. These results align well with industry trends, showcasing a forward-thinking approach to investment decisions. However, there are areas for improvement, notably in team capabilities (42%), indicating a potential need to enhance and communicate the strengths of teams driving e-mobility ventures.

The analysis of after-sales services for e-mobility products emphasizes the commitment to customer satisfaction, with high scores in technical support (75%) and software updates (63%). Opportunities for improvement are identified in maintenance and repair services (58%), warranty services (50%), and charging infrastructure services (42%).

The presence of service centers and repair facilities, marked at 47%, suggests a positive but improvable coverage. Additionally, the response time to customer complaints reveals a commitment to prompt service, particularly in emergencies, although there is room for more clarity on the specific policies guiding response times.

The intellectual property and innovation landscape in Türkiye's e-mobility sector presents a mix of strengths and areas for growth. While 38% of respondents acknowledge existing patent or utility model applications, the distribution of responses indicates a need for companies to strengthen their patent portfolios. Collaboration and partnerships with various institutions, including government bodies, municipalities, local companies, and research institutions, reflect a proactive approach to innovation.

The survey respondents exhibit a comprehensive approach to financial and strategic considerations, with high market potential, technology, and sustainability scores. Opportunities for refinement lie in team capabilities, understanding customer preferences, and providing greater clarity on financial performance metrics. Legal and regulatory compliance is acknowledged, but continuous strategic alignment assessment and refinement are advised for maximizing synergies with broader organizational goals.

In summary, the survey provides a holistic view of the Türkiye e-mobility sector. It highlights its strengths, such as a strategic focus on market potential and technology, and areas for improvement, including team capabilities, after-sales services, and intellectual property portfolios. The interconnected elements of the survey results form a dynamic and harmonious strategy poised for further enhancement within the evolving landscape of Türkiye's e-mobility sector.

CHAPTER 5: THE IDENTIFICATION OF COMPARATIVE ADVANTAGES

5.1. Why is a patent important? What importance does a patent have for the development of climate change mitigation technologies?

A patent is a type of intellectual property(Wikipedia Contributors, 2019). It is the right to produce, sell, import, and use a certain subject for a certain period. It derives from the Latin word “patere,” which means “to be open” or “to present to the public.” A patent may relate to a device, a product, or a method. As can be deduced from the meaning of the word, a patent document is a document that explains and discloses the invention it is related to. An invention is a technically advanced solution introduced or caused by a theory, which has the quality of innovation. The inventor explains the creation and features of his invention with the patent application. When the patent application or document is examined by an expert in the relevant field or a colleague of the inventor, it is written clearly so that the same can be produced if the invention is a product or the same method can be applied if it is a method. At the same time, the inventor writes down the product features or method steps that he wants to protect legally with a patent. In order to grasp the concept of patent, it is necessary to establish the patentability criteria and the concept of state of the art. Patent data provide important information on the specific technical knowledge embedded in the invention, which is crucial for analyzing the development of new technologies. A patent is important for several reasons, and its significance extends to the development of climate change mitigation technologies. Here are some key points (Climate Change and The Intellectual Property System: What Challenges, What Options, What Solutions, N.D.) explaining the importance of patents and their relevance to climate change mitigation:

Protection of Intellectual Property: Patents provide legal protection for inventors and assignees, granting exclusive rights to their inventions for a specified period. This protection is crucial as it prevents others from using, making, or selling the patented invention without permission. In the context of climate change mitigation technologies, patents safeguard the intellectual property behind innovative solutions. This protection encourages inventors and companies to invest in the development of these technologies, knowing that their ideas will be safeguarded, and they can reap the

benefits of their efforts.

Incentivizing Innovation: By offering exclusive rights, patents incentivize individuals and organizations to invest in research and development. They provide a potential return on investment and market advantages to inventors and companies, encouraging them to explore and create new technologies. In climate change mitigation, patents play a crucial role in driving innovation. They encourage inventors and companies to focus on developing technologies that can reduce greenhouse gas emissions, enhance e-mobility generation, improve energy efficiency, or promote sustainable practices.

Technology Transfer and Licensing: Patents facilitate technology transfer and licensing agreements. When a technology is patented, inventors or companies can enter into agreements with other parties interested in using or commercializing the technology. This allows for wider dissemination and deployment of climate change mitigation technologies. Licensees gain access to patented inventions, enabling them to manufacture, distribute, or utilize the technologies in different markets, accelerating their adoption and impact.

Disclosure of Information: To obtain a patent, inventors must disclose their invention's technical details and workings to the public. This disclosure helps disseminate knowledge and technical information, contributing to the collective scientific and technological knowledge body. In the context of climate change mitigation technologies, patent disclosures can provide valuable insights into novel approaches, processes, or materials. Information sharing can foster further innovation and collaboration among researchers, inventors, and companies working towards addressing climate challenges.

Investment and Funding Opportunities: Patents can enhance the attractiveness of climate change mitigation technologies to investors and funding agencies. Investors often seek assurances that their investments will be protected and that there is a competitive advantage in the market. The existence of patents demonstrates the uniqueness and protectability of a technology, which can increase investor confidence. This, in turn, supports acquiring funding necessary for research, development, and commercialization efforts of climate change mitigation technologies.

In summary, patents are important for protecting intellectual property, incentivizing

innovation, facilitating technology transfer, promoting disclosure of information, and attracting investment and funding. In the context of climate change mitigation technologies, patents play a crucial role in fostering the development and deployment of innovative solutions to address the pressing challenges of climate change (Climate Change and The Intellectual Property System: What Challenges, What Options, What Solutions?).

5.1.1. If the patent period was longer or shorter, would it affect the companies positively/negatively?

In the world of ideas and inventions, there's a discussion about whether patents (which give exclusive rights to inventors) should last a longer time. Some people argue that if companies have more time with exclusive rights, they can invest more in creating new and complex technologies (Flammer and Bansal, 2017). This longer protection might motivate them to come up with really important and groundbreaking ideas.

However, there are downsides to making patents last longer. One big issue is that it can reduce competition. If one company has exclusive rights for a long time, it might discourage other companies from trying to come up with similar or better ideas. This lack of competition can slow down the overall progress of technology (Boldrin and Levine, 2012).

Another problem is that longer patents can give a single company too much power – like a monopoly (Zhang, Zhu and Liu, 2024). This means that one company has too much control over a particular market, making it hard for other companies to join and contribute. This kind of situation could limit diversity and make the market less dynamic.

In summary, while longer patents can encourage companies to be more innovative, they also have drawbacks. They can limit competition, slow down technological progress, and give too much power to one company. Finding the right balance is important to make sure the system supports both innovation and healthy competition (Jaffe and Lerner, 2004).

5.2. Is Türkiye suitable to invest in climate change mitigation technologies related to mobility by considering the cases in terms of Y02T10/00, Y02T30/00, and Y02T90/00?

Determining the suitability of Türkiye for investing in climate change mitigation technologies related to mobility, specifically considering the cases represented by Y02T10/00, Y02T30/00, and Y02T90/00, requires an analysis of several factors. Here is an original assessment of Türkiye's potential in these areas:

Y02T10/00 - Hybrid vehicles: Türkiye has recently shown increasing interest in hybrid and electric vehicles (2023). The government has introduced incentives and subsidies to promote the adoption of electric vehicles, including tax reductions and exemptions (Gönül, Duman and Güler, 2021). The country has a growing automotive industry and a robust manufacturing sector, which could provide opportunities for investment in producing hybrid vehicles and related technologies. Additionally, Türkiye's strategic location provides access to European, Middle Eastern, and Asian markets, enhancing its potential as a production and export hub for climate-friendly mobility solutions.

Y02T30/00 - Electric charging infrastructure: The development of an extensive electric charging infrastructure is crucial for the widespread adoption of electric vehicles. Türkiye has made progress in this area, with the government initiating plans to install a network of charging stations nationwide. Moreover, private companies and municipalities have begun investing in charging infrastructure projects (Karahan, Kaplan, and Tolun, 2022). Investing in establishing and expanding electric charging networks in Türkiye could be an attractive opportunity, given the increasing demand for electric vehicles and the supportive government policies.

Y02T90/00 - Energy-efficient transportation systems: Energy-efficient transportation systems encompass various technologies and approaches, including intelligent transportation systems, optimized logistics, and eco-friendly public transportation. Türkiye has been focusing on improving its transportation infrastructure and reducing emissions. The country has invested in major cities' metro systems, light rail networks, and bus rapid transit systems (Babalık, 2015). Furthermore, there are ongoing initiatives to enhance the efficiency of logistics and transportation operations. Investing in energy-efficient transportation systems in Türkiye could contribute to the development of sustainable mobility solutions and support the country's efforts in

mitigating climate change.

In conclusion, Türkiye presents opportunities for investment in climate change mitigation technologies related to mobility, as represented by the cases mentioned. The country's growing interest in hybrid and electric vehicles, efforts to establish electric charging infrastructure, and emphasis on energy-efficient transportation systems create a favorable environment for investors. However, it is essential to conduct a thorough market analysis, assess regulatory frameworks, evaluate competition, and consider potential challenges before making investment decisions (OECD, 2021).

5.2.1. Ecosystem Analysis

An Ecosystem Analysis tool containing nine headings/segments for the thesis was developed. Economic Complexity Index and Indexes related to Macro Economy and Trade, Business Environment, Technology and Innovation, Human Resources, Infrastructure, Product Capacity, and Market, Finance, and Energy were identified and based on the ranking or scoring of the countries, and a comparison table was made. The ecosystem parameters were designed. Accordingly, related indexes were chosen to create an overview of the condition of countries like Germany, Norway, and Spain, which directly affect economies, companies, and industries in e-mobility.

Twenty international index results were studied to compare the indicated pillars between Türkiye and selected countries.

Table 9. Ecosystem Analysis - Resources of Indexes

Index Name		**Resources**
Economic Complexity	Economic Complexity Index	Harvard University https://atlas.cid.harvard.edu/rankings
Macro Economy and Trade	Economic Performance	IMD World Competitiveness Yearbook https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-competitiveness-ranking/
	Trade Openness Index	UNCTAD https://hbs.unctad.org/trade-indicators/
Business Environment	Business Efficiency Index	IMD World Competitiveness Yearbook https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-competitiveness-ranking/

Table 7 (Continued).

	Infrastructure Index	IMD World Competitiveness Yearbook https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-competitiveness-ranking/
	Business Dynamism Index	WEF Global Competitiveness Report https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf
	Economic Freedom Index	Heritage Foundation https://www.heritage.org/index/
Technology and Innovation	Network Readiness Index	Network Readiness Level Report https://networkreadinessindex.org/wp-content/uploads/reports/nri_2022.pdf
	ICT Adaption Index	WEF Global Competitiveness Report https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf
	Global Innovation Index	WIPO; Global Innovation Index 2020 https://www.wipo.int/global_innovation_index/en/2020/index.
	Innovation capability	WEF Global Competitiveness Report https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf
Human Resources	Investment & Development Index	IMD World Talent Ranking https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-talent-ranking/
	Readiness Index	IMD World Talent Ranking https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-talent-ranking/
	Skills Index	WEF Global Competitiveness Report https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf
	Labour Market Index	WEF Global Competitiveness Report https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf
Infrastructure	Infrastructure Index	WEF Global Competitiveness Report https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf
Product	Product Market Index	WEF Global Competitiveness Report https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

Table 7 (Continued).

	Productive Capacities Index	UNCTAD Productive Capacities Index https://unctad.org/topic/least-developed-countries/productive-capacities-index
Finance	Financial Systems Index	WEF Global Competitiveness Report https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf
Energy Transition	The Energy Transition Index	Fostering Effective Energy Transition WEF https://www3.weforum.org/docs/WEF_Fostering_Effective_Energy_Transition_2023.pdf

As shown in the summary table below, Türkiye has the lowest score for almost all of each group when all the groups are considered. Türkiye scored over three on only three index groups: economic complexity, technology and innovation, and infrastructure. However, Türkiye's relatively good performance in these areas does not prevent it from being in bad shape among benchmarked countries. Although Norway is a small-populated country, it is ahead of Türkiye in many criteria.

Table 10. Ecosystem Analysis Comparison Summary Table

Main Headings	**Indexes/ Rankings**	**Türkiye**	**Germany**	**Norway**	**Spain**
Economic Complexity	Economic Complexity Index (2021)	40	4	44	34
Macro Economy and Trade	Economic Performance Index (2023)	43	12	17	32
	Trade Openness Index UNCTAD (2022)	33.21	38.53	NA	31.66
Business Environment	Business Efficiency Index (2023)	44	29	18	37
	Infrastructure Index (2023)	48	14	8	27
	Business Dynamism Index (2019)	75	5	11	34

Table 8 (Continued).

	Economic Freedom Index (2023)	104	14	12	51
Technology and Innovation	Network Readiness Index (2022)	48	8	10	26
	ICT Adaption Index (2019)	69	36	10	19
	Global Innovation Index (2023)	39	8	19	29
	Innovation Capability Index (2019)	49	1	20	25
Human Resources	Investment & Development Index (2023)	51	12	6	25
	Readiness Index (2023)	43	16	15	42
	Skills Index (2019)	78	5	6	37
	Labour Market Index (2019)	109	14	13	61
Infrastructure	Transport Infrastructure Index (2019)	33	7	62	9
Product	Product Market Index (2019)	78	9	36	34
	Productive Capacities Index (2021)	53.90	65.47	66.00	60.17
Finance	Financial Systems Index (2019)	68	25	20	26
Energy	The Energy Transition Index (2023)	65	11	3	16

Infrastructure ranking is an indicator of the WEF Global Competitiveness Report. Within the report, under the infrastructure pillar, Türkiye is ranked 48th, Germany 14th, Norway 8th, and Spain 27$^{th.}$ In response to the demands of a rapidly growing economy,

Türkiye especially performs better in those sub-pillars that shape the Infrastructure Index: road connectivity, quality of road infrastructure, airport connectivity, and liner shipping connectivity.

During the last 20 years, Türkiye's economy has become relatively more complex, moving to the 40th position in the ECI (Economic Complexity Index) rank. ECI measures the quality level of exports as this value reflects the quality of the production skills of the countries. While many qualified products are in the export basket of countries with a high ECI value, these products are sophisticated products that require expertise and are produced by a few countries. In addition, the Productive Capacities Index (PCI), as a part of ECI, measures a product's knowledge intensity by considering its exporters' knowledge intensity. In other words, ranking is based on the diversity and sophistication of the productive know-how required to produce a product.

The Global Innovation Index (GII) aims to capture the multi-dimensional facets of innovation and provide the tools that can assist in tailoring policies to promote long-term output growth, improved productivity, and job growth. Global Innovation Index defines Türkiye as an upper-middle-income country. In the Global Innovation Index, Türkiye is ranked 39th, Germany is 8th, Norway is 19th, and Spain is 29th. While one reason for the relatively high score is that the study covers as many as 131 countries, another reason is that Türkiye ranks 27th in the "creative outputs" pillar within this index. In the same index, Türkiye is ranked 105th for institution's pillar, 41st for human capital and research, 50th for infrastructure, 46th for business sophistication, 44th for knowledge technology outputs, and finally 50th for market sophistication pillar.

On the other hand, the Innovation Capability index is indicated ranking in the WEF Global Competitiveness Report. It ranks Türkiye 49th, Germany 1st, Norway 20th, and Spain 25th.

Macro Economy and Trade, business environment, human resources, product capacity, and the market, finance, and energy transition are the areas where Türkiye experiences difficulty in being competent.

The below-detailed table has been prepared to visualize the comparison between selected countries based on each group of parameters. As shown below, Germany and Norway lead in almost all areas. At the same time, Spain and Norway make a difference in Transport Infrastructure. Please find the detailed scoring for each group

and each index/ranking in Appendix 3 and Table 9.

Table 11. WEF Index by Countries

WEF Competitiveness Index Rankings (141 countries)							
	Finance	Skills Index	Labour Market	Business Dynamism	ICT Adaption	Innovation Capability	Transport Infrastructure
Türkiye	68	78	109	75	69	49	33
Germany	25	5	14	5	36	1	7
Norway	20	6	13	11	10	20	62
Spain	26	37	61	34	19	25	9

Based on the overall results, Türkiye has the lowest index/rank on Human Resources: Investment and Development Index, Readiness Index, Skills Index, and Labour Market Index. Business Environment is another area where Türkiye suffers from competing with the ranking in Business Efficiency Index, Business Infrastructure Index, Business Dynamism Index, and Economic Freedom Index.

The Energy Transition Index (ETI) by the World Economic Forum was also included in the study. It is an effective tool to benchmark countries on their current energy system performance, compositing scores of 40 indicators and benchmarks 115 countries. Türkiye's ETI ranking is 65, which is not enough to compete with countries such as Norway (ranked third), Germany (ranked 11th), and Spain (ranked 16th).

From the industry point of view, Table 7 indicates the availability of production capacity and transportation infrastructure even though it can be considered as limited compared to other countries. However, the list of indexes/ranking strongly emphasizes the minimal existence of the business environment and ecosystem, which are the mechanisms that can activate the competencies and capabilities.

The regulatory framework where conditions are determined, such as macroeconomic indicators, finance and market structure, and competition, strongly affects entrepreneurship and innovation (OECD 2023). Therefore, building a supportive institutional environment is crucial for bringing together all ecosystem actors, design and technology capabilities as an accelerator of business operations and new idea development processes and enhancer of competitiveness and internationalization.

However, it is important to recognize that these areas are interrelated, implying a comprehensive policy approach rather than one-shot solutions.

5.3. Which technologies (Y02T) should be invested in? What are the pros and cons of Türkiye in this regard?

5.3.1. International Comparison - ESPACENET

In the context of the thesis, a total of Y section 26 International Patent Classification (IPC) categories has been identified for analysis, and a comparison is made among four countries: Türkiye, Germany, Norway, and Spain. Detailed data for each IPC number were collected using the patent search database Espacenet. Within the scope of the research, the number of patents in the Country of Publication (PC), Applicant Country (AC), and Inventor Country (IC) categories under each patent subject were examined for the countries indicated above.

The research focuses on patents related to the electromobility industry, particularly in the areas of climate change mitigation technologies related to transportation (Y02T), including "Road transport of goods or passengers" (Y02T10/00), "Transportation of goods or passengers via railways, e.g., energy recovery or reducing air resistance" (Y02T30/00), and "Enabling technologies or technologies with a potential or indirect contribution to GHG emissions mitigation" (Y02T90/00).

It should be noted that the main headings and sub-headings in the IPC classification system do not always overlap. Some patents registered under sub-headings may not be included in the main headings. As a result, each heading needs to be evaluated separately.

The relevant patents under the main headings are assessed based on the "Country of Publication (PC)" class to provide an overview of the data analysis. Patents are classified under three main categories: Publish Country (PC), Applicant Country (AC), and Inventor Country (IC). While related patents are listed under the respective country, it is important to consider international collaborations involving companies and academicians, which may influence the country's attribution of patents. Despite this, for the analysis, the Publish Country (PC) is determined as the country with the strongest ties to the patent, and the analysis is conducted based on the PC percentages.

When considering investments in climate change mitigation technologies in Türkiye, exploring various Y02T technology subclasses is beneficial. While specific investment decisions depend on market dynamics and individual circumstances, here are some Y02T subclasses worth considering, along with the pros and cons associated with investing in Türkiye:

Y02T10/00 - Hybrid vehicles: Türkiye has a growing automotive industry with established manufacturing capabilities, making it potentially attractive for investments in hybrid vehicle production. Pros include access to a skilled workforce, established supply chains, and a strategic location for domestic and export markets. However, challenges may include intense competition from global manufacturers, continuous technological advancements, and the necessity to align with evolving emission standards and regulations.

Y02T30/00 - Electric charging infrastructure: Investing in electric charging infrastructure can address the growing demand for electric vehicles. Türkiye has initiated plans to expand its charging network, presenting opportunities for infrastructure development. Pros include a supportive regulatory environment, increasing government incentives, and a rising electric vehicle market. However, challenges may include the need for significant capital investment, coordination with various stakeholders, and ensuring the scalability and accessibility of charging networks.

Y02T90/00 - Energy-efficient transportation systems: Investments in energy-efficient transportation systems can contribute to sustainable mobility. Türkiye has invested in metro systems, light rail networks, and optimized logistics. Pros include focusing on infrastructure development, government support for sustainable transportation projects, and potential collaboration with local municipalities. Challenges may involve navigating complex bureaucratic procedures, addressing existing transportation infrastructure gaps, and managing potential disruptions during project implementation.

Other relevant Y02T subclasses: Depending on specific market demands, other Y02T subclasses such as Y02T20/00 (Advanced vehicles propulsion) and Y02T50/00 (Climate change mitigation technologies related to industrial processing or heavy-duty road vehicles) could also be explored for investment opportunities in Türkiye. Evaluating market potential, existing capabilities, regulatory frameworks, and

alignment with national climate change and sustainability goals is important.

In summary, investing in climate change mitigation technologies in Türkiye offers several advantages, including a growing market, supportive government policies, and an established manufacturing base. However, challenges such as competition, regulatory compliance, infrastructure development, and bureaucratic procedures should be carefully considered. Conducting thorough market research, engaging with local stakeholders, and seeking expert advice will be essential for making informed investment decisions in Türkiye's climate change mitigation technology sector.

The table below indicates the detailed patent numbers registered within the Espacenet database. Espacenet provides services for searching patents and patent applications developed by the European Patent Office (EPO) and the European Patent Organisation member states. Four countries have been evaluated under 26 patent classifications.

In advance of the overall detailed table, please find the figure below that indicates the number of patent applications in the " Transport " field. Based on the European Patent Office data, Germany’s share of the total number of applications made by the indicated four countries between 2013 and 2022 is as high as 91.3%. Spain follows Germany and Norway with a 4.9% and 2.4% share, respectively.

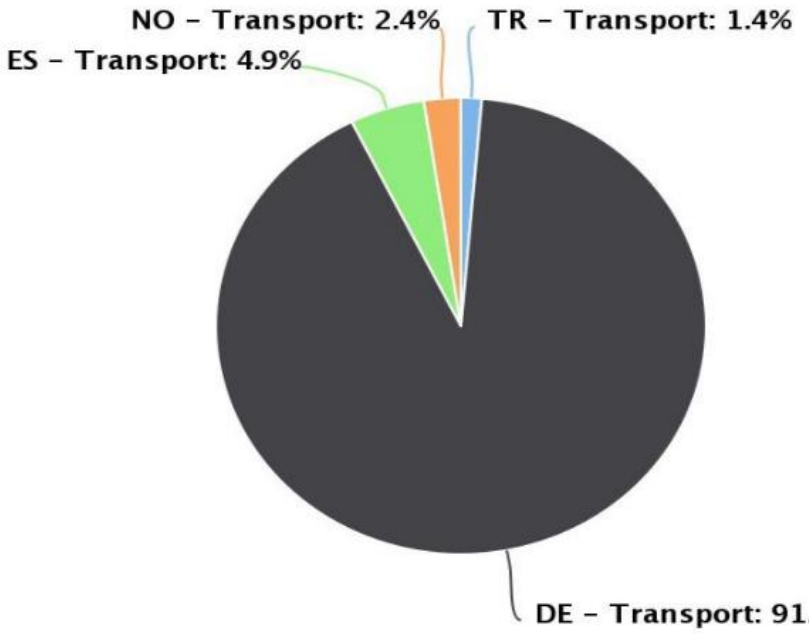


Figure 26. European Patent Applications by Country 2013-2022 (Source: European

Patent Office)

One of the world's most innovative nations, Germany, has intense domination in all IPC classes, as shown below. Germany has a significant superiority over countries in the number of registered patents. Clear leadership in Y02T10/00 “Road transport of goods or passengers.” Germany is ahead of Spain and Norway in the “Transportation of goods or passengers via railways, e.g., energy recovery or reducing air resistance” and “Enabling technologies or technologies with a potential or indirect contribution to GHG emissions mitigation” classes. It is observed that “Road transport of goods or passengers” is one of the prominent classes that Germany studies. Within this group, most patents registered by Germany are in the classes of “Internal combustion engine [ICE] based vehicles,” “Improving ICE efficiencies,” and “Other Road transportation technologies with climate change mitigation effect,” as they stand out as the most important technologies for the future of energy transition and key areas for clean energy future. In all IPC classes, Germany is followed by Spain and Norway, and similar patterns in terms of the distribution of classes can be observed for those countries. It is crucial to mention that these three countries have adopted policies for electric cars and batteries, accelerating the decline in battery prices and supporting the integration of variable renewables into electricity systems.

Table 12. Espacenet Comparison Table

Y02T: CLIMATE CHANGE MITIGATION TECHNOLOGIES RELATED TO TRANSPORTATION - October 28, 2023														
No		**Name**	**Türkiye (TR)**			**Germany (DE)**			**Norway (NO)**			**Spain (ES)**		
			PC	**AC**	**IC**	**PC**	**AC**	**IC**	**PC**	**AC**	**IC**	**PC**	**AC**	**IC**
A1	**Y02T10/00**	Road transport of goods or passengers	272	177	194	85,227	48,602	47,267	627	222	225	5,891	737	778
	Y02T10/10	Internal combustion engine [ICE] based vehicles	125	75	82	50,130	26,336	26,029	409	117	114	3,427	310	319
	Y02T10/12	Improving ICE efficiencies	103	61	66	36,595	19,253	19,077	341	95	90	2,593	259	268
	Y02T10/30	Use of alternative fuels, e.g. biofuels	22	12	13	3,614	2,182	2,125	97	26	27	306	37	37
	Y02T10/40	Engine management systems	9	7	8	16,149	7,893	7,949	18	7	8	833	26	36
	Y02T10/60	Other road transportation technologies with climate change mitigation effect	101	84	90	32,456	20,328	19,320	206	105	111	2,072	383	415
	Y02T10/62	Hybrid vehicles	15	8	8	11,231	6,585	6,285	25	10	12	354	43	51
	Y02T10/64	Electric machine technologies in electromobility	13	7	8	6,865	3,280	3,031	50	6	9	514	40	40
	Y02T10/70	Energy storage systems for electromobility, e.g., batteries	58	56	61	18,702	12,245	11,767	145	88	90	1,385	242	274
	Y02T10/7072	Electromobility-specific charging systems or methods for batteries, ultracapacitors, supercapacitors or double-layer capacitors	45	59	57	10,615	7,109	6,696	114	75	77	917	217	230
	Y02T10/72	Electric energy management in electromobility	25	8	9	6,933	3,421	3,343	49	6	8	567	45	54

Table 10 (Continued).

	Y02T10/80	Technologies aiming to reduce greenhouse gasses emissions common to all road transportation technologies	51	21	25	5,285	3,359	3,275	14	5	6	536	69	82
	Y02T10/82	Elements for improving aerodynamics	7	8	8	1,290	953	921	3	0	0	74	13	14
	Y02T10/84	Data processing systems or methods, management, administration	1	0	0	840	593	566	1	0	0	43	14	14
	Y02T10/86	Optimization of rolling resistance, e.g., weight reduction	29	2	5	674	327	343	5	0	0	189	8	8
	Y02T10/88	Optimized components or subsystems, e.g., lighting, actively controlled glasses	7	9	10	1,601	1,096	1,104	1	0	0	112	12	14
	Y02T10/90	Energy harvesting concepts as the power supply for auxiliaries' energy consumption, e.g. photovoltaic sun-roof	1	3	3	249	193	157	0	2	2	27	13	13
	Y02T10/92	Energy-efficient charging or discharging systems for batteries, ultracapacitors, supercapacitors or double-layer capacitors specially adapted for vehicles	7	1	1	1,058	487	469	4	3	4	120	12	23
			891	598	648	289,514	164,242	159,724	2,109	767	783	19,960	2,480	2,670

Table 10 (Continued).

A2	**Y02T30/00**	Transportation of goods or passengers via railways, e.g., energy recovery or reducing air resistance	9	1	1	945	588	511	18	1	4	302	16	17
			9	1	1	945	588	511	18	1	4	302	16	17
A3	**Y02T90/00**	Enabling technologies or technologies with a potential or indirect contribution to GHG emissions mitigation	33	44	42	12,348	8,552	8,253	128	83	82	873	181	209
	Y02T90/10	Technologies relating to charging of electric vehicles	26	40	38	8,633	6,151	5,933	98	75	74	704	156	176
	Y02T90/12	Electric charging stations	14	23	23	4,624	3,512	3,362	71	50	49	477	99	105
	Y02T90/14	Plug-in electric vehicles	16	27	26	6,107	4,369	4,244	78	50	51	502	81	102
	Y02T90/16	Information or communication technologies improving the operation of electric vehicles	11	11	12	3,438	2,254	2,241	34	23	22	334	66	69
	Y02T90/167	Systems integrating technologies related to power network operation and communication or information technologies for supporting the interoperability of electric or hybrid vehicles, i.e. smart grids as the interface for battery charging of electric vehicles [EV] or hybrid vehicles [HEV]	2	2	2	1,138	867	845	17	9	8	148	25	26
	Y02T90/40	Application of hydrogen technology to transportation, e.g., using fuel cells	7	4	4	4,020	2,522	2,437	33	8	8	172	17	23
			109	151	147	40,308	28,227	27,315	459	298	294	3,210	625	710

In the picture of Türkiye, the most patented class is “Road transport of goods or passengers” (891 registered patents), which contains variable sub-headings such as internal combustion engine [ICE] based vehicles, improving ICE efficiencies, use of alternative fuels, e.g., biofuels, engine management systems, other road transportation technologies with climate change mitigation effect, hybrid vehicles etc. Even though “Enabling technologies or technologies with a potential or indirect contribution to GHG emissions mitigation” main heading is the second most patented class for Türkiye with 109 patents, a significant difference can be observed in comparison with other countries. Also, the registered patents of Türkiye in the class of “Transportation of goods or passengers via railways, e.g., energy recovery or reducing air resistance” are relatively low.

As analyzed earlier, the results are not very different when each area/sub-sector where Türkiye is compared to is evaluated with the relevant country. When we compare Türkiye and Norway based on the number of registered patents (PC) in the field of road transport of goods or passengers (consist of Y02T10/00, Y02T10/10, Y02T10/12, Y02T10/30, Y02T10/40, Y02T10/60, Y02T10/62, Y02T10/64, Y02T10/70, Y02T10/7072, Y02T10/72, Y02T10/80, Y02T10/82, Y02T10/84, Y02T10/86, Y02T10/88, Y02T10/90, Y02T10/92) Norway has 2109 patents against Türkiye's 891 patents. Similarly, the ratio of Türkiye's patents to Spanish registered patents in the field of road transport of goods or passengers (consist of Y02T10/00, Y02T10/10, Y02T10/12, Y02T10/30, Y02T10/40, Y02T10/60, Y02T10/62, Y02T10/64, Y02T10/70, Y02T10/7072, Y02T10/72, Y02T10/80, Y02T10/82, Y02T10/84, Y02T10/86, Y02T10/88, Y02T10/90, Y02T10/92) is 42%.

When the main IPC shares by country are analyzed in the context of climate change mitigation technologies related to transportation for Türkiye (%PC), Germany, Norway, and Spain, the percentages below represent the distribution of patent activity in these specific areas.

Table 13. Main IPC Shares by Country

ESPACENET		Türkiye %PC	Germany%PC	Norway %PC	Spain %PC
Y02T10/00	Road transport of goods or passengers	**0.29%**	**92.65%**	**0.67%**	**6.39%**
Y02T30/00	Transportation of goods or passengers via railways, e.g., energy recovery or reducing air resistance	**0.71%**	**74.18%**	**1.41%**	**23.70%**
Y02T90/00	Enabling technologies or technologies with a potential or indirect contribution to GHG emissions mitigation	**0.25%**	**91.43%**	**1.04%**	**7.28%**

Regarding the main headings, Germany has clear leadership in all three areas. The percentages are calculated by proportioning the total number of patents of 4 countries in the related field. Spain and Norway followed Germany's domination, respectively. Türkiye is ranked 4th, falling behind Norway, although it is important to mention that Norway is a small country with a population of just over 5,408 million.

Y02T10/00 - Road transport of goods or passengers: Germany dominates in this category, indicating a strong focus on road transport technologies. Türkiye, with a lower percentage, might consider investing more in research and development for

innovations in road transport, possibly through incentives for the industry or collaborations with research institutions.

Y02T30/00 - Transportation of goods or passengers via railways: Germany and Spain are leading in railway-related technologies. Türkiye may want to explore opportunities to enhance its railway transportation technologies, potentially through partnerships with leading countries or research institutions.

Y02T90/00 - Enabling technologies for GHG emissions mitigation: Germany is heavily invested in enabling technologies for GHG emissions mitigation, indicating a strong commitment to sustainable solutions. Türkiye could focus on fostering innovation in this area by encouraging collaborations between industry and academia and providing incentives for green technologies.

According to the Main IPC Shares by Country table, below suggestions can be made to Türkiye:

- Identify areas with lower percentages and consider policies to incentivize research and development in those domains.
- Foster international collaborations to share knowledge and resources, possibly with leading countries like Germany and Spain.
- Invest in education and training programs to build a skilled workforce capable of contributing to climate change mitigation technologies in the transportation sector.

Türkiye can tailor its approach based on its specific strengths, weaknesses, and priorities in climate change mitigation technologies.

Please find the International IP Espacenet table in Excel format in Appendix 2.

5.4. What can be suggested for Türkiye?

When considering investments in e-mobility technologies (Y02T) in Türkiye, the following suggestions can be made:

Strengthen Electric Vehicle (EV) Adoption: Türkiye should continue promoting the adoption of electric vehicles through various incentives and policies. This includes

offering financial incentives such as tax reductions or exemptions for EV purchases, providing subsidies for charging infrastructure installation and developing public awareness campaigns to highlight the benefits of EVs. Such measures can stimulate demand and create a favorable market for e-mobility technologies.

Expand Charging Infrastructure: Investing in expanding charging infrastructure is crucial for supporting the widespread adoption of electric vehicles. Türkiye should focus on developing a nationwide network of charging stations, ensuring easy access for EV owners. This involves collaborations with municipalities, private companies, and energy providers to install charging stations in urban areas, public parking lots, commercial facilities, and major transportation routes. Encouraging the use of e-mobility sources for charging stations can also enhance the sustainability of e-mobility infrastructure.

Foster Research and Development: Türkiye should prioritize investment in research and development (R&D) activities related to e-mobility technologies. This includes supporting universities, research institutions, and private companies in conducting R&D projects focused on improving battery technologies, developing efficient charging solutions, enhancing vehicle-to-grid integration, and advancing smart mobility systems. Encouraging collaboration between academia, industry, and government can accelerate innovation and drive the development of cutting-edge e-mobility technologies.

Promote Local Manufacturing and Supply Chains: Investing in local manufacturing capabilities for e-mobility technologies can enhance Türkiye's competitiveness and reduce reliance on imports. Encouraging domestic production of EVs, batteries, and charging equipment can generate employment opportunities, strengthen the local economy, and create a sustainable supply chain. The government can incentivize partnerships between local manufacturers and international companies to transfer knowledge, technologies, and production techniques.

Support Skill Development: Building a skilled workforce is crucial for successfully implementing e-mobility technologies. Türkiye should invest in vocational training programs, higher education initiatives, and skill development courses focused on e-mobility. This will create a pool of qualified professionals in areas such as EV maintenance and repair, charging infrastructure installation and maintenance, battery

technology, and smart mobility systems. Collaboration with educational institutions and industry associations can help develop comprehensive training programs.

Collaborate with International Partners: Türkiye should seek collaboration and knowledge exchange opportunities with international partners with advanced expertise in e-mobility technologies. Engaging in research collaborations, joint ventures, and technology transfer agreements can facilitate the transfer of knowledge, access to advanced technologies, and market expansion opportunities. This can accelerate the development and deployment of e-mobility technologies in Türkiye.

In addition to the previous suggestions, the following recommendations can be made for Türkiye regarding Y02T investment in e-mobility:

Encourage Intellectual Property Protection: Türkiye should prioritize protecting intellectual property rights, including patents, in e-mobility. Strengthening patent laws, improving enforcement mechanisms, and providing support and resources for patent registration can incentivize inventors, researchers, and companies to innovate in e-mobility technologies. This will help create a conducive environment for intellectual property development and protection.

Foster Collaboration between Universities, Technoparks, and Industry: Türkiye should promote closer collaboration between universities, technoparks, and the industry to drive innovation in e-mobility technologies. Establishing research and development centers within universities and technoparks focused on e-mobility can facilitate knowledge exchange, promote interdisciplinary research, and attract funding for cutting-edge projects. Encouraging partnerships between academia and industry can help bridge the gap between research and commercialization, transforming patents into products with high-added value.

Provide Funding and Support for Technology Commercialization: Türkiye should offer financial support, grants, and incentives specifically targeted at technology commercialization in e-mobility. Establishing dedicated funding programs or venture capital funds that focus on supporting startups and innovative projects in e-mobility can accelerate the transformation of patented technologies into market-ready products. Additionally, providing mentorship, business incubation, and entrepreneurship training programs can assist inventors and researchers in navigating the commercialization process.

Facilitate Technology Transfer and Licensing: Creating mechanisms and platforms for technology transfer and licensing can help commercialize patented e-mobility technologies. Türkiye should establish frameworks and platforms that connect inventors, universities, technoparks, and industry players, facilitating the transfer of patented technologies to companies interested in their commercialization. Streamlining licensing procedures and offering support in negotiating licensing agreements can further incentivize technology transfer and promote the conversion of patents into products.

Promote Entrepreneurship and Startups in E-mobility: Türkiye should foster a supportive ecosystem for entrepreneurship and startups in the e-mobility sector. Providing mentorship, incubation programs, and funding opportunities tailored to e-mobility startups can encourage the commercialization of patented technologies. Creating innovation clusters or hubs focused on e-mobility can bring together startups, investors, industry experts, and researchers, fostering collaboration and knowledge sharing.

By implementing these suggestions, Türkiye can boost the number of patents in e-mobility, facilitate the transformation of patents into high-value products, growth of e-mobility technologies, drive sustainable transportation practices, and contribute to climate change mitigation efforts, and encourage the commercialization of projects carried out in universities and technoparks. This will contribute to the growth of the e-mobility sector, foster technological advancements, and position Türkiye as a hub for innovation in sustainable transportation.

5.4.1. The Conclusion from the Survey's Open-Ended Questions

According to the open-ended questions of the survey, it was concluded the results below.

While this increase is a promising indicator of Türkiye's commitment to embracing clean energy solutions, it also suggests that there is potential for further growth and enhancement. One crucial aspect that deserves attention is the need to boost innovation in Y02T-related patents to solidify and sustain this positive momentum. As Türkiye embraces e-mobility, increasing Y02T patents could propel the nation to the forefront of electric vehicle technology and infrastructure.

By fostering a conducive environment for research and development in Y02T, Türkiye can stimulate homegrown innovations in electric vehicle technology, battery efficiency, and charging infrastructure. This, in turn, supports the domestic automotive industry and positions Türkiye as a key player in the global shift toward sustainable transportation.

The government, industry stakeholders, and academic institutions can collaborate to incentivize and promote research activities in Y02T-related fields. Providing financial support, establishing research grants, and encouraging partnerships between academia and industry players can contribute to a thriving innovation ecosystem.

Additionally, an increased focus on Y02T patents aligns with Türkiye's broader goals of technological self-sufficiency and competitiveness on the global stage. It presents an opportunity for the nation to meet its current e-mobility targets and set the stage for future advancements in electric vehicle technology. Türkiye's positive increase in e-mobility is commendable, and the momentum can be further amplified by strategically increasing efforts in Y02T-related patents. This holistic approach will solidify Türkiye's position as a leader in sustainable transportation and pave the way for a future where innovation is at the forefront of the nation's green agenda.

Several practical suggestions have been identified to boost the growth of the e-mobility sector in Türkiye. One critical aspect involves supporting local businesses. To compete globally, our companies must produce components for electric cars that meet international standards.

Additionally, it was recognized the importance of clearer rules and increased government support. Such measures can significantly push the e-mobility industry, fostering a more conducive environment for its development.

A key consideration is the support required by small businesses. By reducing their obstacles in obtaining funding, we can enable these enterprises to grow and contribute to the sector's expansion.

Recognizing the need for skilled individuals in the e-mobility field, the government should focus on supporting training programs. This investment in education will ensure a workforce well-versed in the industry's intricacies.

Encouraging people to embrace e-mobility is vital. The government can play a role by incentivizing those who choose electric cars. These incentives can make this technology more appealing to the general public.

Local governments also have a crucial role to play. By taking the lead and collaborating with electric companies, they can improve the electric grid's infrastructure and make the entire system more transparent.

An essential hurdle to overcome is the inadequacy of electric grids. Electricity providers need to be more transparent and work towards enhancing infrastructure to support the widespread adoption of electric vehicles.

Education is key in this endeavor. Many people lack sufficient knowledge about electric cars. Implementing clear and straightforward educational programs will increase awareness and understanding among the public.

Identifying convenient locations for charging electric cars is another practical step. This simplifies the charging process, making it more accessible for everyone.

Ensuring fair competition is fundamental. Government intervention should prevent any single organization from having too much influence, allowing equal opportunities for all players in the sector.

Finally, fostering innovation is crucial. By providing financial support and resources to new companies with innovative ideas, the e-mobility industry can stay dynamic and interesting. This support will contribute to the continuous growth and evolution of the sector.

CHAPTER 6: CONCLUSION

The recent increase in e-mobility adoption in Türkiye (www.aa.com.tr, n.d.), as highlighted by the doubling of electric cars' share in new registrations from 1.1% in January-March 2022 to 2.4% in the same period of 2023, is undoubtedly a positive development. With 4,870 electric cars registered during the first quarter of 2023, Türkiye is making significant strides toward a greener, more sustainable transportation landscape.

A twenty-first-century innovation ecosystem comprises systems designed at multiple levels and modes involving different agents. These systems include innovation meta-networks and knowledge clusters organized in a self-referential or fragmented knowledge and innovation architecture. This architecture aims to create active bonds among political, technological, and institutional domains, whether virtual or physical; innovation networks play a crucial role in supporting new technologies, fostering creativity, and promoting innovation in public and/or private contexts.

Innovation networks involve collaborations among individuals in academia, private sectors, and government, contributing to technological innovation globally through project planning, joint research, and idea exchanges. These formations should be self-organizing and learning-driven and should possess dynamically adaptive competencies. All companies in a market are connected through visible or invisible links with suppliers, subcontractors, customers, and other players, serving as sources of market information and knowledge. Networks and clusters act as bridging mechanisms, enabling companies to leverage relationships for innovation and rapid internationalization.

In the E-mobility Industries, internationalization and innovation are key factors enhancing competitiveness. Innovative activities, considering both supply and demand, are crucial. Priority areas include ecosystem development, network and cooperation development, value-added production, human resource development, result-oriented R&D, innovation, and new technology development.

Inclusive growth strategies in Europe emphasize innovation in micro, small, and

medium-sized enterprises (SMEs), aiming to increase productivity, wages, and working conditions. SMEs, facing resource constraints and innovation barriers, can overcome these challenges by integrating into innovation systems. Support for SMEs includes adopting and effectively using ICT, fostering IP use, implementing inclusive R&D policies, cultivating collaboration, and enhancing the workforce.

The thesis identifies priority areas for action, investment, and development, such as ecosystem development, network development, value-added production, human resource development, R&D, innovation, and entrepreneurship ecosystem strengthening. Collaboration and communication among ecosystem actors are crucial, requiring mechanisms for continuous information sharing and joint decision-making.

The e-mobility sector in Türkiye faces challenges related to R&D, technology development, and human resources. Collaboration between science, technology, and innovation actors and effective support mechanisms is necessary. The study emphasizes the importance of intellectual property development, human resource development, and collaboration for sustainable capability creation.

The thesis also highlights the need for increased involvement of scientists in e-mobility technologies and collaboration between universities, SMEs, and startups. Public and private sector collaboration is crucial for R&D, and despite private sector dominance in R&D expenditures, public sector support remains relatively high in Türkiye compared to European countries.

The relationship between R&D and innovation is dynamic and reciprocal, with businesses seeking a competitive advantage through innovation. Product and process innovations are essential for internationalization in the e-mobility sector. Result-oriented studies, application-oriented R&D organizations, and clusters can help SMEs develop and launch new products.

Adding to this, the discussion on the duration of patents reveals a nuanced perspective. While longer patent durations can encourage companies to invest more in ground-breaking technologies, there are downsides. Extended patents may limit competition, slow down technological progress, and concentrate too much power in a single company, closer to a monopoly.

Improving growth opportunities for small companies requires awareness of grants and funds, access to finance, and collaboration with investors. Türkiye's investment environment needs improvement, and clear key target indicators and policy development activities are essential. Fundamental planning and implementation involving all ecosystem actors are critical for nurturing research and development for newer technologies.

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APPENDICES

Appendix 1: Appendix 1_E-Mobility Capability Matrix & Survey Q&A.xlsx

Appendix 2: Appendix 2_International IP Espacenet_ 28102023.xlsx

Appendix 3: Appendix 3_Ecosystem Analysis Data.xlsx