

EVALUATION FACTORS AFFECTING ESCO MARKET DEVELOPMENT

by

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ABSTRACT

EVALUATION FACTORS AFFECTING ESCO MARKET DEVELOPMENT

The development of Energy Service Companies (ESCOs) is vital for addressing global energy efficiency and sustainability challenges. However, the ESCO market faces significant barriers, such as financial constraints, regulatory gaps, limited client awareness, and underdeveloped technological infrastructure, particularly in emerging markets. These challenges hinder policymakers from formulating effective strategies and businesses from adapting to market demands. This study examines factors influencing ESCO market development for residential projects in Turkey, focusing on its unique economic and regulatory dynamics. A conceptual model explored the impact of legal, financial, market-related, technical, and client characteristics. Structural Equation Modeling (SEM) analyzed survey data from 41 Turkish ESCO professionals, providing valuable insights despite the small sample size. The findings revealed that client characteristics had the greatest influence on ESCO market development, emphasizing the demand-oriented nature of the Turkish market. Financial factors, particularly support from financing organizations, also played a critical role. However, the direct impact of legal, market-related, and technical factors was limited, with “Energy Saving Monitoring Infrastructure” excluded for its minimal influence, reflecting underutilized advanced technologies in Turkey. This study underscores the importance of clear legal frameworks, robust financial mechanisms, and targeted client awareness campaigns in fostering ESCO market growth in Turkey. Theoretical contributions identify key variables influencing the ESCO market, while practical recommendations include enhancing regulations, enhancing client awareness, and improving financing access. This study integrates findings with frameworks, providing insights for policymakers, practitioners, and researchers, and paving the way for future studies in emerging markets.

ÖZET

EVD PAZARININ GELİŞİMİNİ ETKİLEYEN FAKTÖRLERİN DEĞERLENDİRİLMESİ

Enerji Verimlilik Damışmanlık (EVD) firmalarının gelişimi, küresel enerji verimliliği ve sürdürülebilirlik hedeflerine ulaşılmasında hayati bir öneme sahiptir. Ancak, EVD sektörü, özellikle gelişmekte olan ülkelerde finansal kısıtlamalar, mevzuat boşlukları, sınırlı müşteri farkındalığı ve az gelişmiş teknolojik altyapı gibi önemli engellerle karşı karşıyadır. Bu engeller, strateji geliştirmeyi ve piyasa taleplerine uyumu zorlaştırmaktadır. Bu çalışma, Türkiye’deki konut projeleri için EVD pazarının gelişimini etkileyen faktörleri, ülkenin kendine özgü ekonomik ve düzenleyici dinamiklerini dikkate alarak incelemektedir. Hukuki, finansal, sektörel, teknik ve müşteri özelliklerinin etkilerini araştırmak üzere kavramsal bir model geliştirilmiştir. Türk EVD sektöründen 41 profesyonelin katıldığı anket verileri, Yapısal Eşitlik Modellemesi (YEM) kullanılarak analiz edilmiştir ve sınırlı örneklem büyüklüğüne rağmen değerli bulgular elde edilmiştir. Bulgular, müşteri özelliklerinin EVD pazarının gelişiminde en büyük etkiye sahip olduğunu ortaya koymuş, sektörün talep odaklı yapısını vurgulamıştır. Finansal faktörler, özellikle finansman kuruluşlarının desteği, müşteri katılımını şekillendirmede kritik bir rol oynamıştır. Ancak, hukuki, sektörel ve teknik faktörlerin doğrudan etkisi sınırlı kalmış, ”Enerji Tasarrufu Ölçme Altyapısı” ise düşük etkisi nedeniyle modelden çıkartılmıştır. Bu çalışma, Türkiye’de EVD pazarının büyümesi için yasal çerçevelerin, finansal mekanizmaların ve müşteri farkındalığının önemini vurgulamaktadır. Teorik katkılar değişkenleri tanımlarken, pratik öneriler düzenlemeler, farkındalık ve finansmana odaklanmaktadır. Bu çalışma, bulguları teorik çerçevelerle birleştirerek politika yapıcılar, uygulayıcılar ve araştırmacılar için değerli içgörüler sunmakta ve gelişmekte olan piyasalarda yapılacak gelecekteki çalışmalar için yol göstermektedir.

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LIST OF ACRONYMS/ABBREVIATIONS

AEEG	Italian Regulatory Authority for Electricity and Gas
AGESI	Energy Service Industry Organization
AVE	Average Variance Extracted
BBN	Bayesian Belief Networks
BOOT	Build Own Operate Transfer
CB-SEM	Covariance-Based Structural Equation Modelling
CHP	Combined Heat and Power
CR	Composite Reliability
DC	Delivery Contracting
EE	Energy Efficiency
EED	Energy Efficiency Directive
EEL	Energy Efficiency Law
EMCA	China Energy Conservation Service Industry Association
EPC	Energy Performance Contracting
ESC	Energy Supply Contracting
ESCO	Energy Service Company
EU	European Union
EVD	Enerji Verimliliği Danışmanlık
GDP	Gross Domestic Product
GEF	Global Environment Facility
GW	Giga Watt
HTMT	Heterotrait - Monotrait Ratio
IBRD	International Bank for Reconstruction and Development
IDEA	International District Energy Agency
IEA	International Energy Agency
IEC	Integrated Energy Contracting
JRC	Joint Research Center
M&V	Measuring and Verifying

MENR	Ministry of Energy and Natural Resources
NAPE	National Action Plan on Energy Efficiency
NEEAP	National Energy Efficiency Action Plan
O&M	Operation and Maintenance
PLS-SEM	Partial Least Square Structural Equation Modeling
SDGs	Sustainable Development Goals
SEM	Structural Equation Modeling
SME	Small and Medium-Sized Enterprises
TEDAŞ	Türkiye Elektrik Dağıtım A.Ş.
TPF	Third Party Financing
TURSEFF	Turkey Sustainable Energy Financing Program
UK	United Kingdom
US	United States
USD	United States Dollar
VIF	Variance Inflation Factor

1. INTRODUCTION

Energy efficiency (EE) has emerged as a key focus across various industries, driven by factors such as climate change, economic growth, volatile energy costs, advancements in technology, and the growing need for renewable energy solutions [1]. Energy Service Companies (ESCOs) play a pivotal role in the energy efficiency (EE) market. These entities, whether individual or corporate, take on a certain level of financial risk to deliver energy services while ensuring measurable improvements in efficiency [2]. The European Energy Efficiency Directive (EED) describes an ‘energy service provider’ as an individual or organization that offers energy services or implements energy efficiency improvement measures at a customer’s facility or premises. Additionally, it defines ‘energy performance contracting’ (EPC) as a contractual agreement between the provider and the beneficiary, where energy efficiency improvements are implemented and monitored throughout the contract’s duration. The associated investments, whether in labor, materials, or services are tied to achieving an agreed level of energy efficiency or other performance metrics, such as cost savings [3].

Energy service companies have been active since the late 1970s in the United States and gained traction in Europe during the 1980s and early 1990s [4, 5]. Energy efficiency (EE) has become more important and people are more aware of these concerns since the Sustainable Development Goals (SDGs) were adopted in 2015, the Paris Agreement was enforced in 2016, and the European Green Deal was introduced in 2019 [2]. Despite this, recent reports indicate that the energy service market, particularly in the European Union (EU) and surrounding regions, has yet to reach its full potential, even in nations with well-established ESCO sectors [6].

Turkey was introduced to the ESCO concept around 2007 with the enactment of the Energy Efficiency Law (EEL) by the Turkish government. This legislation facilitated the implementation of the ESCO model, aligning with Turkey’s commitment to comply with European Union (EU) guidelines [7]. In Turkey’s Energy Efficiency

Law (EEL), the term “ESCO” is referred to as “EVD companies”, which is a direct translation of Energy (E) Efficiency (V) Consulting (D) companies [1].

As a developing country, Turkey, continue its dependence on foreign energy sources along with the rising energy demand [2]. While Turkey has taken steps to reduce its energy dependency through investments in renewable and nuclear energy, achieving its targets will take longer without a strong focus on energy efficiency [8]. Although EPC holds significant potential for reducing energy consumption and enhancing efficiency, several barriers hinder its implementation. These include limited awareness and understanding, legal and political challenges, market-related issues, the absence of standardized procedures for measuring and verifying (M&V) energy savings, financial constraints, insufficient support mechanisms, and concerns related to risk perception [9]. The Ministry of Energy and Natural Resources highlights significant potential for energy efficiency improvements in Turkey, with possible savings reaching up to 30% in residential sectors and 20% in industrial sectors [10]. Despite these challenges, these obstacles hinder the achievement of the full potential of energy efficiency and the development of a well-structured ESCO market.

1.1. Gap in Literature

The Energy Service Company (ESCO) market is a key driver for promoting energy efficiency and implementing sustainable energy solutions in both public and private sectors [3]. However, the development of the ESCO market in Turkey faces several significant challenges, including regulatory barriers, limited access to financing, lack of market awareness, and technological constraints [3]. Previous studies have highlighted the importance of regulatory frameworks, financial incentives, and technological advancements in shaping the growth of energy efficiency markets [1-3], [8].

Despite these studies, there remains a significant gap in the literature, as no academic research has specifically examined the collective influence of the factors affecting the development of the ESCO market in Turkey through a comprehensive model frame-

work. While previous research has explored individual barriers and enablers, a holistic approach that evaluates the interrelationships among these factors is crucial for understanding the complexities of the Turkish ESCO market and providing actionable insights for its growth. This study aims to address this gap by developing a model framework to assess the combined impact of these factors, offering a more integrated perspective on the challenges and opportunities within the market.

1.2. Aim and Objectives of the Study

This study aims to examine the factors shaping the development of the ESCO market in Turkey for residential projects. It employs a comprehensive research framework that integrates stakeholder insights and quantitative data analysis to evaluate the collective influence of these factors.

The objectives of the study are:

- (i) To explore the current state of the ESCO market and its challenges in Turkey,
- (ii) To construct a conceptual framework through a comprehensive literature review and expert consultations,
- (iii) To develop and validate appropriate criteria for assessing the key barriers and opportunities affecting the ESCO market using stakeholder insights and quantitative analysis, and
- (iv) To analyze the relationships between the identified factors within the proposed model to derive actionable recommendations for market development.

By achieving these objectives, the study aims to fill a critical knowledge gap in the development of the ESCO market in Turkey, offering practical solutions to promote energy efficiency, reduce energy dependency, and support the country's environmental and economic goals. Moreover, this study represents the first academic effort to evaluate the factors influencing the ESCO market in Turkey through a comprehensive model framework, analyzing the collective impact of these identified factors.

1.3. Research Methodology

This study adopts a mixed-method approach to evaluate the factors influencing the development of the ESCO market in Turkey for residential projects. The research is structured in four main phases.

In the first phase, a comprehensive literature review is conducted to identify the key factors impacting the ESCO market, including market dynamics, financial barriers, regulatory challenges, awareness levels, and technical considerations. The literature review is focused on journal articles, conference papers, and other relevant academic sources, accessed primarily through databases such as Google Scholar and academic libraries.

In the second phase, based on the insights gained from the literature review, a theoretical framework is developed, and a set of hypotheses is proposed. These hypotheses will explore the relationships between regulatory barriers, financial challenges, market dynamics, client characteristics and technological advancements. Expert consultations are conducted to refine and strengthen the proposed framework, ensuring it accurately reflects and aligns with the current dynamics and challenges of the Turkish ESCO market.

The third phase focused on data collection and surveys. Stakeholders from various segments of the energy efficiency sector, including policymakers, ESCO professionals, and residential project developers, are engaged to validate the identified factors and provide insights into the challenges and opportunities in the Turkish context.

The final phase involves quantitative data analysis using a Structural Equation Modeling (SEM) approach to assess the collective impact of the identified factors on the development of the ESCO market. SmartPLS 4 is employed to test the proposed model and evaluate the relationships between the variables.

1.4. Scope and Limitations

This study focuses on evaluating the factors influencing the development of the Energy Service Company (ESCO) market in Turkey, with a particular emphasis on residential projects.

The analysis relies on data collected from stakeholders in Turkey's ESCO market; however, the sample size is relatively limited, which may pose challenges for achieving comprehensive quantitative analysis and statistical generalization. Lastly, the study relies on survey responses and expert opinions, which, while valuable, may be influenced by subjective biases.

1.5. Organization of the Study

This study is organized into six chapters. The first chapter introduces subject of the study, outlines the problem definition and statement, give general information regarding the study and presents the aims, objectives, research methodology, scope and limitations, and the organization of the study. The second chapter provides a comprehensive review of the literature, focusing on the Energy Service Company (ESCO) market, its development globally and in Turkey, and the key factors influencing its growth. It presents the relevant academic studies previously done. This chapter also discusses regulatory frameworks, financial incentives, market awareness and technological advancements, offering a foundation for the research framework. The third chapter details the research methodology, including the conceptual framework, hypotheses development, data collection process, expert consultations, and survey implementation. The application of Structural Equation Modeling (SEM) using SmartPLS 4 is also explained in this chapter. The fourth chapter presents the results and findings of the study. This includes a detailed analysis of the collected data and the relationships between the identified factors within the proposed model framework. The fifth chapter provides a discussion of the results, interpreting the findings in the context of the Turkish ESCO market and comparing them with existing literature. This chapter also

highlights the implications of the findings for policymakers, industry stakeholders, and researchers. Finally, the sixth chapter concludes the study, summarizing the key findings, contributions, and practical recommendations. It also outlines the limitations of the study and provides suggestions for future research. Supplementary information, including survey questionnaires, descriptive statistics, and detailed data analysis outputs, is provided in the Appendix section.



2. RESEARCH BACKGROUND

2.1. What is ESCO

Although there are various definitions stated in the literature, the establishment of a common framework and definition provided with the introduction of the EN 15900 standard in 2010, which was later reinforced by the Energy Efficiency Directive (EED, 2012/27/EU) in 2012 [3]. The Energy Efficiency Directive (EED) defines an energy service company (ESCO) as an entity (individual or organization) that offers energy services or implements energy efficiency improvements at the customer's location [3]. Additionally, it characterizes Energy Performance Contracting (EPC) as a contractual agreement between the service provider and the beneficiary, where energy efficiency upgrades are carried out and monitored throughout the contract period [8]. Payments are made based on achieving a predefined energy efficiency target or another agreed performance indicator, such as cost savings [3]. Dursun and Bertoldi (2015) made a parallel definition of ESCO as specialized companies that provide comprehensive energy-saving services and implement energy efficiency projects for clients through Energy Performance Contracting (EPC) models, where they identify potential improvements and guarantee energy savings based on predefined performance criteria [8]. The evolution of Energy Performance Contracting (EPC) can be divided into four stages. Initially, before 1985, ESCOs focused on supporting utilities with energy conservation services to meet regulatory mandates [11]. From 1985 to 1993, EPC began to emerge as ESCOs shifted to implementing and financing large-scale energy-saving projects. Between 1994 and 2002, EPC gained widespread acceptance, supported by standardized savings verification methods, which boosted investor confidence. After a brief slowdown in 2003, EPC experienced rapid growth driven by rising energy prices, stricter regulations, and the increasing need for sustainability and greenhouse gas reduction [11].

One such model is the Super ESCO, a business model illustrated in Figure 2.1. Limaye and Limaye (2011) [12] defines Super ESCO as a government-established entity

that acts as an ESCO to implement energy efficiency projects within public facilities. Additionally, it supports the growth and development of private ESCOs by providing capacity building and assisting in project development. This approach allows Super ESCOs to play a dual role, both directly driving projects and strengthening the broader energy service market [12].

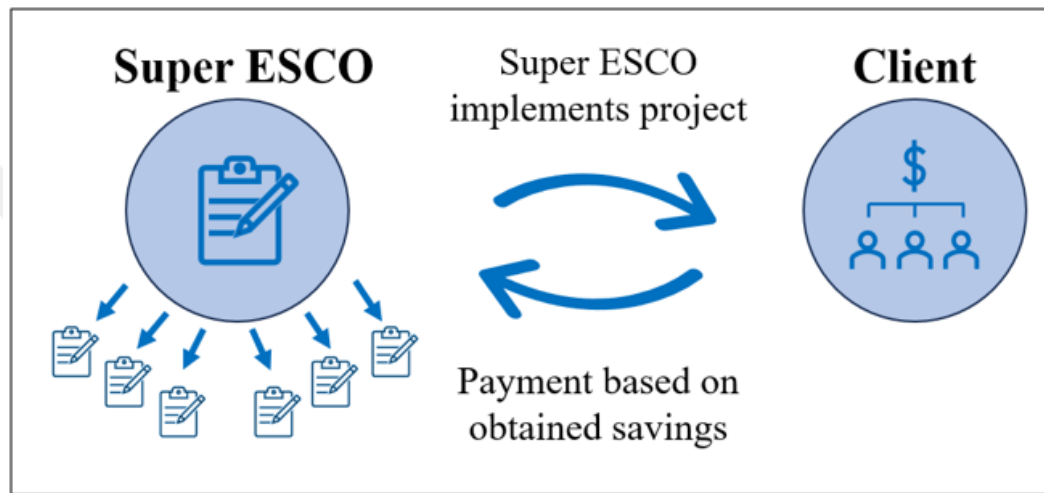


Figure 2.1. Super ESCO business model [13].

According to IEA (2018), Super ESCOs are valuable because traditional programs often lack sufficient funding for implementing energy efficiency projects. Although clients may have the financial means, energy efficiency is often not a priority, but Super ESCOs address this by providing easier access to external financing, which boosts project implementation rates [13].

2.1.1. ESCO Service Scope

Currently, a typical EPC project managed by an ESCO includes turnkey services from the initial energy audit to long-term savings verification, along with tailored measures like energy efficiency upgrades, renewable energy, and water conservation [14].

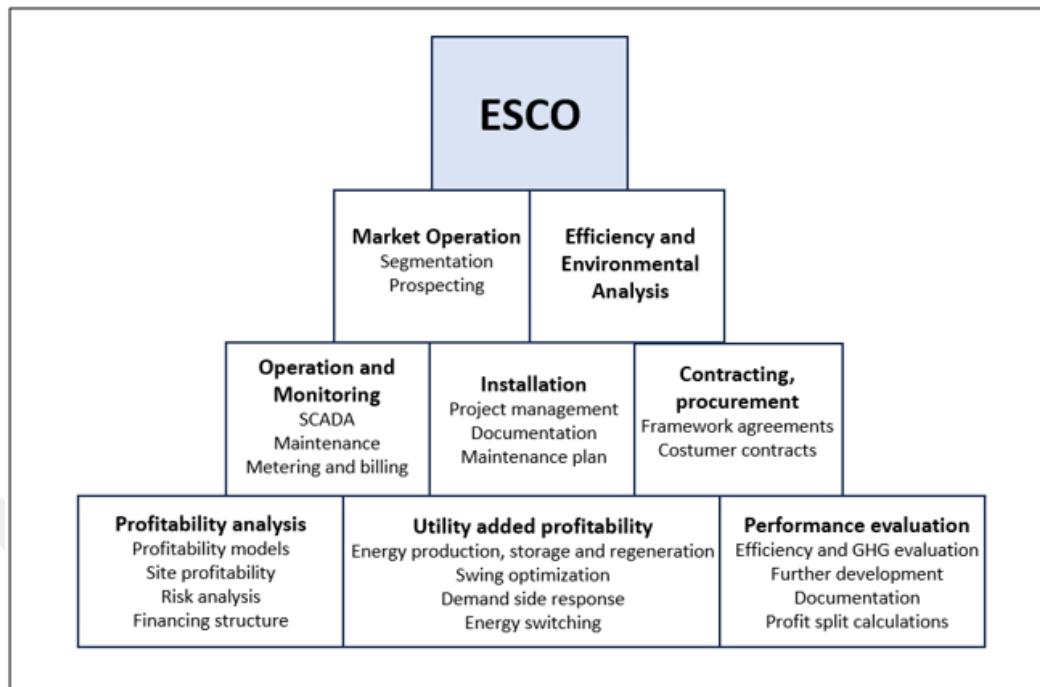


Figure 2.2. ESCO service scope [8].

Figure 2.2 outlines the service range of ESCOs, starting with market operations and efficiency analysis to identify opportunities. It then covers installation, operation and monitoring, and contracting. Additional services include profitability analysis, utility optimization, and performance evaluation, highlighting ESCOs' role in managing energy projects from planning to performance assessment [8].

Once the project parameters and service scope are established, the EPC contract typically follows a structured process. It begins with the signing of a planning agreement, followed by a detailed investment-grade energy audit to assess the project's potential. After the audit, the owner approves the measures to be implemented, and an energy services agreement is signed. The project is then executed under the ESCO's supervision, where a dedicated construction manager oversees the implementation phase [8]. Throughout the project's duration, the ESCO's project manager monitors and ensures compliance with contractual terms. The ESCO also provides ongoing Operation and Maintenance (O&M) services to maintain optimal performance. Regular Measurement and Verification (M&V) procedures are conducted to track energy savings [15]. Payments are made to the ESCO and any associated financiers based on the agreed

financial structure. Each year, an evaluation is carried out to confirm that the realized savings cover the service obligations. If the savings fall short, the ESCO compensates the client for the deficit, ensuring that the guaranteed performance is met [16].

2.1.2. ESCO Contracting Structures

Energy service contracting typically encompasses three main business models: Energy Performance Contracting (EPC), Energy Supply Contracting (ESC), and “Chauffage”, whereas in practice, most models are hybrid or simplified versions that combine elements from each type [17].

An Energy Performance Contract (EPC) is a commercial agreement involving the ESCO, customer, and financier, with two primary models-the shared savings contract and the guaranteed savings contract-that define different approaches for allocating savings and project risks among the parties [8]. In the shared savings model, the ESCO funds the project and recuperates its investment by obtaining a percentage of the realized energy savings, with the allocation of savings contingent upon criteria such as contract term, payback period, and associated risk levels [3].

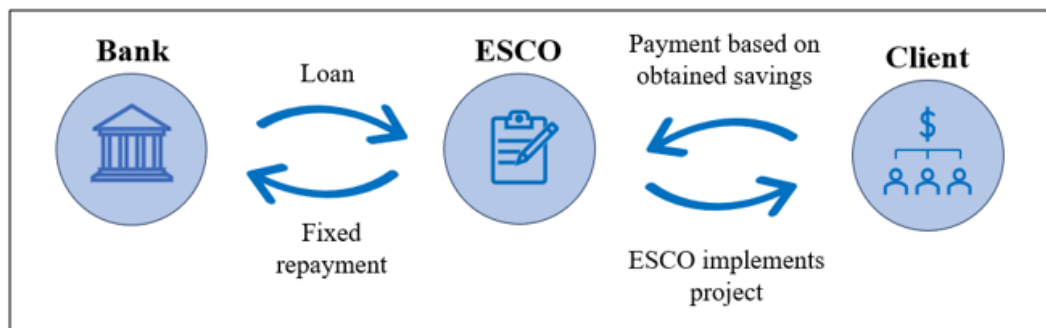


Figure 2.3. Shared saving business model [13].

The International Energy Agency (2018) describes the Shared Savings model as an arrangement in which the ESCO not only provides financing but also covers project development and implementation costs as displayed in Figure 2.3. Under this model, the energy savings are divided between the ESCO and the client throughout

the contract period. In this structure, the ESCO assumes both the technical and credit risks, relieving the client from the need for upfront capital investments [13]. The Shared Savings model is better suited for countries with emerging ESCO markets because it eliminates the need for clients to bear investment or repayment risks. Instead, the client only pays a portion of the actual savings achieved to the ESCO over an agreed period, making it a low-risk option for clients [18]. Nonetheless, over time, competition in the market decreases [19].

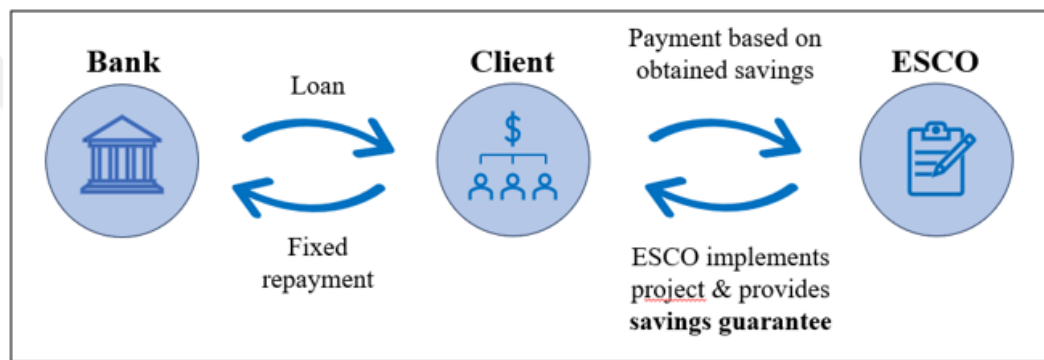


Figure 2.4. Guaranteed saving model [13].

In the guaranteed savings model, the ESCO commits to achieving a specific amount of energy savings throughout the contract period, ensuring that the client receives the agreed-upon energy cost reductions [8]. IEA defines the guaranteed savings model as a structure where the ESCO assures a specific level of energy savings on the client's energy bill, assuming the technical risks, while the client secures financing through a bank loan or their own equity to pay the ESCO, retaining any additional savings beyond the guaranteed amount [13]. The shared savings model is typically more prevalent in emerging markets or in situations where financial constraints exist, as clients often have limited capital access and opt for ESCO financing solutions rather than using their own funds due to the financial flexibility this model offers [3]. Dursun & Bertoldi (2015) argue that the guaranteed savings model aligns well with Turkey's constitutional framework because it bases performance guarantees on the actual amount of energy saved, unlike the shared savings model, which focuses on the monetary value of savings. As a result, the majority of ESCOs in Turkey tend to favor the guaranteed savings model [8].

Chauffage refers to a more comprehensive approach in which the ESCO oversees and optimizes both energy supply and demand efficiencies, delivering a higher value-added service to the client [17]. In this model, the service fee is typically calculated based on the client’s current energy bill minus a predetermined savings amount, with a guarantee of service quality [3]. In a chauffage contract, the ESCO evaluates the client’s current costs for maintaining specific conditions, such as temperature, per square meter, which includes energy, service, and maintenance expenses. The ESCO then proposes a fixed fee that is lower than the client’s existing total cost, ensuring cost savings for the customer [20]. The contract duration in this model is considered long usually from 20 to 30 years [21]. Chauffage is a popular contract type in Europe alongside EPC, operates as a form of Delivery Contracting (DC) [3].

Table 2.1. Division of role and tasks between the ESCO and the client [3].

	Whose balance sheet?	Performance risk lies with	Financial risk lies with	Is there project specific financing?
Shared Savings EPC	ESCO	ESCO	ESCO	Yes
Guaranteed Savings EPC	Customer	ESCO	ESCO/customer	Yes
“Chauffage”	ESCO	ESCO	ESCO	no

Table 2.1, adapted from Bertoldi *et al.* (2014), compares three common energy service contract models-Shared Savings EPC, Guaranteed Savings EPC, and Chauffage-based on financial and performance risks, as well as balance sheet implications and financing structures. To briefly overview each model, in the Shared Savings EPC model, the ESCO assumes both the performance and financial risks, meaning the project is kept off the client’s balance sheet. Here, the ESCO finances the project and is paid through a share of the savings achieved. Since the ESCO is responsible for both risks, this model typically involves project-specific financing. For the Guaranteed Savings EPC, the customer is accountable for the financial risk while the ESCO takes on the performance risk. This means the client’s balance sheet reflects the project,

as they often secure financing through a loan or their own capital. ESCO guarantees a certain level of savings, and if not achieved, compensates the customer, creating a shared financial risk. In a Chauffage model, the ESCO manages both the performance and financial risks, with all project-related expenses and savings staying off the customer's balance sheet. Unlike the other models, Chauffage typically does not involve project-specific financing, as the ESCO provides a fixed fee for maintaining energy services and efficiency levels. This comparison highlights the varying degrees of risk and financial responsibilities among the different contracting models, offering flexibility based on client needs and market maturity.

Energy Supply Contracting (ESC) on the other hand, centers around providing specific energy services, such as heating, lighting, or power, through outsourcing the energy supply. This model shifts the responsibility for delivering these energy services to an external provider [3]. It is important to distinguish Energy Supply Contracting (ESC) from Energy Performance Contracting (EPC), as EPC focuses on improving energy efficiency, while ESC is primarily concerned with supplying energy; additionally, unlike EPC, companies involved in ESC do not assume performance risks [21]. In Energy Supply Contracting (ESC), the contractor typically manages the financing, operation, and maintenance of the energy systems. However, they have limited or no control over the client's actual energy consumption or demand for the final energy services provided [22]. In addition to above mentioned contract types, other type of contracts like the BOOT model and Integrated Energy Contracting (IEC) also exist; the Build-Own-Operate-Transfer (BOOT) model involves an ESCO designing, building, financing, and operating energy equipment for a set period before transferring ownership to the client, while IEC combines elements of EPC and Delivery Contracting (DC) to maximize energy cost savings by prioritizing demand-side measures and supplementing them with efficient energy supply, offering a simpler and more cost-effective solution [3].

2.2. Development of the ESCO Market in Different Countries

2.2.1. US

The history of the ESCO market in US reaches back in 1970s as a reaction to the oil shocks and it grew yearly [5]. From 2009 to 2011, the ESCO industry's income increased by almost 9% annually, continuing a growth trend that began in the 1990s and outpacing the growth of the U.S. GDP during that period [23]. Upon presidential memorandum at 2011, new supportive regulations employed, and EPC total of 2 billion USD implemented by U.S. Department of Energy in 2012 and 2013 [23].

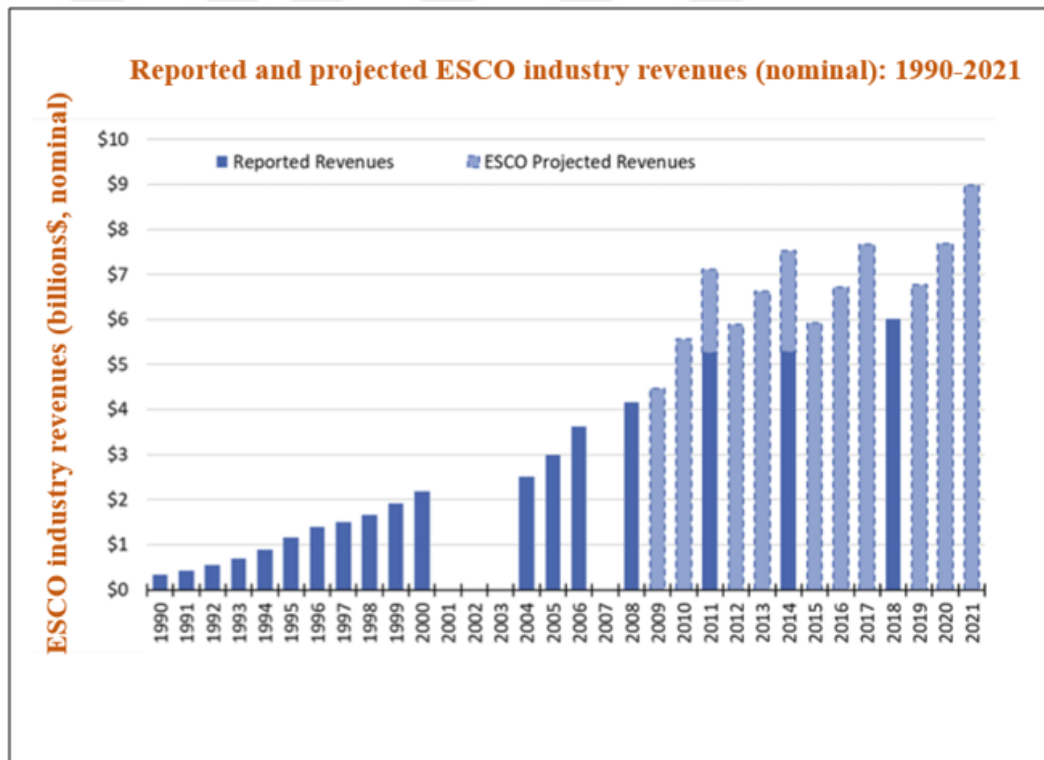


Figure 2.5. Growth and projections of ESCO industry revenues in US [24].

The above graph obtained from a study by Stuart *et al.* (2021) [24] provide a historical and projected overview of the ESCO industry's revenue growth from 1990 to 2021. It highlights steady growth in reported revenues until 2008, followed by significant projected revenue increases in subsequent years. The revenue growth trajectory indicates a robust expansion of the ESCO market, with particularly rapid increases ob-

served in the early 2000s and continuing into the 2010s. This consistent rise in revenues reflects the increasing adoption of energy-saving services and performance contracting, despite various market challenges. The projections for future years suggest sustained confidence in the industry's capacity to grow, driven by evolving demand for energy efficiency solutions. According to 2020 data by International Energy Agency (IEA), US ESCO market revenue has reached to 7.6 billion [25].

For the contracting side, guaranteed savings contracts, design/build or fee-for-service arrangements, and other similar models have become the norm for ESCOs and their clients in the past ten years [26].

In terms of the ESCO market activity, public projects have consistently been more prevalent in the U.S. ESCO market [26]. Approximately 40% of public projects are fully supported with cash, whereas ESCOs stated employing a range of techniques for their initiatives. Roughly 31% of these projects used alternative financing methods, while about 19% used third-party funded leases [23].

2.2.2. UK

The UK ESCO market could be considered one of the most mature and early ESCO market within the Europe region. In 1966, the National Coal Board established Associated Heat Services, which is now Dalkia, as the first ESCO [27]. By 1984, when engineering and energy conglomerate units began to provide value-added services like project finance alongside their more conventional offerings, the EPC industry had taken root [4]. By 2006, about 20 ESCOs had long-standing operations in the UK which were subsidiaries of multinational oil, control equipment, and electric utility conglomerates as the main actors [28]. This number has risen up to 62 as an actively operating ESCOs in the UK ESCO market by 2018 with a market size of 108.3 million euros [29]. According to recent country report, guaranteed savings contracting is the most preferred contracting type for the EPC projects (Keegan, 2017). In the UK, the majority of Energy Performance Contracting (EPC) clients are concentrated in the public sector,

with municipalities and the education sector being the primary contributors. This differs from global trends, where EPC clients are more evenly distributed across various sectors. In the UK, other significant sources of EPC clients include the health sector and the industrial sector, though their representation is less dominant. The private sector, particularly offices and retail/leisure sectors, makes up a smaller portion of the EPC client base. This highlights the strong involvement of public institutions in driving the UK's EPC market, while private sector participation remains comparatively limited [30].

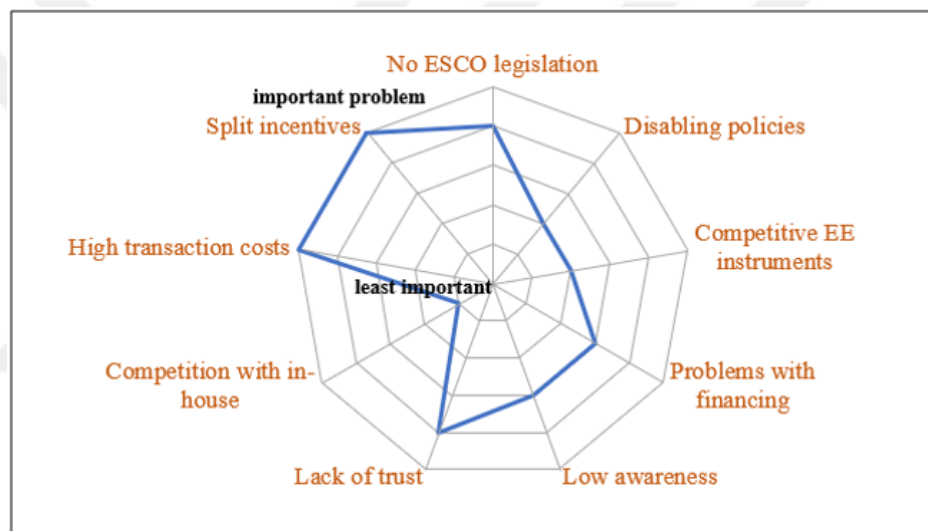


Figure 2.6. Barriers to ESCO projects in UK [3].

The figure illustrates the major barriers faced by Energy Service Companies (ESCOs) in the UK, based on a study by Bertoldi *et al.* (2014) [3]. The radar chart highlights the relative significance of various obstacles to ESCO project implementation, with the most prominent barriers being the lack of specific ESCO legislation, disabling policies, and high transaction costs. Additionally, split incentives and competition with in-house energy management solutions also pose considerable challenges. On the other hand, issues such as low awareness and lack of trust were considered less critical, yet still present hurdles in the broader adoption of ESCOs. This visualization underscores the multifaceted nature of barriers, which range from regulatory and policy-related issues to financial and market dynamics, affecting the development of the ESCO market in the UK.

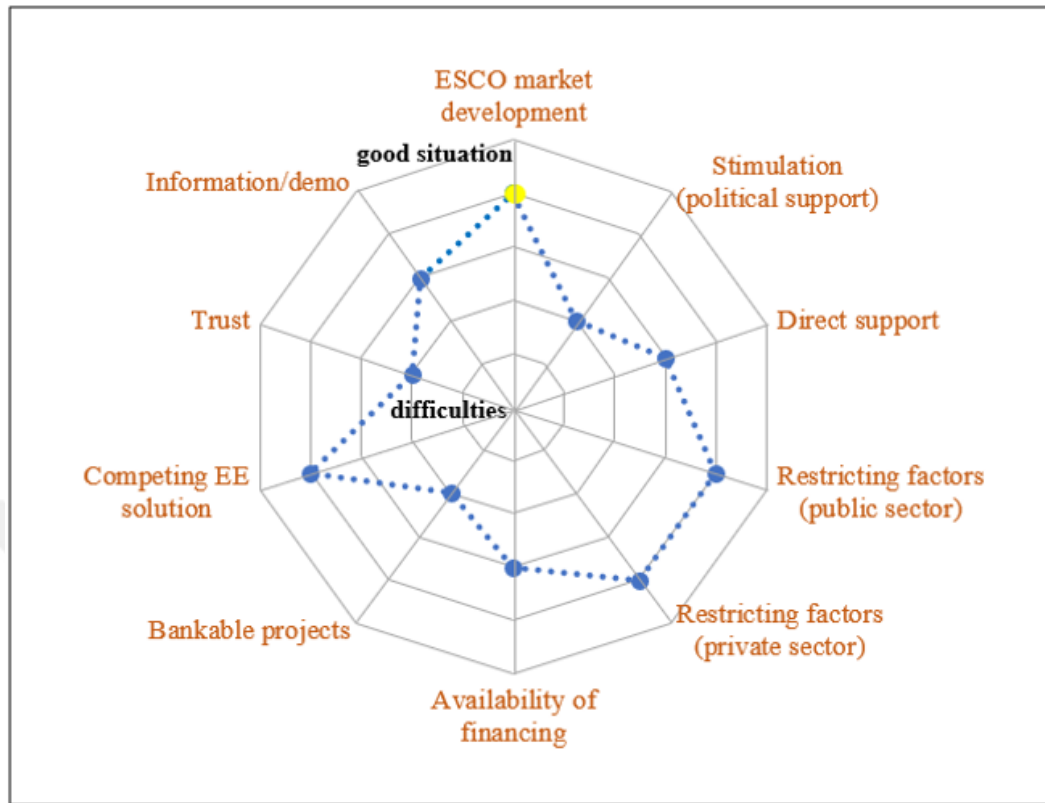


Figure 2.7. Key futures of UK ESCO market [3].

The radar chart above highlights the key characteristics of the ESCO market in the United Kingdom. It evaluates various factors that influence market development, indicating areas of both strength and difficulty. The chart shows that the UK enjoys a relatively favorable situation in terms of political support and market development for ESCOs, with strong performance in information dissemination and demonstration activities. However, challenges still exist, particularly in accessing financing and dealing with restricting factors in both the public and private sectors. Bankable projects and the trust required to engage stakeholders are also noted as areas where difficulties persist, alongside competition from existing energy efficiency solutions. This chart provides a comprehensive overview of the landscape, emphasizing the mixed progress and ongoing hurdles in developing the ESCO market.

2.2.3. Finland

The EPC market in Finland began in the 2000s, with small-scale private energy efficiency (EE) projects dominating the early phase of market development [14]. By 2002 Finnish ESCO market turnover reached approximately 4.5 million Euros and 10 million Euro objective set for the 2004 market turnover [28]. Through market development efforts, Motvia Oy is one of the main actors to drive the Finnish ESCO market by developing standards for ESCO contracts as a state-owned company as a state-owned enterprise advocating for energy and material efficiency with sustainability [31]. Many smaller public and private sector projects make up Finland's EPC market. There has been a small increase in the number of public sector projects and overall project size by 2015, suggesting that the market is still in its early stages of development [14].

Recently, the private sector has been steadily growing, while the public market has been relatively modest and steady, according to the EU Survey 2022. Both public and private buildings often go for EPC with guaranteed savings [32]. Maintenance, part replacement (mostly for lighting and ventilation), control system installation, energy management, and renewable energy generation are typical EPC interventions [32].

The JRC (2018) country report identifies the small scale of projects, elevated transaction costs, lack of trust from potential customers, availability of in-house technical competence, and the limited experience of stakeholders as primary obstacles to the growth of the ESCO market [29]. On the other hand, in the Finnish market, there is growing interest from clients, and the concept of ESCO is widely understood. Consequently, there is no necessity to substantially enhance awareness [33].

2.2.4. Germany

Upon successful development of ESCO market and project in USA, concept has arrived to Europe and Germany was one of its initial stops [34]. The rise of the German

ESCO industry began in the early 1990s, but today it is known as one of the most mature and thriving ESCO markets on the continent [35]. In Germany alone, over 70,000 energy service contracts were established by the end of 2000s with significant results. This involved the installation of more than fifty thousand units of generation and an aggregate investment exceeding 5 billion euros. The total installed thermal capacity amounted to 46 GW while the electric capacity was about 8 GW. In 2003 it is reported that 3-billion-euro annual turnover has been accumulated by 480 active ESCO in German ESCO market [33]. In 2020, approximately 500 to 550 companies are actively serving as energy service companies [36]. According to the International Energy Agency (IEA), 86% of the ESCO revenues come from Energy Supply Contracts (ESC) where 14% comes from Energy Performance Contracts – Guaranteed Savings [37]. A country report on Energy Efficiency Services published in 2018, nearly 70% of the EPC clients come from public sector such as municipalities, hospitals and education buildings [38]. On the financing side, the sale of claims constitutes 58% of the total funding for EPC projects in Germany. Next, the customer and the service provider each secure loan funding, with the client obtaining 50% and the supplier 42% [38]. Given the lack of favorable loans in Germany, the main source of funding was predominantly obtained from banks, who were very active in the nation. Nonetheless, the growth of ESCO marketplaces was hindered by persistent high transaction costs [39].

In Germany, the reforms in the energy supply system involve more of decentralization with a number of local and regional energy services companies coming out in response to the market-oriented thrust [39]. In 2012, by implementing the EU Energy Efficiency Directive which involves National Action Plan on Energy Efficiency (NAPE) energy performance contracting has affected positively and become more important instrument for the government [36]. Despite to the stabile course of the prices in energy consumption from 2013 to 2019 which have made it very weak for the owners of the buildings to spend their money in the energy efficiency investments or to go for the upgrades of the energy services of their properties like energy performance contracting, increase in energy prices starting from 2020 fostered the clients desire to EPC investment lately [6, 36].

2.2.5. Netherlands

As of 2002, although several utility providers in the Netherlands offer energy management and energy service contracts, EPC projects had not yet been developed [40]. Between 2010 and 2013 there were 50 ESCOs actively operating within the EPC market [39]. The primary client segments for ESCOs in the Netherlands are the business and public sectors. The main areas of concentration for public sector initiatives are public administration and healthcare. These projects often entail the creation of expansive, energy-efficient non-residential structures, with a focus on architectural design and equipment installation. The critical areas of focus include combined heat and power (CHP), heat and cold storage, heat pumps, insulation, and operation and maintenance [36].

According to QualitEE (2018) [38] report actors of the Dutch ESCO market indicate that the “guaranteed savings” model is the prevailing energy savings approach in EPC projects in the Netherlands, chosen by 38% of respondents as a result of the market survey. In the Dutch EPC market, the “shared savings” model is not employed [41].

Regulatory measures on energy efficiency and the energy performance of office buildings, as well as the promotion of energy efficiency through Real Estate Finance loans by banks and financial institutions, are the main drivers of the well-developed energy service market in the Netherlands, according to the JRC ESCO report by Bertoldi (2018). Nevertheless, significant obstacles to the expansion of the industry are the absence of technical proficiency among financial institutions and a limited feeling of concern about energy efficiency in buildings [29]. Currently, Energy efficiency legislation and financial institutions have been the driving forces behind the steady development of the ESCO industry in the Netherlands. Despite the market’s expansion, particularly in public buildings, constraints such as insufficient understanding among financial institutions and a lack of urgency for energy efficiency remain [42].

2.2.6. Norway

EPC projects existed in Norway as early as 1995, but prior to 2008, such projects were infrequent, and the market response remained limited. Ten to fifteen ESCOs were actively operating at the year 2007, with together generating an estimated turnover of 30-40 Million Euros. Annually, between 2005 and 2010, around two to three projects were executed (. The combination of low energy prices in Norway and the financial crisis of 2012/13 has resulted in a somewhat diminished level of interest in energy efficiency measures, particularly within the banking industry [14]. The majority of ESCO initiatives were conducted in public buildings. Notwithstanding the considerable commercial potential of building renovation and modernization endeavors, only a restricted number of such projects were successfully executed [43].

According to Multiconsult's country report where they aimed to assess the barriers against investments into ESCO market in the Norway shows that the economical, knowledge and practical barriers has cover 30% each among all barrier types. The report finds out a shortage of financing for public enterprises and the high costs of investment are key challenges as economical barriers. Furthermore, insufficient incentives, lack of interest, and the time needed for implementation were recognized as obstacles to the acceptance of energy saving measures identified as the main practical barriers. Finally, the major knowledge barriers have been identified as a general lack of understanding of the benefits and economics of energy efficiency initiatives, as well as inadequate experience in building operations [42]. According to the European Commission supported market report from 2013, an essential regulatory step that supports ESCOs is the EPC standard, which is approaching its ultimate approval. Upon formal adoption, this standard is anticipated to improve knowledge of EPCs and tackle several obstacles, including trust problems, obstacles in public procurement, and concerns around outsourcing. Nevertheless, the still affordable energy costs and the wide availability of installed hydropower remain major challenges in attaining energy savings. Despite its relatively low visibility a few years ago, the ESCO model has lately garnered growing interest from both the demand and supply sides of the market [3].

2.2.7. Spain

Besides from the private ESCOs operation in Spain ESCO market through years, the majority of regional and select municipal energy agencies, as well as the International District Energy Agency (IDAE), operate as Energy Service Companies (ESCOs) and provide third-party financing (TPF) for specific projects [33]. Especially private ESCOs are primarily engaged in providing financial support for wind farms whereas public ESCOs such as IDEA are actively promoting developing sectors such as cogeneration with biomass, solar thermal, and photovoltaic technologies [33, 44]. Based on 2020 data, ESCO projects in Spain are comprised of 13% public, 34% private, and 53% public-private partnerships. The turnover of the Spanish ESCO market has reached 1.604 billion euros [45].

Many European ESCOs, such as those in Spain, usually utilize their own funds for EPC projects. Typically, these initiatives are organized based on the shared savings method, but guaranteed savings are less frequent. Despite Third-party financing (TPF) was popular in the Spanish ESCO market currently TPF seldom employed as a means of funding for these types of projects [3, 28]. 80% of ESCOs utilized their own capital, while 58% relied on external financial channels to fund their initiatives as per 2020 market data [46].

The latest market studies suggest that an important barrier to the growth of the ESCO industry is the insufficient knowledge among end users, along with inflexible laws that restrict innovation and impede demand involvement [45]. Nevertheless, the Spanish government has introduced public procurement mechanisms for long-term contracts with the goal of establishing more dynamic frameworks for ESCOs [39].

2.2.8. Italy

Early in the 1980s, the first Energy Service Provider Companies (ESPCs) in Italy started running “heat service” for public buildings under contracts including fuel

delivery as well as boiler operation and upgrading [28]. ASSOCALOR, the association of the heat supply companies, was founded in 1984. ASSOCALOR changed its name to AGESI (an energy service industry organization) in response to a new legal framework that mandated public authorities take energy-saving alternatives into account when examining energy supply possibilities in the middle of the 1990s [33].

In November 2004, government's standardization efforts have been expedited and accreditation of ESCOs initiated by Italian Regulatory Authority for Electricity and Gas (AEEG) [39]. Energy conservation measures used by ESCOs must be officially approved by the Market Operator, who grants certifications upon request from the regulator AEEG following verification. Suppliers can purchase White Certificates obtained by Energy Service Companies (ESCOs) to fulfill their end-use energy conservation requirements as outlined in the Australian Energy Agency [47].

According to a national report on the energy efficiency services in Italy as of 2009, 1,342 companies were accredited as ESCOs and 221 companies were submitted energy efficiency projects (EEPs) to certified energy savings [48]. The energy performance contract (EPC) services contributed 35% to its 2018 revenue of €3.7 billion, while EE and consultancy projects accounted for 42% and sales of white certificates for 23% [45]. For the buildings such as offices, commercial, and residential structures, received energy efficiency investments amounting to €4.6 billion in 2018. The majority of these investments were allocated to the residential sector, accounting for 82%, while the remaining portion was distributed among private offices (14%) and commercial buildings (4%) [45]. Among the energy saving interventions, public lighting retrofits are the most performed projects based on the EU Survey 2022 [32]. Among the energy service contracts as of 2018, 60% of the EPC projects are contracted as Shared Savings followed by Guaranteed Saving with 20% and both with 20% [49].

2.2.9. China

The Chinese ESCO sector was established in 1998 as part of a strategic initiative led by the Chinese government, with financial and technical backing from international organizations like the World Bank, Global Environment Facility (GEF), and other global partners [50]. In China, ESCOs are referred to as Energy Management Companies (EMCs) because “ESCO” was registered as a trademark and could not be legally used [51]. The “China Energy Efficiency Project” which identifies the energy efficiency transition of China, was implemented in two stages, with the first stage running from 1998 to 2003 and the second stage taking place from 2003 to 2008 [52]. The first stage backed by GEF and International Bank for Reconstruction and Development (IBRD) funding nearly \$80 million, aimed to promote the EPC mechanism and develop the ESCO industry, resulting in the creation of three ESCOs in Liaoning, Shandong, and Beijing [53]. Following the successful implementation of the new model by the initial three ESCOs, the next challenge was to secure financing from domestic commercial banks to replace the government-supported World Bank loan [50]. The second phase of the China Energy Efficiency Project began in 2003 as a five-year initiative, focusing on fostering new ESCOs. During this phase, the China Energy Conservation Service Industry Association (EMCA) was founded, and a loan guarantee system was introduced to encourage market entry and support the growth of the ESCO sector [53]. The guarantee initiative provided loans to 42 ESCOs between 2004 and 2009, allowing them to carry out 148 projects [53].

In China, energy performance contracting (EPC) is driven by industrial and commercial clients, with public sector involvement still limited. Projects are typically short-term, simple, and focus on off-balance sheet financing. Unlike in North America and Europe, repayment risks and reliance on relationships play a central role in the Chinese EPC market [50].

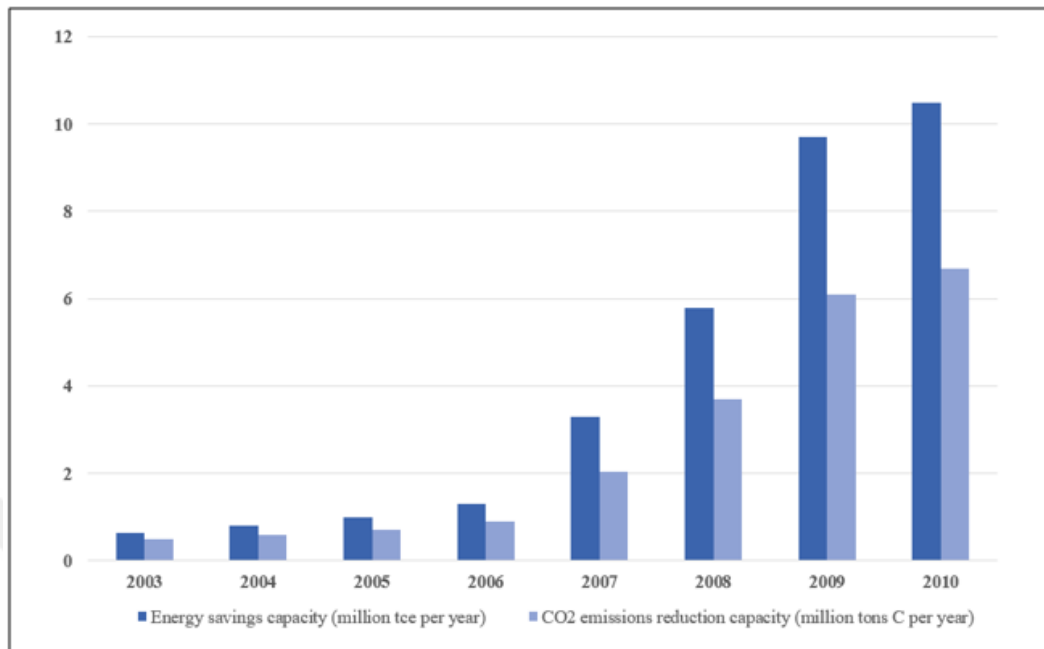


Figure 2.8. ESCO projects' energy savings through 2003 to 2010 [53].

According to International Energy Agency report in 2019, key barriers in ESCO market in China include low demand for energy efficiency services, limited ESCO capacity, especially among SMEs, and financing challenges, driven by the difficulty in valuing energy efficiency [54]. Most ESCOs in China are small and medium-sized enterprises (SMEs) facing significant financial barriers. Lacking sufficient capital to fund projects independently, they rely on financial intermediaries for growth. However, access to capital remains limited, and high interest rates further increase financing costs [53]. Many energy end-users in China remain unfamiliar with the ESCO concept, prioritizing revenue growth over long-term ESCO projects, which often involve lengthy implementation and payback periods [52]. Nevertheless, the ESCO market in China possesses considerable potential, attributed to its multiple energy-intensive sectors, with projections surpassing \$100 billion. This substantial opportunity pushes energy efficiency companies to penetrate the market [51]. Figure 2.8 depicts the energy saving and saving opportunity levels of the ESCO projects in China. As of 2019, ESCO projects in China were distributed across four main sectors: 41% in the industrial sector, 16% in public facilities, 18% in residential buildings, and 25% in commercial buildings [55]. Recently, China's investment in ESCO projects rose by 12.3% to \$19.2

billion, accounting for 59% of the global ESCO market, a notable achievement as many other markets stagnated or declined [54].

2.3. ESCO Market Development in Turkey

The roots of Turkish ESCO market reaches to 2007 when new Energy Efficiency Law (EEL) was enacted by the Turkish government, allowing the ESCO idea to be implemented due to Turkey's obligations to adhere to European Union (EU) guidelines [3, 7]. The EEL's principal objective is to dismantle the state monopoly by facilitating private-sector participation and promoting competition under independent regulation, with the establishment of an ESCO market emerging as a crucial focal point in Turkey's developing energy sector [7]. Furthermore, the legislation optimizes energy utilization and encompasses administrative organization, energy audits, financial mechanisms and incentives, public awareness initiatives, and the creation of a market for Energy Service Companies (ESCOs) providing energy efficiency (EE) services [19]. "ESCO" is designated as "EVD companies" in Turkish EEL which is a direct translation of Energy (E) Efficiency (V) Consulting (D) companies [1]. In 2011, entitled companies were started to get authorizations for ESCOs from the General Directorate of Energy Efficiency and Environment under the Ministry of Energy and Nature Resources [2,3]. With a loan from Turkey Sustainable Energy Financing Program (TURSEFF) and the Energy Performance Contract agreed with Johnson Controls, an ESCO business, the first actual ESCO project was executed in Turkey in 2012 for Carousel, one of the oldest shopping mall in Istanbul [3].

In 2017 Turkey established the National Energy Efficiency Action Plan (NEEAP) to save \$30.2 billion by 2033 while investing \$11 billion by 2023. The plan seeks 66.6 million tons of carbon reduction, or 14% of primary energy usage. Energy managers were ordered to cut public building energy usage by 15% by 2023 by a presidential decree in August 2019. After the 2018 Energy Efficiency Law modification, public institutions might use ESCOs to sign energy performance contracts for up to 15 years, enabling long-term energy efficiency gains [56].

Through years, ESCOs are established by obtaining necessary permits and fulfilling the obligations set by the ministry and involved to the Turkish ESCO market.

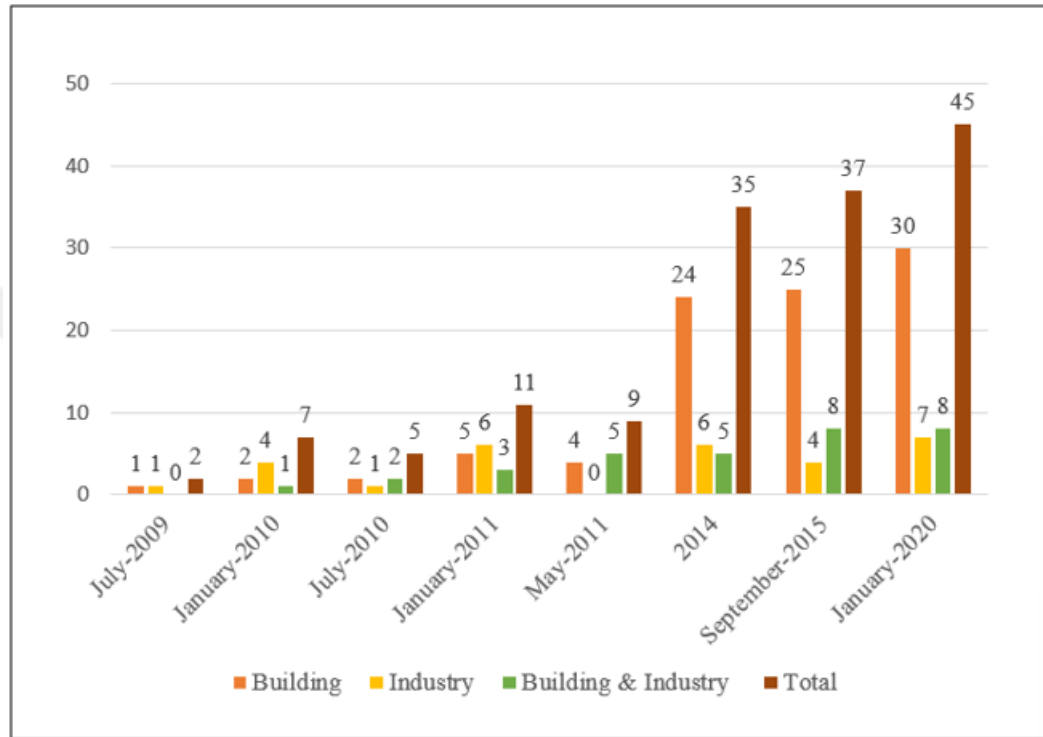


Figure 2.9. Distribution and number of ESCO projects categorized by type over time in Turkey [1].

The Figure 2.9 illustrates the growth of Energy Service Companies (ESCOs) in Turkey across different sectors-buildings, industry, and a combination of both-from July 2009 to January 2020. The total number of registered ESCOs steadily increased over the years, with a notable rise between 2014 and 2020. The building sector consistently dominates the market, showing significant growth, especially in the later years, with 45 companies registered in January 2020. The industry sector shows more moderate growth, with fluctuations, while the combined building and industry category remains relatively small throughout the period. This trend highlights the increasing focus on energy efficiency in the building sector in Turkey, aligning with the growing awareness and policy support for energy-saving initiatives. According to 2023 data, a total of 56 ESCOs have been actively operating out of which 22 are involved in both residential/

commercial and industrial building projects, 23 in the residential/ commercial and 11 in the industrial solely [2]. According to Ministry of Energy and Natural Resources (MENR) energy efficiency improvements have a lot of potential to grow in Turkey, with savings of up to 30% in residential and 20% in industrial settings [10]. This potential is considered a vital opportunity for both ESCOs and government. To show the potential energy savings in residential buildings pwc's Turkish Electricity Market Report (2023) have been examined. According to report, by the end of 2024, residential buildings' energy consumption in Turkey will rise to 69.2 Terawatt – hour (TWh) in total [57]. Currently the price of the electricity in Turkey is approxametly 2.28 TL/ kWh (VAT included) according to Turkish Electricity Distribution Corporation (TEDAŞ). In light of these information by considering all residential builds in Turkey receives ESCO services, the saving amount could rise up to 1.4 billion USD.

In order to release this opportunity, first, market dynamics of the ESCO market have to be comprehended. The dynamics of the Turkish ESCO market including barriers and drivers has examined in various academic and professional studies. According to JRC Report conducted by Panev *et al.* (2018) [58], the existing legal framework in Turkey concerning local self-government, particularly municipalities, poses significant challenges to the growth of ESCO services. Procurement regulations are overly rigid and complex, making it difficult to implement energy efficiency projects. Additionally, the strict nature of public-private partnership laws further limits opportunities for collaboration. Another issue is the lack of specific legislation that promotes energy efficiency in multi-apartment residential buildings, which also hampers the development of the sector [58].

Kalangos (2017) [59] provides an in-depth examination of the barriers and policy drivers influencing energy efficiency (EE) within Turkey's automotive, chemicals, and textile industries. Using a two-fold research methodology, the study goes beyond traditional survey-based assessments by incorporating a market analysis to evaluate the strengths and limitations of key market actors and institutional structures. This dual approach enables a more comprehensive understanding of both internal and external

barriers to EE, avoiding the subjectivity often associated with field responses. Kalangos' findings emphasize the intertwined nature of these barriers, calling for a holistic approach to address them effectively. The study also highlights several critical challenges, including poor behavioral and managerial practices related to EE, the lack of private capital for EE investments, and the underdeveloped energy service company (ESCO) market in Turkey. Additionally, the loose EE practices among energy suppliers further complicate market dynamics. To overcome these barriers, the study advocates for a policy framework that reinforces best practices, drawing on national and international examples, and promoting a more robust and reliable ESCO marketplace. This research provides a critical perspective on the macroeconomic and institutional factors that impact the development of the EE and ESCO markets in Turkey, aligning with broader discussions on market drivers and policy needs for ESCO market development.

Okay *et al.* (2008) [60] explore the potential impacts of Turkey's Energy Efficiency Law (EEL), introduced in 2007, on the emerging ESCO market. The authors provide a global overview of ESCO financing mechanisms and relate these to the Turkish context. They emphasize that while the EEL sets the stage for growth in both public and private sector energy policies, the success of the Turkish ESCO market will depend heavily on financial infrastructure and associated risks. Drawing from the experiences of EU-related projects involving the banking sector and SMEs, the paper highlights the importance of robust credit and banking systems to support the growth of ESCOs. The authors argue that maintaining Turkey's economic growth rate and completing structural reforms are essential for attracting capital inflows, which will, in turn, help ensure the stability and financing necessary for a competitive ESCO market. The research underscores the need for continued policy support and economic reform to sustain the long-term success of the ESCO sector in Turkey. Akman *et al.* (2013) [18] also assess the impact of Turkey's Energy Efficiency Law (EEL), enacted in 2007, on the development of the country's ESCO market. Although the law was expected to stimulate significant growth in energy policies across both public and private sectors, the relevant communiqué pertaining to ESCOs was only introduced in 2012.

This delay limited the early progress of the market. The paper reviews the current landscape of the Turkish ESCO sector, identifying key barriers and enabling factors, and examines the financial mechanisms available to ESCOs. While the communiqué is positioned as part of broader regulatory efforts to enhance Turkey's global competitiveness, the authors note potential challenges, particularly for smaller ESCOs, which may struggle with some of the new regulatory requirements. Despite these concerns, the communiqué is anticipated to strengthen the ESCO market over time, provided these barriers can be addressed. The study highlights the importance of continued policy support and the role of financing in fostering the market's growth, offering a detailed analysis of the intersection between regulation and market dynamics in the Turkish ESCO sector. According to the JRC report conducted by Bertoldi *et al.* (2014) [3] comprehensively examined the Turkish ESCO market.

Report states that Turkey's rapid economic growth has led to a surge in energy demand, which the current energy infrastructure cannot support. The government aims to reduce energy consumption due to its heavy reliance on imported oil and natural gas. Rising tariffs on electricity and natural gas since 2008 could drive ESCO market growth, with electricity prices increasing by 17.7% in 2012-2013 and natural gas by 35.2% in 2011-2012. To expedite the development of ESCO market Turkish government adopted two types of incentives in the industrial sector: one focused on supporting energy efficiency projects and the other involving voluntary agreements aimed at promoting energy-saving practices within the industry [3].

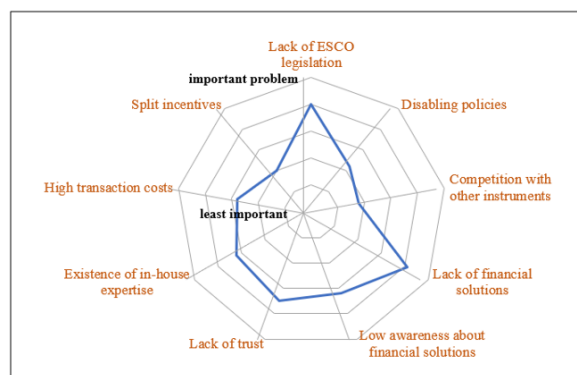


Figure 2.10. Barriers to ESCO projects in Turkey [3].

The graph from the JRC 2014 report illustrates the key barriers impacting the development of ESCO projects in Turkey, ranked by their significance. The most critical challenges include the lack of ESCO-specific legislation and disabling policies, both of which create a restrictive environment for ESCO market growth. High transaction costs and split incentives are also highlighted as significant obstacles, indicating complexities in project implementation and benefit-sharing among stakeholders. Conversely, issues such as low awareness of financial solutions and lack of trust are considered less important barriers. Similarly, the availability of in-house expertise and competition with other instruments are deemed to have a lower impact on the ESCO market. This ranking suggests that addressing legislative and policy-related barriers should be prioritized to foster a supportive environment for ESCO projects in Turkey.

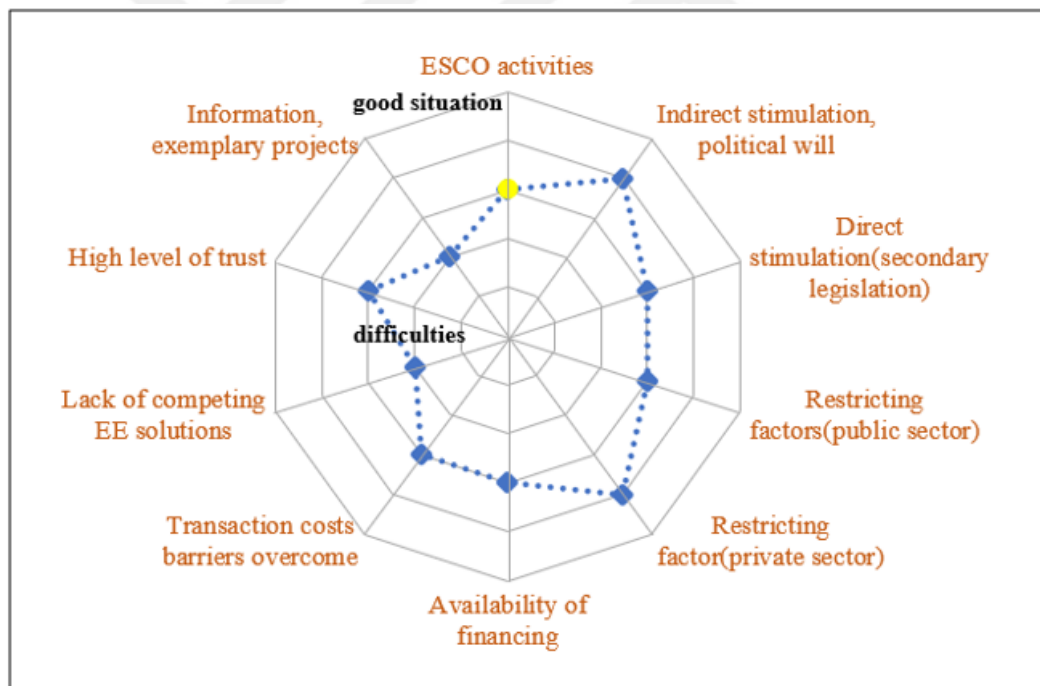


Figure 2.11. Key futures of Turkish ESCO market [3].

The report also illustrates the key futures of the Turkish market as it is depicted in Figure 2.11. The report also illustrates the key features of the Turkish market, highlighting both strengths and challenges for ESCO development. The radar chart provides an assessment of various factors affecting the market, with indicators ranging from “good situation” to “difficulties”. On the positive side, Turkey shows strong

performance in areas such as ESCO activities, information dissemination, exemplary projects, and a high level of trust among stakeholders. This suggests that there are already some successful implementations and a foundation for further growth in energy efficiency services. However, the chart also points out significant difficulties in other areas, particularly in the availability of financing and overcoming transaction costs. The lack of competing energy efficiency solutions and restrictive factors in both public and private sectors further complicate market development. Political will and indirect stimulation show a relatively favorable position, indicating some level of government support, but direct stimulation through secondary legislation is still a concern. Overall, while Turkey demonstrates potential for ESCO market expansion, addressing financial barriers and refining legislation are crucial to creating a more enabling environment.

In analyzing the development of the ESCO market, Acuner *et al.* (2021) [1] provide valuable insights into the current status of Turkey's energy service sector, particularly focusing on energy efficiency consulting (EVD) companies which is considered as Turkish ESCOs. Their research, based on a survey conducted with 13 EVD companies, utilized Bayesian Belief Networks (BBN) to evaluate the market's success rate, which was determined to be around 58%. The study underscores the critical role of regulations and effective project implementation in shaping the future of the market.

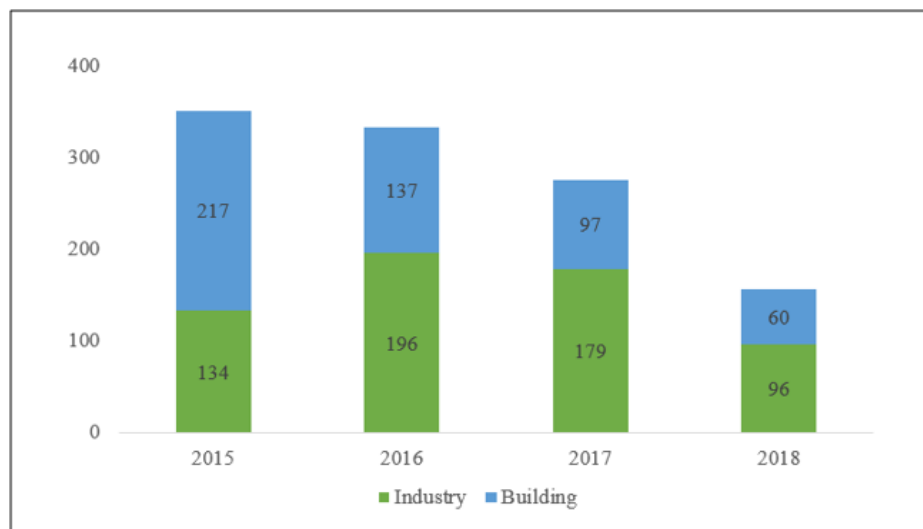


Figure 2.12. ESCO project audit activities in industry and building projects [1].

The study also indicates the number of ESCO projects through the audit activities in Figure 2.12. The graph shows a declining trend in energy efficiency audits in Turkey's industry and building sectors from 2015 to 2018. In 2015, there were 351 audits (134 in industry, 217 in buildings), dropping to 156 audits in 2018 (96 in industry, 60 in buildings). While industry audits remained relatively steady, building sector audits saw a significant decrease over the years, indicating reduced focus or opportunities in this area.

A key finding of their research highlights the need to increase both the quantity and quality of energy efficiency projects. Additionally, the authors advocate for the establishment of a National Energy Efficiency Fund and emphasize the importance of integrating energy performance contracts (EPCs) with measurement and verification systems to enhance market reliability. The SWOT analysis conducted in the study outlines the market's strengths, weaknesses, opportunities, and threats, offering a strategic perspective on necessary improvements to support the sustainable growth of Turkey's energy service market.

Acuner *et al.* (2021) [1] identified several critical weaknesses that limit the development of the ESCO market in Turkey. One major issue is the lack of dedicated ESCO legislation, which creates an unclear regulatory framework and reduces investor confidence. Additionally, restrictive procurement processes, especially in the public sector, present a significant barrier, making it challenging for ESCOs to access opportunities in this domain. Financial limitations are also prominent, as high transaction costs and the lack of suitable financial solutions impede the execution of large-scale energy efficiency projects.

Another challenge is the low awareness among stakeholders regarding the benefits of energy efficiency and the available financial options according to the study. This lack of understanding, coupled with a lack of trust in ESCOs, particularly within the private sector, further diminishes market engagement. The split incentive issue, where the party making the investment does not always reap the benefits, also poses a challenge,

especially in the building sector. Finally, the shortage of qualified professionals and in-house expertise in ESCO-related activities reduces the ability to implement and manage energy efficiency projects effectively. Addressing these barriers is crucial for the growth of the Turkish ESCO market, as they highlight the need for a comprehensive regulatory framework, improved financial instruments, and capacity-building efforts to promote market confidence and awareness. This analysis complements broader discussions on regulatory and financial mechanisms that can drive the development of the ESCO sector.

In evaluating factors affecting the development of the ESCO market, it is essential to consider the role of energy performance contracts (EPCs) in promoting energy efficiency. Akkoç *et al.* (2023) [2] conducted a comprehensive study that focused on assessing the awareness and experiences of various market participants, including energy service company representatives and facility managers, regarding EPCs. Their findings highlight the significant challenges in the Turkish market, particularly with respect to securing project financing, which is a critical stage for both EPC and non-EPC projects.

The study also provided the future EPC preference factors of the respondents. The primary factors that participants consider important when prefer EPCs. The most critical factor is having an energy-saving guarantee, with 48% of respondents marking it as very important. External financing is also a significant concern, highlighted by 28% as very important and 36% as important, indicating that access to funding plays a crucial role in the decision-making process. The presence of good national and international examples is moderately valued, with 43% identifying it as important, while avoiding technology risks is considered relatively less significant, with only 13% rating it as very important.

Table 2.2 indicates the list of factors participants consider important when preferring EPCs. The factors are arranged as per their importance obtained from the study's survey.

Table 2.2. Key factors influencing participant preferences for EPCs [2].

No.	Factors Participants Consider Important When Preferring EPCs
1	Energy Saving Guarantee
2	External Financing
3	Good National and International Examples
4	Avoiding Technology Risk

The barriers that discourage participants from preferring EPCs are also examined in the study. The top concerns include the lack of an accepted EPC standard and the absence of an independent auditor structure, both marked as important by 58% of respondents. Additionally, the inadequacy of existing legislation and the lack of understanding of EPC structures (risks, interests, loan terms) are rated as highly significant, with 43% considering them important. Concerns about the length of contract terms, exchange rate fluctuations, and difficulties in measuring and verifying savings are also noted as barriers. Moreover, insufficient good practice examples and challenges in implementing energy efficiency measures within existing operating systems contribute to the hesitation towards EPC adoption. Table 2.3 indicates the list of factors that discourage participants from preferring EPCs. The factors are arranged as per their importance obtained from the study's survey.

Table 2.3. Factors discouraging participants from adopting EPCs [2].

No.	Factors that Discourage Participants from Preferring EPCs
1	Lack of an Accepted EPC Standard
2	Lack of Independent Auditor Structure
3	Challenges in Applying Energy Efficiency Measures to the Operating System
4	Inadequacies in Insuring Risk
5	Length of Contract Term
6	Inadequacy of Existing Legislation
7	Inadequacy of Measuring/Verification Systems
8	Lack of Understanding of the EPC Structure (Risks, Interests, Loan Terms)
9	Energy Price Fluctuations
10	Exchange Rate Fluctuations
11	Concern That the Promised Savings Could Not Be Achieved
12	Concern About Changes in the Energy Consumption Model or Profile
13	Lack of Good Practice Examples

According to Akkoç *et al.* (2023) [2] Despite EPCs being a valuable tool for mitigating customer risk and encouraging large-scale energy efficiency initiatives, the study suggests that the current EPC applications in Turkey fall short of meeting key requirements. Moreover, the research identified gaps in market knowledge and coverage, emphasizing the need for further sectoral development to fully capitalize on EPC mechanisms. This analysis provides important insights into the barriers that impede the effective deployment of EPCs, aligning with broader discussions on improving market conditions for ESCOs in Turkey.

Akkoç *et al.* (2023)'s [2] study also can be considered as the point of departure for the current study since regarded research closely aligns with this study's focus on evaluating factors that influence the development of the ESCO market, particularly in its examination of market barriers and the role of EPCs in promoting energy efficiency. Their findings regarding the financial difficulties faced by ESCO projects and the gaps in market knowledge offer a valuable starting point for this research, which will further explore these issues through the lens of Structural Equation Modelling (SEM). While Akkoç *et al.* (2023) [2] provide an important qualitative and statistical foundation, this study will take a more comprehensive approach by using SEM to quantitatively evaluate the relationships between various factors impacting the ESCO market.

In Turkey, despite regulatory efforts and initiatives like the Energy Efficiency Law (EEL), the ESCO market has not achieved the anticipated growth and impact [18]. This recession indicates that there are underlying factors impeding the development of the market, which need to be thoroughly investigated and addressed. The existing literature highlights barriers such as financial limitations, regulatory hurdles, and lack of market awareness, but there is a lack of comprehensive analysis that integrates these factors into a cohesive model to better understand their interrelationships and influence on market development.

The research gap that aimed to be filled is the lack of empirical evaluation using advanced statistical methods, such as Structural Equation Modelling (SEM), to assess

how different factors-ranging from regulatory frameworks and financial mechanisms to market awareness and stakeholder involvement-affect the growth of the ESCO market in Turkey by considering collective influence of the relevant factors. While previous studies have identified individual barriers and enablers, they often treat these factors in isolation, without exploring their collective impact or the interactions between them. By applying SEM, the study intends to develop a model that provides a more holistic understanding of these dynamics. This methodology allows for the simultaneous analysis of multiple variables and the relationships between them, which will offer deeper insights into how these factors collectively contribute to the development or stagnation of the ESCO market. Additionally, this research fills the gap by empirically testing the factors identified through an extensive literature review and surveys, thus providing a more data-driven perspective that can inform future policy and business strategies for promoting the ESCO market in Turkey. Through this research, the study aims to offer a well-rounded understanding of the challenges and opportunities in the Turkish ESCO market, contributing to both the academic discourse and practical efforts to enhance energy efficiency in the country.

3. RESEARCH METHODOLOGY

This study aims to identify and analyze the key factors influencing the development of the ESCO market in Turkey, focusing on the challenges and opportunities faced by the industry. To achieve this, a comprehensive research framework was developed, which involves several stages. Initially, the primary factors affecting ESCO market growth were identified through an extensive literature review. Based on these findings, a theoretical model was constructed, with hypotheses formulated to explore the relationships among these factors.

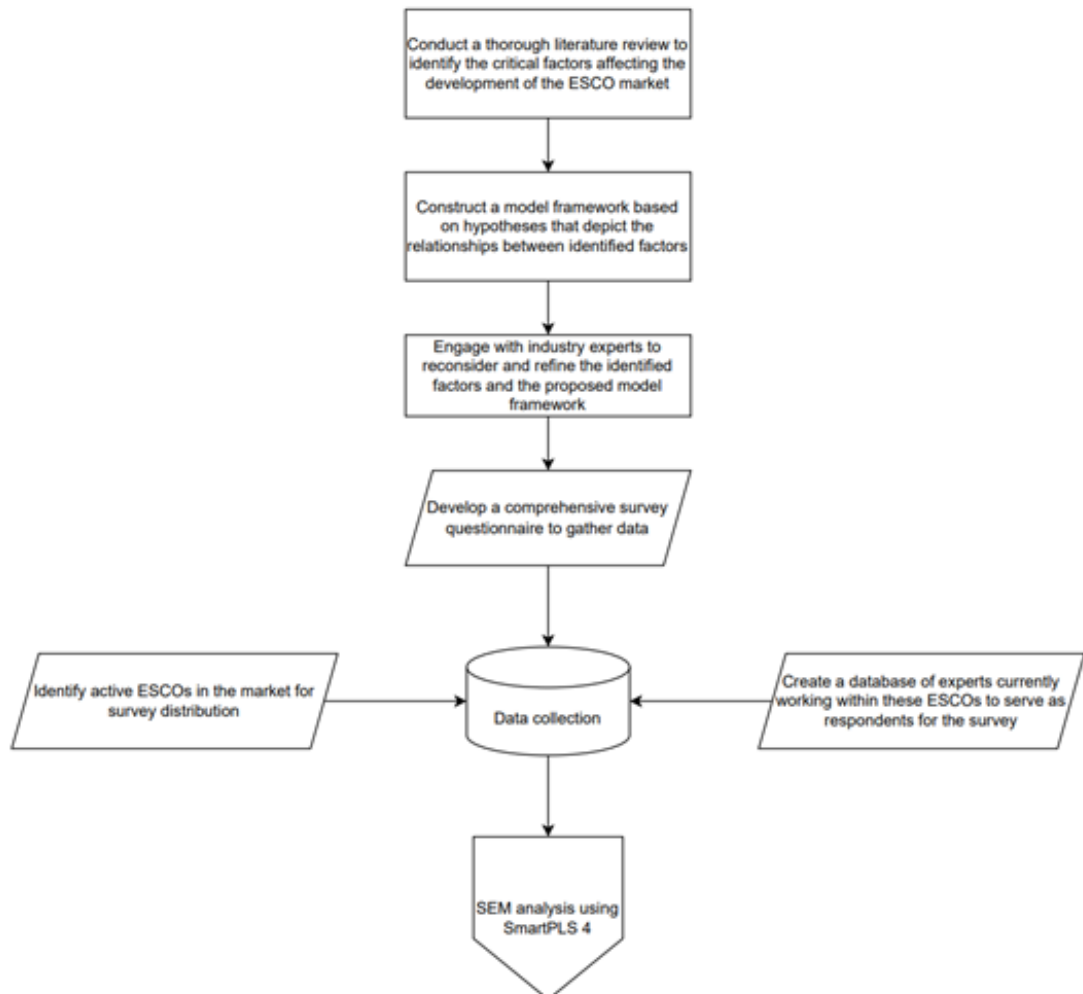


Figure 3.1. Research methodology framework.

Subsequently, expert opinions were sought to refine both the model and the identified factors, ensuring that the framework reflects the practical realities of the ESCO market. A questionnaire was then designed to collect data from ESCO experts, and a database of active ESCOs and industry professionals was created to ensure the reliability of the data collection process. The gathered data was then analyzed using Structural Equation Modeling (SEM) through the SmartPLS 4 software, allowing for a detailed examination of the relationships between the factors and their impact on the market. Figure 3.1 illustrates the step-by-step process of this research methodology.

3.1. Research Framework and Hypothesis Development

In this section, the research framework and the development of hypotheses are outlined to explore the factors influencing the ESCO market in Turkey. While various studies have examined the factors driving the growth of energy efficiency markets, limited research has specifically focused on the ESCO market development, particularly within the Turkish context. To gain a deeper understanding of the dynamics of the market, it is essential to establish a framework that accurately reflects the critical factors influencing this market. This study proposes a comprehensive model (Figure 3.2), designed based on an extensive literature review and validated through consultations with industry experts.

The proposed model examines several key factors believed to influence the development and success of the ESCO market, including regulatory frameworks, financial barriers, market awareness, and technological advancements. These factors are hypothesized to directly and indirectly affect the growth and adoption of ESCO services in Turkey. Through the literature review, key criteria were identified, and their relevance was further validated by engaging experts actively involved in the ESCO sector. Based on this process, the model incorporates both well-established factors from previous research and additional elements that emerged during expert consultations, ensuring a comprehensive analysis.

Through this process, a comprehensive list of factors was compiled, refined, and structured to reflect the unique challenges and opportunities within Turkey’s ESCO market. The final model incorporates both well-documented factors from existing research and new elements suggested by industry experts, ensuring that it addresses the specific dynamics of the Turkish market.

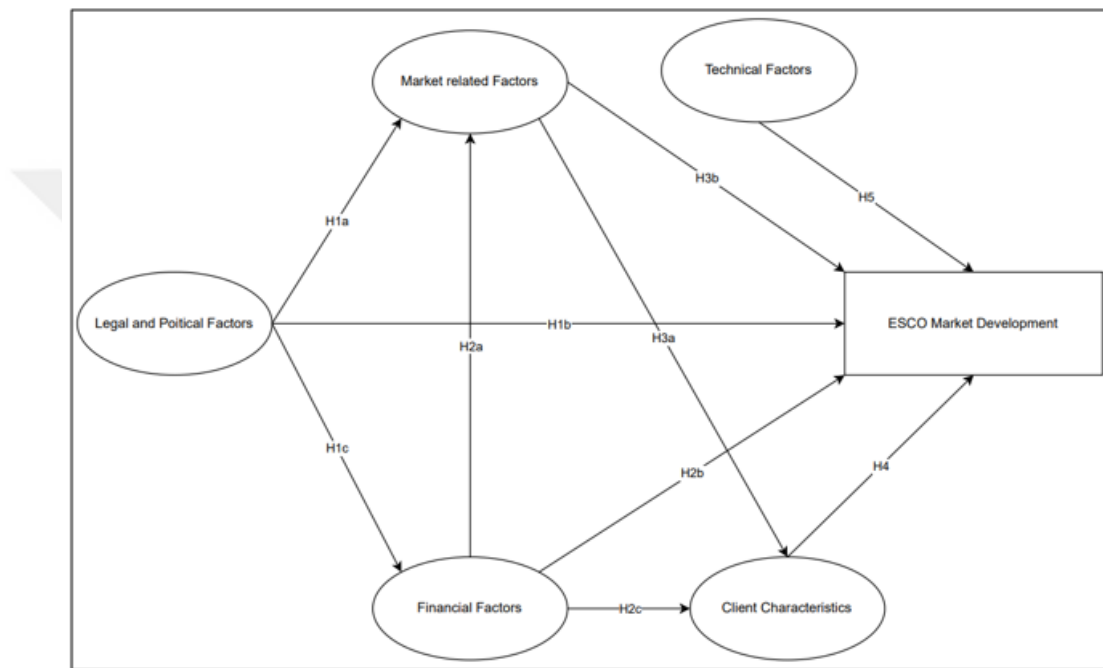


Figure 3.2. Conceptual model.

Since the primary objective of this study is to assess the influence of various factors on market development, it is crucial to define what is meant by “market development” and clearly explain the perspective from which it is addressed in this research. Few studies in the literature have quantified Turkish ESCO market development using indicators such as market age, total project value, and the number of active ESCOs [18]. Other studies aiming to assess the level of ESCO market development in different countries have focused on several key aspects: regulatory maturity, which refers to the establishment and effectiveness of a legal framework supporting the market; financial support, measured by the availability of well-established financing options and mechanisms tailored to energy efficiency projects; and the overall market environment, which includes factors such as market awareness, stakeholder engagement, competitive

dynamics, and the presence of enabling policies that foster trust and reduce transaction barriers [29, 32, 47]. These dimensions collectively provide a comprehensive understanding of the factors driving or hindering ESCO market development.

Therefore, market development, in the context of this study, refers to the process of expanding and strengthening the ESCO market by increasing the adoption of energy efficiency services, enhancing market capacity, and fostering sustainable growth. It involves not only the entry of new participants, such as clients and service providers, but also the creation of a supportive ecosystem characterized by effective policies, financial mechanisms, and awareness among stakeholders.

3.1.1. Legal and Political Factors

The development of the ESCO market relies heavily on a supportive legal and political environment, as clear regulations and government policies provide the necessary structure and security for ESCOs to operate and expand effectively [61]. According to Bertoldi and Boza-Kiss (2017) [39], a strong and stable legal and political framework is essential for the successful development of ESCO markets.

Among legal and political factors, government commitment to energy efficiency and supportive regulations creates a secure business environment that encourages investment and long-term planning among ESCOs and clients [39]. Furthermore, governmental commitment to energy efficiency policies, paired with clear and supportive regulations, establishes a secure environment that encourages investment and long-term planning among ESCOs and clients [39]. A strong national energy policy is also crucial for the development of the ESCO market, as it provides a stable and supportive environment for energy efficiency projects [18]. According to Okay *et al.* (2008) [19], Turkey's energy efficiency legislation, such as the Energy Efficiency Law (EEL), is a critical step toward reducing energy demand and dependency on imports. Policies that encourage private sector participation, establish competitive energy pricing, and provide financial incentives for energy efficiency are essential to foster ESCO market

growth [19]. Dedicated legislation and targeted measures for ESCOs, including clear definitions, certification standards, and supportive procurement laws, significantly contribute to reducing transaction costs and fostering trust in the ESCO model as well [39].

All in all, the development and sustainability of the ESCO market are found to be heavily influenced by three distinct legal and political factors as per the literature review, each with its own scope and impact. Firstly, long-term, manifested, and credible commitment by the public administration is essential, as it reflects the government's ongoing prioritization of energy efficiency. This commitment builds trust among ESCOs, clients, and investors, creating a stable environment conducive to long-term investments in energy efficiency projects. Secondly, a strong energy (efficiency) policy framework provides a structured regulatory foundation that outlines national energy-saving goals, standards, and incentives. This framework ensures that energy efficiency is a national priority and supports the development of related markets, including ESCOs. Finally, dedicated ESCO legislation, measures, and service standards address the specific needs of the ESCO industry by establishing clear guidelines, certifications, and standards for ESCO operations. These targeted regulations facilitate market entry, ensure quality and accountability in service delivery, and provide a solid foundation for the professionalization of the ESCO sector. Together, these three factors form a comprehensive and supportive legal and political environment crucial for ESCO market growth.

The hypothesis related to Legal and Political Factors are as follows:

- H1a: Legal and political factors have a direct impact on market related factors.
- H1b: Legal and political factors have a direct impact on ESCO market development.
- H1c: Legal and political factors have a direct impact on financial factors.

Table 3.1. Legal and political factors.

Clusters	Code	Factors	References
Legal and Political Factors	LPF1	Long-term, manifested and credible commitment by the public administration.	[39, 61]
	LPF2	Strong energy (efficiency) policy framework.	[19, 23, 61-64]
	LPF3	Dedicated ESCO legislation, measures and service standards.	[1, 3, 28, 39, 61, 63, 65, 66]

3.1.2. Financial Factors

Financing factors are among the most significant factors for the growth of the ESCO market, as accessible financial resources and favorable financing mechanisms are essential for the sector's sustainability and expansion [28]. Access to capital is a primary challenge for many ESCOs, as traditional lenders are often reluctant to finance energy efficiency projects due to perceived high risks and the long payback periods typical of these investments [62]. At this point, third-party financing and the support of financial institutions, such as banks, are crucial for meeting the capital needs of ESCO projects, enabling the sector to overcome funding barriers and expand operations, especially in markets where clients are hesitant to directly finance energy efficiency improvements [28]. Financial mechanisms such as concessional loans, credit guarantees, and support from financial agencies are foundational for establishing a sustainable ESCO market [62]. However, there are other financial factors that affect ESCO market development at the macroeconomic level.

In the development of capital-intensive sectors such as construction and energy services, financial stability plays a critical role, particularly regarding interest rates and currency stability [67]. Gunhan and Arditi (2005) [68] pointed out in their study the

impact of currency fluctuations, particularly in the context of construction projects. They emphasize that currency volatility can significantly affect project costs, especially when materials, equipment, or debt are sourced from foreign suppliers. Depreciating local currency can increase the cost of imports and loan repayments, thereby eroding profit margins and introducing financial strain on projects [68]. Moreover, high or volatile interest rates increase borrowing costs, which can discourage investment and make financing energy efficiency projects less feasible. For the ESCO market, where projects often require substantial upfront capital, lower and stable interest rates are essential to ensure that financing remains accessible and affordable. Additionally, currency stability is crucial, as fluctuations introduce uncertainty into long-term contracts and impact [67].

Based on an extensive literature review, Inflation and Currency Fluctuations, Interest Rate, and Support from Financing Organizations have emerged as the most influential financial factors affecting the development of the ESCO market in Turkey. Each of these factors holds a unique role and scope within the model developed for this research. Inflation and Currency Fluctuations affect project costs and profitability, especially in economies reliant on imported materials or foreign loans, adding unpredictability to ESCO projects. Interest Rate is critical because high or volatile rates increase borrowing costs, making financing less accessible and hindering energy efficiency investments. Lastly, Support from Financing Organizations is essential, as concessional loans, credit guarantees, and third-party financing options help overcome capital barriers, enabling ESCOs to expand in a market where traditional lenders may be cautious. These factors collectively shape the financial environment necessary for a sustainable and growing ESCO market in Turkey.

The hypothesis related to Legal and Political Factors are as follows:

- H2a: Financial factors have a direct impact on Market Related Factors.
- H2b: Financial factors have a direct impact on ESCO market development.
- H2c: Financial factors have a direct impact on Client Characteristics.

Table 3.2. Financial factors.

Clusters	Code	Factors	References
Financial Factors	FIN1	Inflation and Currency Fluctuations	[2, 67, 68]
	FIN2	Interest Rate	[2, 58, 62, 67, 68]
	FIN3	Support from financing organizations	[28, 33, 39, 60-63, 66]

3.1.3. Market Related Factors

Market-related factors are critical to the growth and sustainability of the ESCO market, as they directly influence the demand for energy-efficiency solutions. As noted by Bertoldi and Boza-Kiss (2017) [39], structural and market changes, such as fluctuations in energy prices and the recovery of key sectors, can significantly drive client interest in ESCO services. These factors shape the economic landscape within which ESCOs operate, impacting both the willingness of clients to invest in energy efficiency and the overall feasibility of ESCO projects [39].

Furthermore, transaction costs play a pivotal role in shaping the feasibility and attractiveness of ESCO projects. As highlighted in the De La Houssaye (2004)'s [66] research discussion, transaction costs-comprising legal fees, contracting expenses, and monitoring costs-can pose significant barriers to the uptake of ESCO projects. High transaction costs can discourage clients from engaging in energy efficiency contracts, as they may perceive these additional expenses as reducing the overall financial benefit of energy savings [66]. At this point market facilitator could be a vital factor to reduce the transaction costs and facilitate the project development for the ESCO market [65]. Market facilitators, such as energy agencies, industry associations or consultancy agencies, play a significant role by providing resources and services that streamline the contracting process and lower administrative barriers for clients [3]. For example, they document good practices across various sectors, offer information hotlines,

and conduct promotion campaigns, workshops, and seminars to raise awareness about energy efficiency solutions. Additionally, they create detailed guidebooks and model contracts that simplify the procurement process for public administrations and other stakeholders, covering essential stages of project development, from tender evaluation to implementation. By offering databases of existing ESCOs and managing low-interest financing programs or tax incentives, market facilitators can make it easier for clients to access capital and trustworthy ESCO partners.

This study identifies Market Facilitators, Energy Prices, and Transaction Costs as the primary market-related factors influencing the development of the ESCO market, based on a comprehensive literature review. The study defines market facilitators as entities or programs that support the ESCO market by reducing barriers, offering resources like model contracts, consultancy and facilitating access to financing. Energy prices on the other hand defined as a driver of demand for energy efficiency services, as rising or fluctuating costs incentivize clients to seek solutions that reduce their energy expenditures. Finally, transaction costs defined as expenses related to legal, administrative, and monitoring processes can deter clients from pursuing ESCO projects by diminishing the perceived financial benefits. Together, these factors outline the essential external conditions that shape the ESCO market's growth and accessibility in this study.

The hypothesis related to Market Related Factors are as follows:

- H3a: Market related factors have a direct impact on ESCO market development.
- H3b: Market related factors have a direct impact on client characteristics.

Table 3.3. Market related factors.

Clusters	Code	Factors	References
Market	MAR1	Transaction costs	[1, 3, 39, 61, 62, 66]
Related	MAR2	Energy prices	[2, 28, 33, 39, 61, 65, 66]
Factors	MAR3	Market Facilitators	[39, 65, 66, 69]

3.1.4. Client Characteristics

Client willingness and active engagement are fundamental drivers of ESCO market development in many countries, as they directly influence the demand for energy efficiency services and the success of project implementation [65]. Many countries are committed to increasing ESCO activity and are actively implementing awareness-raising initiatives focused on energy efficiency and cost savings [39]. According to Panev *et al.* (2018) [58] raising awareness level among clients is vital to overcome existing barriers to create and develop successful ESCO market. By building client knowledge and confidence, awareness efforts effectively drive demand, creating a more receptive market for ESCO services and paving the way for broader adoption of energy efficiency measures [39].

On the other hand, Hopper *et al.* (2007)'s [70] research highlights that client awareness alone is insufficient to build a successful ESCO market; clients' risk perception is also a significant factor influencing their engagement. De La Houssaye (2004) [66] emphasizes that the perception of risk among clients are crucial factor influencing the growth and stability of the ESCO market. This perception encompasses both technical and business risks, including concerns about disruptions to core operations and a general lack of trust in ESCO services due to past failures and limited understanding [66].

Panev *et al.* (2018) [58] highlighted that one significant barrier to ESCO market development in the residential sector is achieving landlord consensus on employing ESCOs for energy savings. According to market expert opinions obtained from face-to-face interviews, landlord consensus is crucial for ESCO market development, particularly in the residential sector, because energy efficiency projects often require collective agreement among property owners to implement changes across shared spaces or individual units. In multi-tenant buildings or housing complexes, improvements like insulation, lighting upgrades, or HVAC system enhancements benefit all occupants, but they also involve costs and alterations to the property. Without consensus, ESCO projects face

delays or may be entirely unfeasible, as disagreements can prevent necessary upgrades from moving forward.

In light of an in-depth literature review and interviews with experts, Perception of Risk, Landlord Consensus, and Level of Awareness have been identified as essential factors within the client characteristics cluster influencing ESCO market development. In this study, Perception of Risk refers to clients' concerns about potential technical and financial risks associated with energy efficiency projects, which can impact their willingness to engage in ESCO contracts. Landlord Consensus represents the agreement needed among property owners, particularly in the residential sector, to implement energy-saving measures, as lack of consensus can hinder project initiation. Lastly, Level of Awareness pertains to the clients' understanding and knowledge of ESCO services and energy efficiency benefits, which is crucial for informed decision-making and engagement. Together, these factors shape client readiness and acceptance, providing a foundation for successful ESCO project implementation.

The hypothesis related to Market Related Factors are as follows:

- H4: Client characteristics have a direct impact on ESCO market development.

Table 3.4. Client characteristics.

Clusters	Code	Factors	References
Client Characteristics	CLN1	Perception of Risk	[2, 66]
	CLN2	Level of Awareness	[1, 2, 39, 58, 62, 62, 66, 70-73]
	CLN3	Landlord Consensus	Expert Opinion

3.1.5. Technical Factors

The technical perspective on energy efficiency systems has gained increasing importance, as advancements in technology have laid the groundwork for energy efficiency investments [39]. For many countries, the advancement of energy efficiency technology has become a key driver for the growth of the ESCO market [39]. Patlitzianas *et al.*

(2006) [44] emphasize that the maturation of technology and technology support play a crucial role in driving the development and growth of the ESCO market. Therefore, as technologies become more efficient and accessible, they reduce the risks associated with energy efficiency projects and facilitate the EPC project development and execution [74].

Another important factor within the technical cluster is the availability and quality of tools, models, and handbooks. A range of tools, models, and handbooks have been developed to support different phases of project implementation, underscoring their importance in ensuring project success [39]. For instance, management tools are essential for project managers in construction, as they enable effective planning and execution, thereby significantly enhancing the likelihood of project success [75]. Moreover, financial modeling tools are crucial for ESCO projects, as they enable accurate forecasting of project costs, savings, and return on investment, thereby enhancing decision-making and building client confidence in the financial viability of energy efficiency initiatives [49]. On the other hand, handbooks as standard documents have been emerged especially after unsuccessful ESCO procurement projects in several countries since they play a vital role by providing standardized guidelines that address common challenges in ESCO procurement, ensuring more consistent and successful project outcomes [7, 39].

Energy saving monitoring infrastructure is the last factor belongs to this cluster. Saving verification is the most critical outcome of an EPC project since it provides measurable proof of energy savings, ensuring that the project's performance aligns with contractual expectations and justifying the financial investment [2]. According to expert opinions obtained from face-to-face interviews, energy monitoring infrastructure is essential for EPC projects because simply comparing energy bills before and after implementation does not accurately reflect the true energy savings. Factors such as seasonal variations, changes in building occupancy, operational adjustments, and energy price fluctuations can all influence energy consumption, making it difficult to isolate the impact of energy efficiency measures.

As a result of a detailed literature review, Technology Maturation & Support, Tools, Models, and Handbooks, and Energy Saving Monitoring Infrastructure have been identified as key factors within the technical cluster influencing ESCO market development. In this study, Technology Maturation & Support refers to the advancement and availability of reliable, innovative technologies that make energy efficiency projects feasible. Tools, Models, and Handbooks encompass the standardized resources developed to guide project planning, implementation, and management, reducing risks and ensuring consistency across ESCO projects. Finally, Energy Saving Monitoring Infrastructure is defined as the specialized systems and equipment necessary to accurately measure and verify energy savings, ensuring accountability and reliability in performance assessments. These factors collectively establish a robust technical foundation crucial for the success and expansion of the ESCO market

The hypothesis related to Market Related Factors are as follows:

- H5: Technical factors have a direct impact on ESCO market development.

Table 3.5. Technical factors.

Clusters	Code	Factors	References
Technical Factors	TEC1	Technology Maturation & Support	[2, 39, 44, 60, 74, 75]
	TEC2	Tools, models and handbooks	[28, 44, 61, 70]
	TEC3	Energy Saving Monitoring Infrastructure	Expert Opinion

3.2. Questionnaire Survey

In this research, a questionnaire survey was designed to evaluate the factors affecting the development of the Energy Service Company (ESCO) market in Turkey, specifically focusing on residential energy service projects. This survey aims to gather insights from professionals within the ESCO industry regarding the significance and

impact of various factors-categorized into legal, financial, market-related, technical, and client characteristics-on the ESCO market. The collected data will help to identify the primary factors influencing the ESCO market in Turkey, with a focus on the residential sector. The insights gained from this survey will contribute to understanding how various factors interact to either promote or hinder ESCO market development.

The questionnaire survey consists of three main parts, each designed to capture different aspects of the respondents' experience and perspectives on the ESCO market. These sections are: General Information, Project and Market Information, and Factor Evaluation. Together, they provide a structured approach to collecting data that reflects both the professional background of the respondents and their evaluations of the various factors influencing ESCO market development.

The first part of the survey is intended to gather background information about the respondents. This section is essential for understanding the demographics and professional expertise of the participants, which helps contextualize their responses and insights. Questions in this part cover various aspects of the respondents' background, such as their position within their company, level of education, educational background, age, and experience in the ESCO market. By collecting this information, the survey aims to ensure that the data reflects a range of perspectives from individuals with varying levels of experience and expertise in the energy services field. Understanding the respondents' professional roles and educational backgrounds allows for a more nuanced analysis of how different factors are perceived by individuals in different positions within the industry. Furthermore, information on respondents' experience levels within the ESCO market provides insight into how familiarity with ESCO practices might influence their evaluations of the surveyed factors.

The second part of the survey focuses on gathering information about the respondents' experience and involvement in specific energy service projects, as well as their perspectives on the development of the ESCO market. This section is vital since it captures the practical exposure and insights of respondents, which significantly influence

their assessment of the market's maturity and potential. Participants are asked about the types of clients they have worked with, such as public companies, private companies, or individual tenants, providing insights into the variety of client interactions within the ESCO market. This information helps identify whether certain client types present unique challenges or opportunities for the growth of ESCO services. Another question explores the areas of project execution in which the respondents' companies are involved, including industrial, commercial, or residential sectors. This sheds light on the focus areas of ESCO activities and highlights which sectors are actively adopting energy-saving initiatives. Additionally, respondents are asked about the types of contracts their companies have engaged in, such as guaranteed savings, shared savings, energy supply contracts, or other arrangements like chauffage. Understanding the prevalence of these contract types helps reveal preferred contractual frameworks and their impact on the Turkish ESCO market, particularly in various sectors. Lastly, the section includes a question assessing the overall development level of the ESCO market in the respondents' country or region. This question considers critical factors such as market size, client awareness, availability of financing options, policy and regulatory support, and technological readiness. The responses provide valuable insights into the perceived maturity of the ESCO market, identifying key drivers and barriers to its growth. This approach ensures that both practical project experiences and strategic market assessments are captured, enabling a comprehensive understanding of the ESCO market landscape.

The third and most detailed part of the survey involves evaluating various factors that influence the development of the ESCO market. This section is structured around the five main clusters of factors identified through a comprehensive literature review: Legal and Political Factors, Financial Factors, Market-related Factors, Technical Factors, and Client Characteristics. Respondents are asked to rate the significance of each factor based on their professional experience, providing valuable insights into the perceived importance and impact of these elements on the ESCO market in Turkey.

Data collection for this study was conducted through online interviews with professionals and experts in the Turkish ESCO industry. The data gathering process was specifically focused on the Turkish ESCO market to gain insights relevant to the local context. Given the highly specialized nature of the target sample, professional platforms and networks were utilized to identify and reach out to suitable participants within this niche sector. In total, 258 questionnaires were distributed to ESCO market professionals across Turkey. Out of these, 41 complete questionnaires were returned, resulting in a response rate of 15.9 %. This targeted approach ensured that the responses gathered were from individuals with relevant expertise and practical knowledge, thus contributing to the reliability and specificity of the findings.

Given the relatively low response rate, Partial Least Squares Structural Equation Modeling (PLS-SEM) was selected as the analytical method for this study, rather than the traditional covariance-based SEM (CB-SEM). PLS-SEM is especially advantageous for low sample sizes, as it imposes less constraints on data distribution and can manage intricate models with minimal data [76]. Durdyev *et al.* (2018) [77] stated that PLS-SEM is better suited for smaller, non-normally distributed sample sizes, as it does not impose the stringent requirements on data and sample size that CB-SEM does, making it an ideal choice for analyzing complex models with limited data and aligning well with the conditions of this study. Numerous studies advocate for the use of PLS-SEM acknowledging its limitations but highlighting its flexibility in handling data [77]. Thus, this study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze 41 collected questionnaires.

3.3. Structural Equation Modeling (SEM) Analysis

Structural Equation Modeling (SEM) was chosen as the primary analytical method for this study due to its robust capacity to analyze complex relationships between multiple variables simultaneously.

Structural equation modeling (SEM) is a statistical technique widely applied in social and behavioral sciences to explore the relationships between latent variables [78]. It is a flexible multivariate statistical method that enables the analysis of interconnected relationships between dependent and independent variables in a structured, measurable format [79]. In contrast to conventional first-generation statistical techniques such as multiple regression, factor analysis, and analysis of variance, structural equation modeling (SEM) provides a systematic framework for assessing intricate problems and grants researchers the adaptability to modify their models as required [80].

SEM methodology combines statistical techniques such as factor analysis, multiple correlation, regression, and path analysis to construct a validated model, uniquely allowing the inclusion of unobservable variables for accurate representation through variance and covariance analysis [81]. In SEM, the typical approach starts with developing a theoretical model informed by a literature review, which is then evaluated and refined based on fit indices to ensure its accuracy [82].

The created model comprises a blend of a measurement model, often using confirmatory factor analysis, and a structural model, typically involving regression or path analysis [83]. The section of the model connecting measured variables to latent factors is known as the measurement model, while the hypothesized relationships among the constructs, such as direct relation between them, form the structural model [84]. The model components are shown in Figure 3.3 adopted from [85].

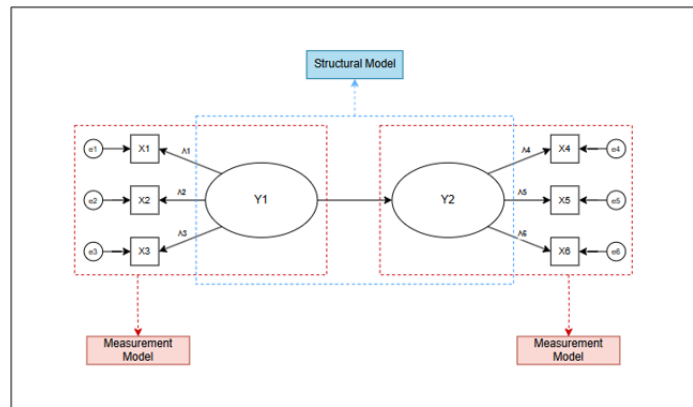


Figure 3.3. Structural equation model framework.

The measurement model represents the relationships between latent variables (shown as ovals labeled Y1 and Y2) and their associated observed variables (depicted as rectangles labeled X1 through X6). In this setup, Y1 is linked to observed variables X1, X2, and X3, while Y2 connects to X4, X5, and X6. Each observed variable is paired with an error term (e1 through e6) to account for measurement errors in the data. Factor loadings (λ_1 to λ_6) are assigned to each path from the latent variables to their respective observed variables, indicating the strength of the relationship between each observed variable and its underlying construct [85].

The structural model outlines the hypothesized relationships among latent variables. Here, a directional arrow links Y1 to Y2, suggesting a causal or predictive relationship where changes in Y1 influence changes in Y2. This component of the SEM framework enables the testing of theoretical relationships, allowing researchers to investigate how different latent constructs interact within the model. Together, the measurement and structural models form a comprehensive SEM framework that facilitates the analysis of complex relationships.

3.3.1. Partial Least Squares Structural Equation Modeling (PLS-SEM)

The SEM method has been applied in numerous studies across various industries worldwide, including tourism, hospitality, service, manufacturing, construction, as well as in universities and other sectors [86]. Due to different nature of statistical needs SEM has two primary approaches based on distinct statistical assumptions and fit statistics: the component-based method, known as Partial Least Squares (PLS-SEM), and the covariance-based approach (CB-SEM) [77].

Among them PLS-SEM is better suited than CB-SEM for theory development research, as it can estimate complex relationships while prioritizing predictive accuracy without imposing strict data requirements or predefined relationships [76]. Furthermore, unlike CB-SEM, PLS-SEM is capable of evaluating complex models without necessitating a large sample size [87]. Hair *et al.* [88] analyzed both PLS-SEM and

CB-SEM, suggesting that PLS-SEM is preferable when the sample size is below 100 [80]. Numerous studies in the literature have utilized the PLS-SEM method for analysis with limited sample sizes [88-91].

For instance, Alsugair (2022) [89] conducted a study on cost deviations in Saudi construction projects, using PLS-SEM with a sample of just 61 participants. The research identified critical factors affecting cost estimation accuracy, including project characteristics, contractual procedures, and estimator performance, with findings highlighting that owners prioritize these factors more than contractors. This study exemplifies the successful use of PLS-SEM to analyze complex relationships with a limited sample, supporting its applicability for small datasets. Aibinu *et al.* (2011) [88] also used a small sample of 41 contractors to explore how cooperative attitudes affect conflict and dispute in construction projects through SEM with partial least-squares estimation. Their findings, despite the limited data, show that perceptions of fairness influence 38% of conflict intensity and 46% of dispute tendencies, highlighting that even with small datasets, SEM can uncover key factors promoting cooperation in construction. Drako *et al.* (2018) [90] used PLS-SEM with a small sample of 43 professionals to study green building technology adoption in Ghana. Despite the limited data, they identified key influences, such as government barriers and company drivers, highlighting the effectiveness of PLS-SEM in revealing significant factors with minimal sample sizes. Alashwal and Abdul Rahman (2014) [91] used PLS-path modeling with a small sample of 36 professionals to study inter-project learning in construction. Again, despite the limited data, they identified key social and technical learning indicators, showing PLS-PM's effectiveness with small samples.

As a result, in the literature, numerous studies have effectively utilized small sample sizes with PLS-SEM, achieving valid and meaningful results. Following this precedent, this study also adopts PLS-SEM due to the limited sample size, using the SmartPLS 4 software to analyze data collected from 41 professionals via a questionnaire survey. This approach allows for a robust assessment of factors influencing ESCO market development, demonstrating that PLS-SEM is well-suited for smaller datasets.

3.3.2. Evaluation of Measurement and Structural Model

To evaluate the validity and reliability of a PLS-SEM, it is crucial to examine both the measurement model and the structural model. The measurement model analyzes the connections between observable indicators and their corresponding latent constructs, guaranteeing correct representation of the constructs by the data. This assessment encompasses tests for reliability, convergent validity, discriminant validity and composite reliability (CR) which verify that the measuring items consistently and distinctly represent the desired constructs [92, 93].

- **Convergent Validity:** When multiple indicators are used for a single construct, it's essential for the researcher to consider both the reliability of each individual item and the degree to which the items collectively exhibit convergent validity [93]. Convergent validity tests whether indicators of latent constructs that are theoretically expected to be related are actually observed to correlate in practice [94]. The Average Variance Extracted (AVE) and factor loadings serve as key indicators of convergent validity [80]. Hulland (1999) [93] recommends a minimum factor loading of 0.5 for a consistent validity result.
- **Discriminant validity:** Discriminant validity tests whether indicators for different latent constructs, which are theoretically expected to be unrelated, are indeed shown to be distinct and uncorrelated in practice [94]. To evaluate discriminant validity of the construct variables, the Fornell-Larcker Criterion, cross-loadings, and Heterotrait-Monotrait Ratio (HTMT) values were examined. HTMT is the most common way to assess discriminant validity. While HTMT is generally advised to be below 0.85, there are sources that may allow values as high as 0.90 in some circumstances [95].
- **Composite Reliability (CR):** Composite reliability reflects the internal consistency of a concept, supposing that all components possess equal dependability [94]. Despite the CR value varies between 0 and 1, Nunnally and Bernstein (1994) [96] recommends a threshold of 0.7 for composite reliability, considering it suitable for achieving 'modest' reliability in the initial phases of research.

In this study, the metrics used to interpret the results of the PLS-SEM measurement model were selected based on established standards in the literature. Key metrics such as composite reliability, Cronbach's alpha, Average Variance Extracted (AVE), and factor loadings were chosen to assess the internal consistency, reliability, and validity of the constructs.

Table 3.6. Metrics for analyzing PLS-SEM measurement model outcomes.

Criteria	Reference Value
Factor loadings	≥ 0.7
Cronbach's alpha	≥ 0.7
Convergent validity	$AVE \geq 0.5$
Discriminant validity Fornell-Larcker	Diagonal values $>$ following items
Discriminant validity HTMT	For conceptually similar constructs: < 0.85

On the other hand, the structural model emphasizes the proposed linkages among the latent components, evaluating the model's prediction capability and path coefficients to ascertain the strength and relevance of these interactions. Collectively, these assessments offer an extensive insight into the model's resilience, guaranteeing that the facts and theoretical frameworks correspond well for dependable analysis.

- **Path Coefficient:** In PLS-SEM, the route coefficient quantifies the magnitude and orientation of the direct influence an independent (exogenous) variable exerts on a dependent (endogenous) variable inside the structural model [95]. Predictions of path coefficients in structural equation models are generally regarded as more accurate when estimated using PLS-SEM compared to CB-SEM [97]. A moderate effect is shown by path coefficient values between 0.3 and 0.5, a weak influence is reflected by values between 0.1 and 0.3, and a strong effect is indicated by values between 0.5 and 1.0 [80].
- **Square of Correlation Coefficient (R^2):** The squared correlation coefficient (R^2), or coefficient of determination, indicates the extent of correlation between actual and expected concentrations in the calibration set samples [98]. The quality of the structural model is assessed by the degree to which the variability of each

endogenous latent variable is clarified by its corresponding exogenous latent predictors, as quantified by the coefficient of determination (R^2) [99]. Although models with lower R^2 values may still be dependable in specific settings, a value of 0.25 is considered poor, a value of 0.50 is considered moderate, and a value of 0.75 is considered significant [80].

- Effect size (f^2): In PLS-SEM, f^2 measures the influence of an independent variable on a dependent variable by showing the change in the dependent variable's R^2 value when the predictor is added or removed. Generally, f^2 values are interpreted as follows: 0.02 for a small effect, 0.15 for a medium effect, and 0.35 for a large effect [96].
- Collinearity or Variance Inflation Factor (VIF): Collinearity (VIF) measures multicollinearity among predictors, indicating how much correlation among them could distort the interpretation of their individual effects [99]. VIF values indicate multicollinearity levels, with 1 showing no correlation, 1-5 suggesting moderate but acceptable collinearity, and above 5 indicating high collinearity that may impact model reliability.
- t-value and p-value: In statistics, t-values and p-values are utilized to ascertain the significance of data, particularly in hypothesis testing [94]. Paths with t-values exceeding 1.64 are deemed statistically significant, indicating a p-value equal or below 0.05 [100].

Table 3.7. Metrics for analyzing PLS-SEM structural model outcomes.

Criteria	Reference Value
R^2	> 0.25: weak; > 0.50: moderate; > 0.75: substantial
f^2	0.02 - 0.15: small; 0.15-0.35: medium; > 0.35: high effect
t-value	> 1.64
Collinearity (VIF)	< 3

4. RESEARCH RESULTS

4.1. Overview of Participant Information

4.1.1. Respondent Profiles

This section provides an overview of the general characteristics of the professionals who participated in this study. These respondents were drawn from a diverse group of 41 industry experts with direct experience in the ESCO market, ensuring the inclusion of valuable insights into the study's findings. The data collected through the survey highlights essential demographics and professional backgrounds, including educational levels, fields of expertise, age distribution, and years of experience in the ESCO market. Furthermore, the respondents shared detailed information about their involvement in energy service projects and market dynamics. This comprehensive profile serves as the foundation for understanding the perspectives and expertise of the participants, enabling an in-depth exploration of the factors influencing the development of the ESCO market. The following sections present the aggregated respondent data through detailed graphs and visual representations.

The respondent profile specifically consists of ESCO market professionals, including engineers, project managers, financial managers, contract specialists, and company owners. This targeted demographic is crucial because these individuals play pivotal roles in the functioning and development of the ESCO market. Engineers bring technical expertise, ensuring that energy solutions are feasible and effective. Project managers provide insights into the operational challenges and success factors in implementing energy efficiency projects. Financial managers offer perspectives on the financial viability and investment strategies that drive ESCO market growth. Contract specialists contribute their understanding of contractual frameworks and risk management, while company owners provide overarching strategic viewpoints and insights into market trends.

By focusing on these professionals, the survey ensures that the data collected is directly relevant to the core activities and decision-making processes within the ESCO sector. This specificity is important because these roles collectively shape the implementation and outcomes of ESCO projects, from technical design to financial planning and contractual execution. Gathering insights from this diverse yet interconnected group allows for a comprehensive understanding of the factors influencing the ESCO market. Moreover, their varied expertise enriches the analysis by providing a multifaceted view of market dynamics, helping to identify challenges and opportunities unique to the industry. This targeted approach ensures the findings are not only representative of the ESCO market but also actionable for improving and advancing its practices.

The age distribution of the respondents is illustrated in Figure 4.1, providing insights into the demographic diversity within the surveyed group. A significant portion of the participants, accounting for 43.9%, fall within the 31–40 age bracket, representing the majority of respondents. This is followed by 34.1% of the participants who are between the ages of 41 and 50, indicating a strong representation from mid-career professionals. Respondents aged 20–30 comprise 14.6% of the total, reflecting the involvement of younger professionals in the ESCO market. Additionally, a smaller segment, 7.3%, is from the 51–60 age range, highlighting the participation of senior industry experts. This age distribution ensures a diverse range of perspectives, encompassing varying levels of experience and generational insights into the ESCO market dynamics.

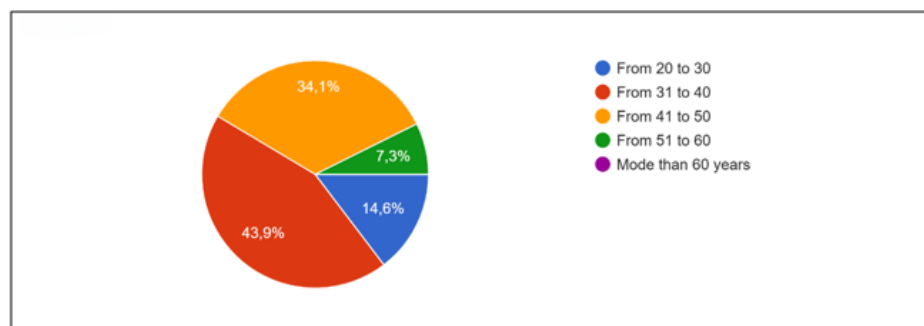


Figure 4.1. Age of respondents.

The educational level of the respondents in Figure 4.2 demonstrates a high level of academic qualification among participants in the survey. As depicted in the chart, the majority of respondents, accounting for 68.3%, hold a bachelor's degree. Additionally, 31.7% of the participants have attained a master's degree, reflecting advanced academic training and expertise. This data highlights the academically proficient nature of the surveyed group, which is crucial for informed insights into the ESCO market and energy efficiency practices.

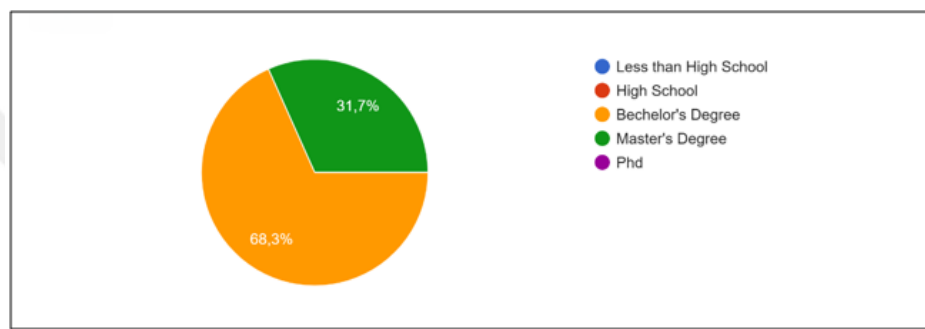


Figure 4.2. Educational level of respondents.

The survey participants' educational backgrounds in as per Figure 4.3 shows a great domination of engineering professionals, with 92.7% having a foundation in engineering. This overwhelming majority demonstrates the technical type of knowledge widespread in the ESCO industry, where engineering skills are required to develop energy saving solutions. Furthermore, 4.9% of respondents have an academic background in economics and business administration, which brings a financial and management perspective to the sector. A smaller fraction, 2.4%, possesses finance qualifications, highlighting the relevance of financial knowledge in supporting ESCO operations.

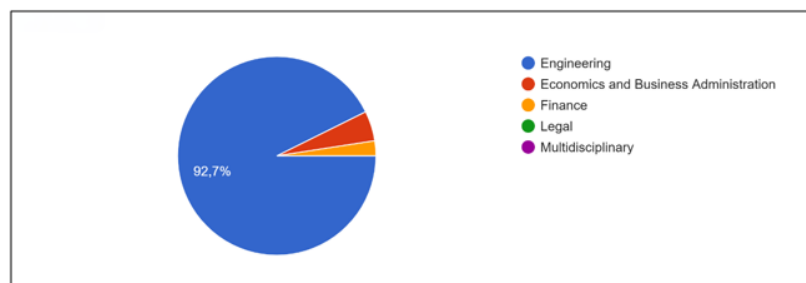


Figure 4.3. Educational background of respondents.

The respondents' experience levels in the ESCO market are evenly distributed. Figure 4.4 shows varied opinions from experts with varying years of involvement. The majority of participants, 36.6%, had between 2 and 5 years of experience, indicating the existence of new but active professionals in the industry. Furthermore, 29.3% of respondents have more than ten years of experience, suggesting that the poll included seasoned experts. An same amount (29.3%) of respondents had 5 to 10 years of experience, indicating that mid-level professionals are actively contributing to the market. A smaller section, accounting for a 4.9%, has less than two years of experience, ensuring that insights are mostly derived from individuals with extensive knowledge and participation in the ESCO business. This distribution enables a thorough grasp of market dynamics across a range of expertise levels.

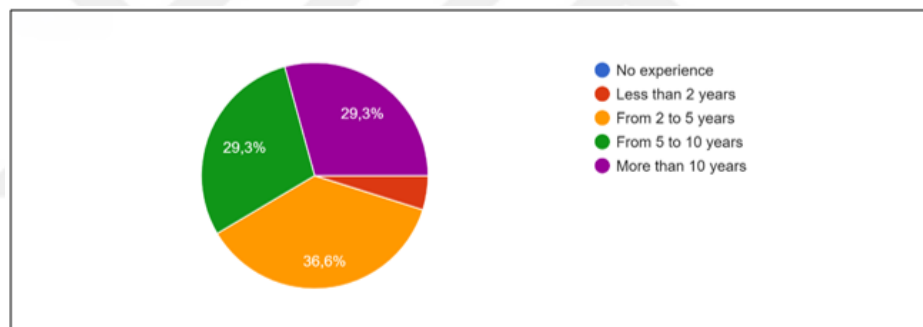


Figure 4.4. Respondents' experience in ESCO market.

4.1.2. Company and Project Involvement Information

The respondents were asked to name the main categories of clients their firms have worked with on energy service projects. Because this question allowed numerous replies, the findings give a comprehensive picture of the diversified client base in the ESCO market. Notably, all participants (100%) reported working with private enterprises, highlighting the private sector's dominating role in energy service interactions. Furthermore, 87.8% of respondents reported working with individual clients, such as tenants, highlighting the rising significance of individual-level energy saving projects. 41.5% of interviewees named public enterprises as clients, indicating a modest yet considerable amount of connection with the government or publicly held entities. This

distribution demonstrates ESCOs' strong participation with private sector clients while also meeting the demands of public organizations and individual customers, demonstrating the market's adaptability.

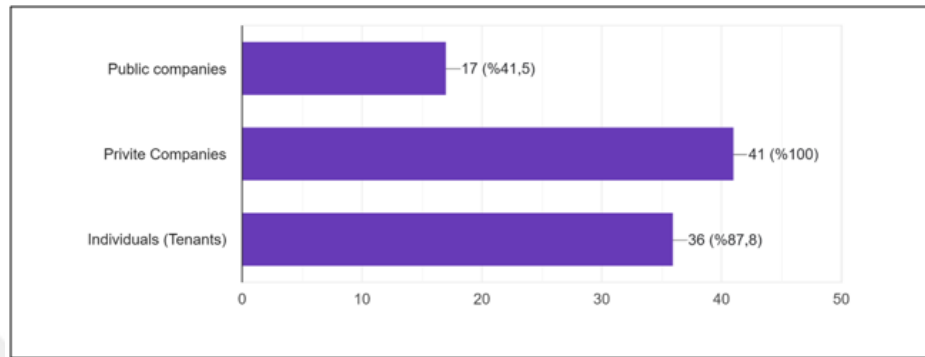


Figure 4.5. Client types in energy service projects engaged by respondents' companies.

Figure 4.5 depicts the key sectors in which respondent organizations have been involved in completing energy service projects, with an emphasis on the industrial, commercial, and residential segments. 92.7% (38 respondents) reported having worked on commercial projects, demonstrating its importance in the energy service business. 87.8% (36 respondents) reported being involved in home projects, highlighting the increased need for energy efficiency in domestic settings. Furthermore, 41.5% (17 respondents) mentioned their involvement in industrial energy service initiatives, demonstrating the sector's importance despite its relatively low representation compared to commercial and residential regions.

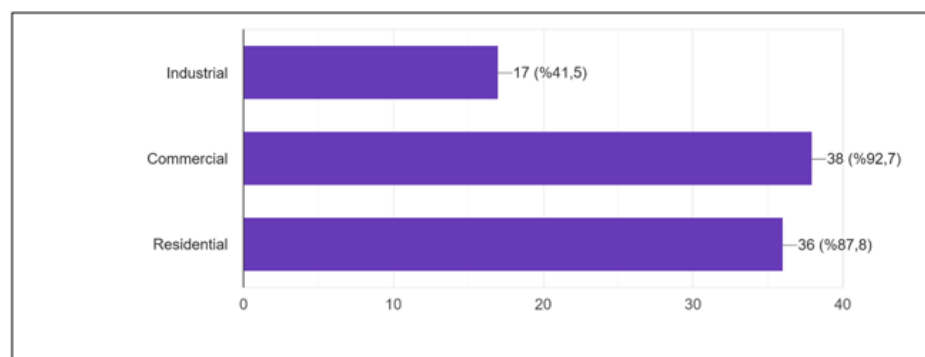


Figure 4.6. Energy service project execution areas of respondent companies.

The contract types utilized in energy service projects by respondent companies were examined to better understand the current contractual arrangements in the ESCO sector. According to the statistics, 100% of respondents had used Guaranteed Savings contracts, demonstrating the company's market dominance. Shared Savings contracts were used by 41.5% of respondents, suggesting modest uptake. Furthermore, 53.7% of interviewees reported engagement in Energy Supply contracts, demonstrating their usefulness in certain contexts. Other contract kinds were less popular, with 29.3% of respondents mentioning their use such as chauffage and engineering, procurement and construction. This distribution emphasizes the importance of Guaranteed Savings contracts in structuring energy service projects, but Shared Savings and Energy Supply contracts offer alternatives adapted to project-specific needs.

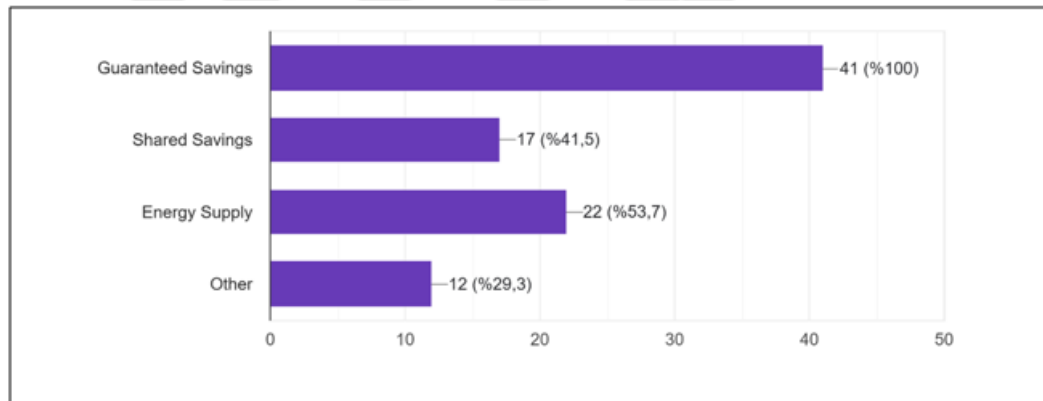


Figure 4.7. Contract types utilized in energy service projects by respondent companies.

4.1.3. Participants ESCO Market Development Perception

Respondents were asked to assess the current level of development of the ESCO market in their respective regions, taking into account critical factors such as market size, potential client awareness, financing options, policy and regulatory support, and technological readiness. According to the feedback, the majority of participants assessed the development level as “High” (46.3%) or “Moderate” (43.9%), suggesting that, while there has been substantial progress in the ESCO industry, more improvements are required to reach full maturity. A lower minority of respondents (9.8%) evalu-

ated the development level as “Very High”, indicating an optimistic outlook among certain professionals. These findings highlight the necessity of tackling major constraints and capitalizing on opportunities to accelerate the ESCO market’s development.

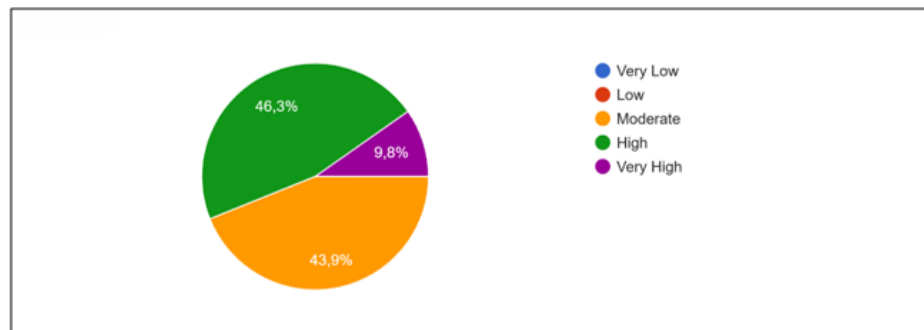


Figure 4.8. Perceived development level of the ESCO market by respondents.

4.2. Statistics of ESCO Market Development Determinants

This section provides a statistical study of the elements that influence the development of the Energy Service Company (ESCO) market. This study gives a thorough grasp of the relative value of each observable feature in the suggested research model. Using mean values as the primary metric of assessment, the study assesses the relevance of these aspects using replies from industry professionals. The mean values reveal how the questioned respondents prioritized each aspect, indicating the professional consensus on the drivers and impediments affecting the ESCO industry. This statistical overview serves as a foundation for understanding the major causes of market growth, allowing for more targeted tactics to overcome hurdles and improve sector development efforts.

Figure 4.9 highlights the mean values of the legal and political factors influencing the ESCO market. LPF3, representing “Dedicated ESCO Legislation, Measures, and Service Standards”, holds the highest mean value of 4.02, emphasizing the significant role of a clear legislative framework in fostering market reliability and growth. This is followed by LPF2, “Strong Energy Policy Framework”, with a mean value of 3.56, showcasing the importance of robust energy policies for market stability. LPF1, “Long-

term Commitment by Public Administration”, with a mean value of 3.54, reflects the necessity of consistent governmental support in enabling market development.

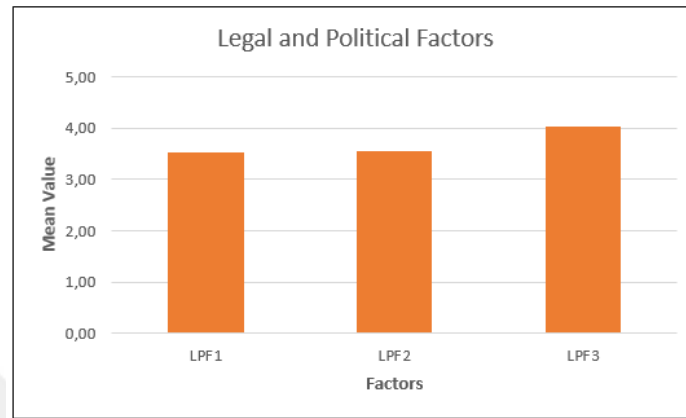


Figure 4.9. Mean values of legal and political factors.

Figure 4.10 presents the mean values of the financial factors influencing the development of the ESCO market. FIN3, representing “Interest Rate”, has the highest mean value of 4.56, highlighting its critical role in shaping the financial viability of energy efficiency projects. This is closely followed by FIN1, “Inflation and Currency Fluctuations”, with a mean value of 4.46, emphasizing the significant impact of macroeconomic stability on the ESCO market. FIN2, “Support from Financing Organizations”, has a mean value of 4.02, underlining the importance of accessible financial resources and institutional backing in overcoming funding barriers.

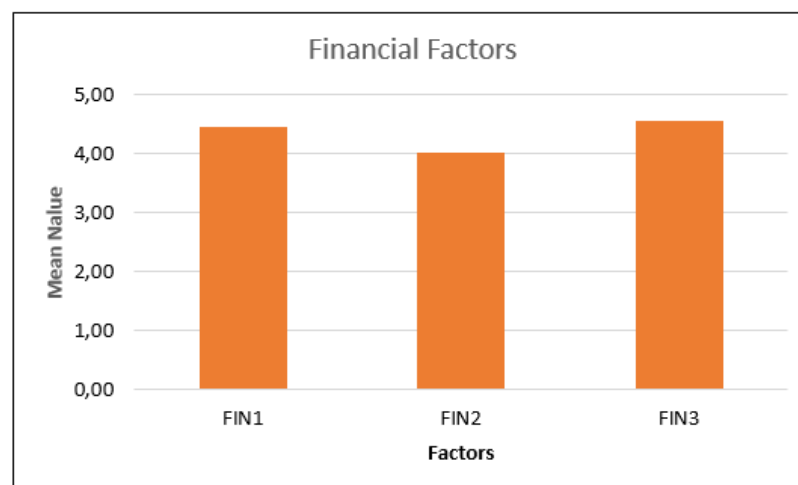


Figure 4.10. Mean values of financial factors.

Figure 4.11 shows the mean values of the market-related factors influencing the ESCO market. MAR2, representing “Energy Prices”, has the highest mean value of 3.63, indicating its prominence among the surveyed factors. MAR1, “Transaction Costs”, follows with a mean value of 2.56, reflecting its impact on market operations. MAR3, “Market Facilitators”, records the lowest mean value of 2.49, highlighting its position within the assessed factors. These results provide an overview of the relative significance of market-related factors based on the responses.

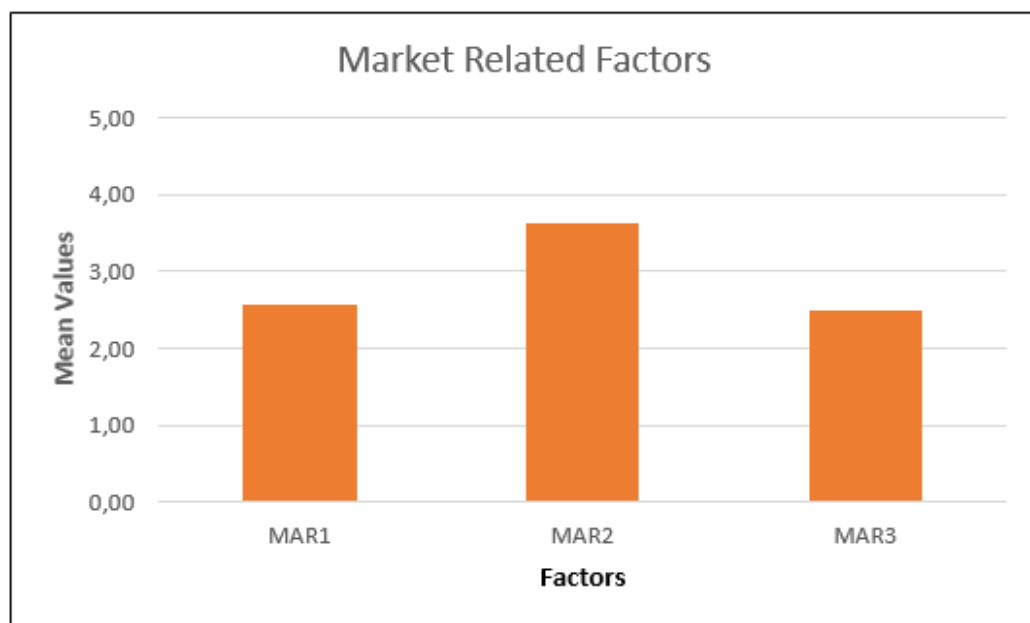


Figure 4.11. Mean values of market related factors.

Figure 4.12 illustrates the mean values of technical factors impacting the ESCO market development. TEC1, representing “Tools, Models, and Handbooks”, has the highest mean value of 3.54, indicating its prominence among the technical factors evaluated. TEC3, “Energy Saving Monitoring Infrastructure”, follows with a mean value of 3.07, reflecting its role in technical considerations. TEC2, “Technological Maturation and Supports”, records the lowest mean value of 2.56, highlighting its relative position within the assessed technical factors.

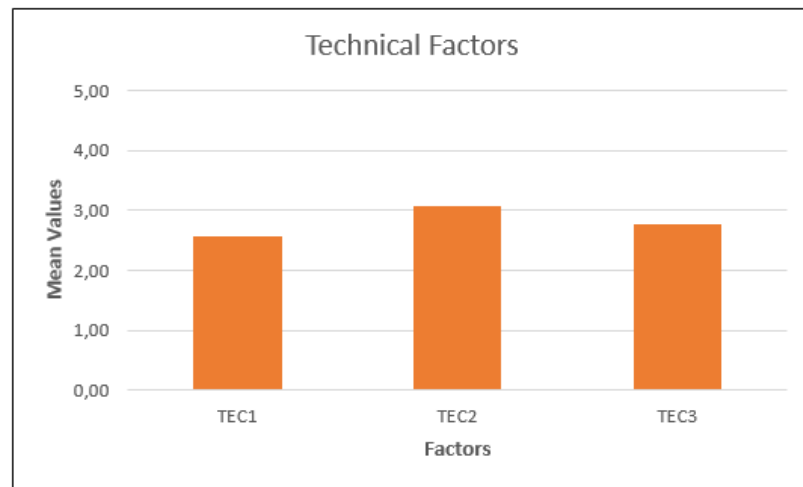


Figure 4.12. Mean values of market related factors.

Figure 4.13 indicates the mean values of client characteristics influencing the ESCO market. CLN2, representing the “Level of Awareness”, has the highest mean value of 3.85, reflecting its significant role among the client-related factors. CLN3, “Landowner Consensus on Energy Efficiency”, follows with a mean value of 3.75, indicating its importance within the category. CLN1, “Perception of Risk”, has the lowest mean value of 2.78, outlining its position relative to the other factors.

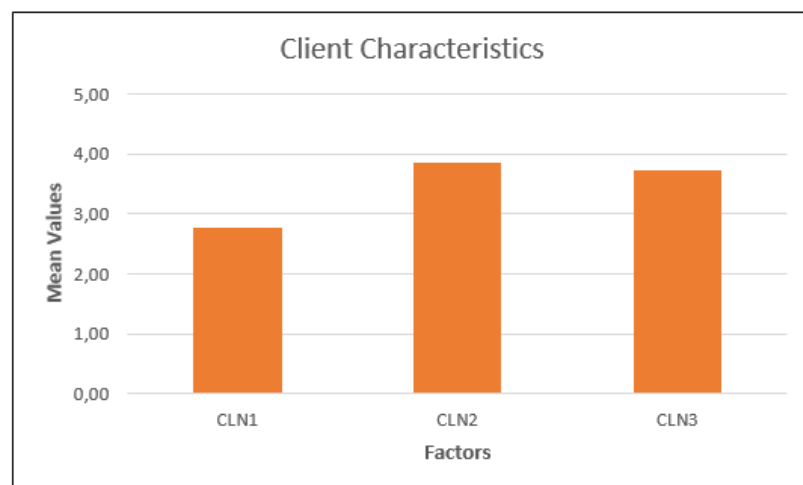


Figure 4.13. Mean values of client characteristics.

4.3. PLS-SEM Model Results

This section presents the statistical findings derived from the SmartPLS4 software analysis, offering a comprehensive evaluation of the relationships between latent variables and their indicators. This section is structured into two key parts: Measurement Model Results and Structural Model Results. The Measurement Model Results focus on assessing the reliability and validity of the constructs used in the study, including tests for convergent and discriminant validity, as well as composite reliability. The Structural Model Results, on the other hand, evaluate the relationships between latent variables, examining path coefficients, effect sizes, and the predictive power of the model. Together, these results provide a detailed understanding of the factors influencing the ESCO market development and offer a robust foundation for subsequent discussion and interpretation.

4.3.1. Measurement Model Results

This section provides a detailed evaluation of the measurement model to ensure the reliability and validity of the constructs used in this study. The analysis involves several key metrics, including factor loadings, Cronbach's alpha coefficient, average variance extracted (AVE), and discriminant validity by examining Heterotrait – monotrait ratio (HTMT). Table 4.1 presents the factor loadings of the measurement components, indicating the relationship between 15 observable variables and their corresponding 5 latent variables.

For model evaluation, a threshold of 0.7 was applied to determine the significance of factor loadings, with values below this threshold deemed insignificant and subsequently excluded from the analysis. Based on the results, the observable variables LPF1 and TEC3 were identified as insignificant, with factor loading values of 0.698 and 0.523, respectively.

Table 4.1. Factor loadings of measurement model components.

Latent Variables	Code	Factor Loading	Final Loading
Legal & Political Factors	LPF1	0.708	0.708
	LPF2	0.843	0.843
	LPF3	0.889	0.889
Financial Factors	FIN1	0.773	0.773
	FIN2	0.910	0.910
	FIN3	0.810	0.810
Market Related Factors	MAR01	0.806	0.806
	MAR02	0.834	0.835
	MAR03	0.824	0.824
Technical Factors	TEC1	0.982	0.983
	TEC2	0.741	0.745
	TEC3	0.523	Excluded
Client Characteristics	CLN1	0.825	0.825
	CLN2	0.770	0.770
	CLN3	0.861	0.861

Table 4.2 presents the Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) values for the latent variables. As outlined in the methodology section, a Cronbach's Alpha value greater than 0.7 is considered indicative of internal consistency and validity. Similarly, the Composite Reliability values exceed the acceptable threshold of 0.7, confirming the reliability of the constructs. Lastly, the AVE values surpass the recommended threshold of 0.5, demonstrating that the latent variables capture a sufficient amount of variance from their associated indicators.

Table 4.2. Cronbach's alpha, composite reliability, and AVE values.

Latent Variable	Cronbach's Alpha	CR	AVE
Legal & Political Factors	0.742	0.854	0.663
Financial Factors	0.788	0.871	0.694
Market Related Factors	0.759	0.861	0.674
Technical Factors	0.764	0.806	0.596
Client Characteristics	0.757	0.860	0.672

Table 4.3 presents the Fornell-Larcker Criterion results for the latent variables. As shown in the table, the diagonal values, representing the square root of the Average Variance Extracted (AVE) for each latent variable, are higher than the off-diagonal values in their respective columns. This finding indicates that each latent variable shares more variance with its own indicators than with other latent variables, thereby satisfying the criteria for discriminant validity. Table 4.4 presents the cross-loadings of each observable variable across the latent constructs. The results demonstrate that the highest loading for each observable variable is found within its respective latent variable cluster, satisfying the cross-loading criterion for discriminant validity. This outcome confirms that the indicators have a stronger association with their designated latent constructs than with any other constructs, thereby supporting the robustness of the measurement model.

Table 4.3. Fornell-lacker criterion.

Latent Variable	CLN	FIN	LPF	MAR	TEC
Client Characteristics	0.820				
Financial Factors	0.470	0.833			
Legal and Political Factors	0.298	0.144	0.814		
Market Related Factors	0.453	0.274	0.354	0.821	
Technical Factors	0.313	-0.048	0.059	0.161	0.772

Table 4.4. Cross loadings of measurement variables.

Measurement Items	LPF	FIN	MAR	TEC	CLN
LPF1	0.698	0.105	0.050	-0.012	0.299
LPF2	0.843	0.108	0.398	0.082	0.192
LPF3	0.889	0.139	0.363	0.059	0.256
FIN1	-0.015	0.773	0.108	0.057	0.343
FIN2	0.136	0.910	0.383	0.016	0.526
FIN3	0.240	0.810	0.084	-0.245	0.221

Table 4.4 Cross loadings of measurement variables. (cont.)

Measurement Items	LPF	FIN	MAR	TEC	CLN
MAR1	0.256	0.286	0.806	0.018	0.466
MAR2	0.230	0.156	0.834	0.257	0.376
MAR3	0.383	0.223	0.824	0.139	0.266
TEC1	0.019	-0.041	0.135	0.982	0.287
TEC2	0.182	-0.061	0.200	0.741	0.306
CLN1	0.155	0.341	0.327	0.316	0.825
CLN2	0.261	0.408	0.214	0.182	0.770
CLN3	0.298	0.402	0.531	0.274	0.861

4.3.2. Structural Model Results

This section delineates the results of the structural model analysis, encompassing path coefficients, t-values, and p-values utilized to evaluate the study's hypotheses. These results clarify the interactions among latent variables inside the model, highlighting their impact on the development of the ESCO market. The analysis employed the bootstrapping tool in SmartPLS 4 to ascertain the statistical significance and confidence intervals for the path correlations, hence ensuring the robustness of the findings. This part is essential for assessing the forecasting powers and theoretical consequences of the structural model. Figure 4.14 presents the final outcomes of the structural model analysis, while Table 4.5 provides detailed insights into the path coefficients, t-values, and p-values. In line with the statistical criteria, t-values exceeding 1.96 are considered significant, indicating hypothesis support. Based on this evaluation, the results confirm that hypotheses H1a, H1b, H2b, H2c, H3b, and H4 are statistically supported.

To evaluate the impact of latent variables, path coefficients were analyzed. This evaluation was conducted using established threshold values for path coefficients: values ranging from 0.5 to 1.0 indicate a strong effect, those between 0.3 and 0.5 reflect a moderate effect, and coefficients between 0.1 and 0.3 represent a weak influence.

Based on the results, hypotheses H1a, H2b, H2c, H3b, and H4 exhibited a moderate effect, while the remaining hypotheses demonstrated a weak influence according to the evaluated path coefficients.

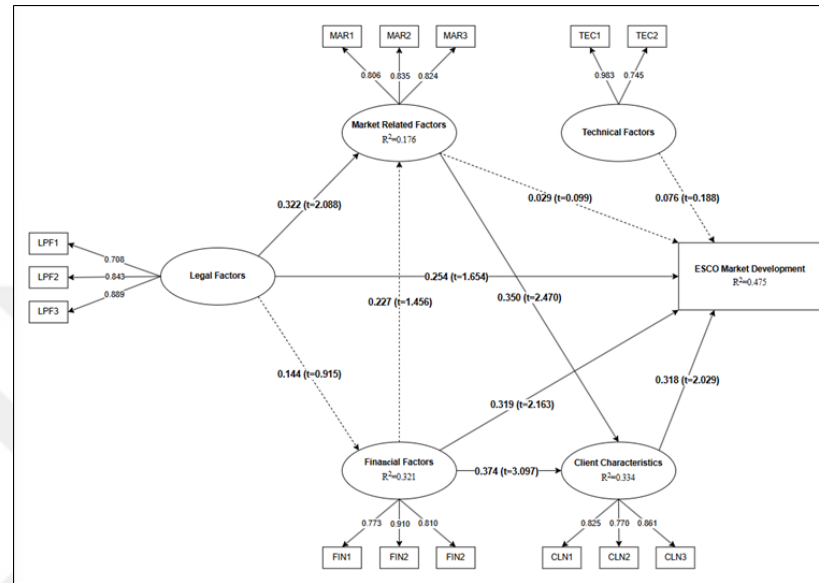


Figure 4.14. Structural model of factors affecting ESCO market development.

Presented below are the hypothesized paths within the structural model, detailing the relationships among latent variables as tested through the analysis.

- H1a: Legal and political factors have a direct impact on market related factors.
- H1b: Legal and political factors have a direct impact on ESCO market development.
- H1c: Legal and political factors have a direct impact on financial factors.
- H2a: Financial factors have a direct impact on market related factors.
- H2b: Financial factors have a direct impact on ESCO market development.
- H2c: Financial factors have a direct impact on client characteristics.
- H3a: Market related factors have a direct impact on ESCO market development.
- H3b: Market related factors have a direct impact on client characteristics.
- H4: Client Characteristics have a direct impact on ESCO market development.
- H5: Technical factors have a direct impact on ESCO market development.

Table 4.5. Structural model results.

Hypothetical Path	Path Coefficient (β)	t-Value	p-Value	Result
H1a	0.321	2.088	0.037	Supported
H1b	0.254	1.654	0.098	Supported
H1c	0.144	0.915	0.360	Not Supported
H2a	0.227	1.456	0.146	Not Supported
H2b	0.319	2.163	0.031	Supported
H2c	0.374	3.097	0.002	Supported
H3a	0.029	0.099	0.834	Not Supported
H3b	0.350	2.470	0.014	Supported
H4	0.318	2.029	0.042	Supported
H5	0.076	0.188	0.698	Not Supported

Furthermore, the R^2 and f^2 values were calculated for each dependent and independent latent variable, as presented in Table 4.6. According to established thresholds, R^2 values of 0.25 are categorized as weak, 0.50 as moderate, and 0.75 as substantial. The evaluation was conducted in alignment with these benchmark values to assess the explanatory power of the model.

To evaluate the effect size of each independent variable, f^2 values were analyzed. Following the guidelines provided by Nunnally and Bernstein (1994) [96], f^2 values are interpreted as follows: 0.02 indicates a small effect, 0.15 represents a medium effect, and 0.35 corresponds to a large effect.

Table 4.6. Effect sizes of variables.

Dependent Latent Variable	R^2	Independent Latent Variable	f^2	Status
Financial Factors	0.321	Legal and Political Factors	0.021	Small Effect

Table 4.6 Effect sizes of variables. (cont.)

Dependent Latent Variable	R^2	Independent Latent Variable	f²	Status
Market Related Factors	0.176	Legal and Political Factors	0.163	Medium Effect
		Financial Factors	0.061	Small Effect
Client Characteristics	0.334	Market Related Factors	0.170	Medium Effect
		Financial Factors	0.194	Medium Effect
ESCO Market Development	0.475	Legal and Political Factors	0.154	Medium Effect
		Financial Factors	0.172	Medium Effect
		Market Related Factors	0.001	Small Effect
		Technical Factors	0.009	Small Effect
		Client Characteristics	0.180	Medium Effect

Finally, Variance Inflation Factor (VIF) values were analyzed in accordance with the assessments of Vinzi and Russolillo (2013), which recommend that all VIF values should remain below 3 to ensure a model free from multicollinearity. Table 4.7 provides the VIF values for the observed variables.

Table 4.7. Collinearity statistics (VIF) values.

Observed Variables	VIF
LPF1	1.305
LPF2	1.715
LPF3	1.969

Table 4.7 Collinearity statistics (VIF) values. (cont.)

Observed Variables	VIF
FIN1	1.532
FIN2	1.746
FIN3	1.740
MAR1	1.403
MAR2	1.711
MAR3	1.603
TEC1	1.711
TEC2	1.681
CLN1	1.707
CLN2	1.380
CLN3	1.629

5. DISCUSSION

The analysis results provide significant insights into the determinants of the ESCO market development in Turkey, highlighting the critical roles of legal, financial, market-related, technical, and client-related factors. As it is seen in Figure 5.1 the model initially hypothesized 10 relationships, the rejection of four hypotheses and the exclusion of the “Energy Saving Monitoring Infrastructure” variable underscore the complexities of the ESCO market in a Turkish context. The findings suggest that, although certain factors were found to have a substantial influence, others-particularly those related to financial and market interactions-did not demonstrate statistically significant relationships. This may reflect specific challenges in Turkey’s economic and regulatory environment, such as currency volatility, inconsistent market facilitation efforts, and gaps in financial support mechanisms for energy efficiency initiatives. The results reinforce the importance of targeted interventions to strengthen enabling frameworks, foster client engagement, and address technical barriers to ensure sustainable ESCO market growth. These findings offer a nuanced understanding of the ESCO market dynamics and provide a foundation for refining strategies to overcome existing barriers and promote the broader adoption of energy-saving solutions in Turkey.

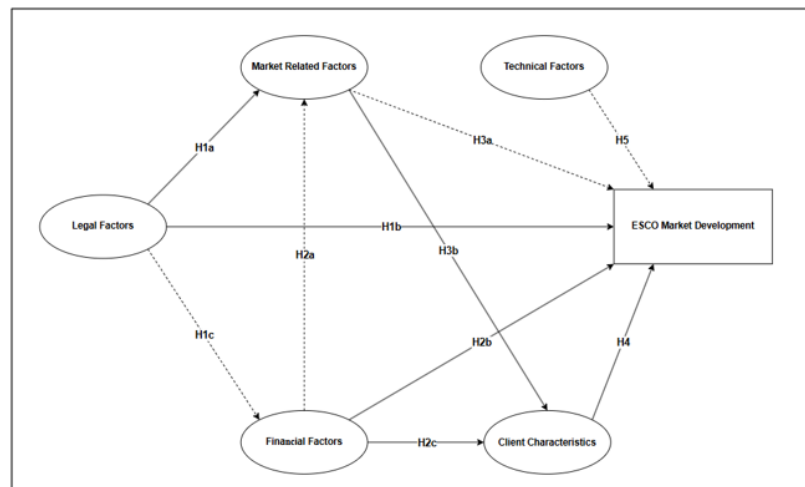


Figure 5.1. Initial model.

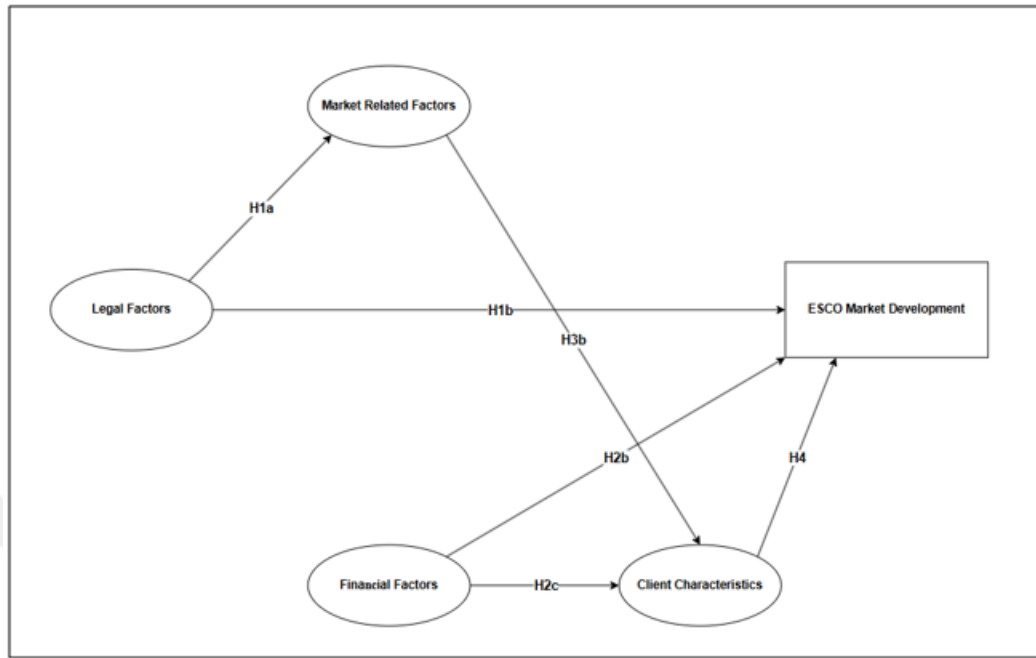


Figure 5.2. Final model.

5.1. Evaluation of Model Results

5.1.1. Legal and Political Factors

Legal and political factors is the first factor that is deemed to have an impact on ESCO market development. The factor loadings of the observable variables associated with the Legal and Political Factors-LPF1 (0.708), LPF2 (0.843), and LPF3 (0.889)-highlight varying levels of influence on the latent construct. In the context of the Turkish ESCO market, these results suggest that while long-term governmental commitment (LPF1) plays a role, it is comparatively less impactful than other factors. This could be attributed to the inconsistent implementation of long-term policies in Turkey, where political changes and shifting priorities often disrupt continuity in energy efficiency initiatives. Conversely, the higher loading of LPF2 (Strong energy policy framework) underscores the critical importance of a well-defined and robust energy policy. This aligns with the current challenges in the Turkish market, where the lack of a cohesive and enforceable energy efficiency framework has been a barrier to market development. Similarly, LPF3 (Dedicated ESCO legislation and standards)

demonstrates the strongest influence, reflecting the necessity of clear legal structures and standardized procedures for fostering trust and reducing transaction costs facilitates the market setup. Apart from observable variables, three hypotheses have been constructed relevant to legal and political factors.

The first hypothesis was constructed to assess the impact of the legal and political factors on the market related factors (H1a). The acceptance of H1a ($\beta = 0.322$, $t = 2.088$, $\alpha = 0.037$), which posits that legal factors influence market-related factors, can be attributed to the pivotal role that regulatory frameworks and government commitment play in shaping the dynamics of the Turkish ESCO market as it is supported by several academic research [19, 39, 61, 74]. Insights from expert interviews highlight that dedicated ESCO legislation especially plays a crucial role in facilitating the setup of ESCO projects and significantly reducing transaction costs. Bertoldi and Boza-Kiss (2017) [39] also indicated that In addition to minimizing transaction costs and building trust in the ESCO model, legislation and specific initiatives for ESCOs, such as clear definitions, certification criteria, and supporting procurement regulations, play a vital role [39].

Second hypothesis was constructed to assess the direct impact of the legal and political factors on ESCO market development (H1b). The acceptance of H1b ($\beta = 0.254$, $t = 1.654$, $\alpha = 0.098$), shows that the legal and political factors have a moderate yet statistically significant influence on the development of the ESCO market, emphasizing the role of robust policies, regulatory frameworks, and government commitments in driving market growth.

This aligns with the findings of Boza-Kiss *et al.* (2015) [61], who emphasize that clear regulations and government policies provide the essential structure and security for ESCOs to operate effectively and expand their market presence. Additionally, a strong national energy policy, as noted by Akman *et al.* (2013) [18], creates a stable and supportive environment for energy efficiency projects, further enabling the development of the ESCO market. Overall, the acceptance of the second hypothesis

highlights the indispensable role of a robust legal and political framework, coupled with comprehensive energy policies, in fostering a conducive environment for the growth and sustainability of the ESCO market.

The third hypothesis within this cluster, which assessed the impact of legal and political factors on financial factors (H1c), was found to be statistically insignificant based on the analysis results ($\beta = 0.144$, $t = 0.915$, $\alpha = 0.360$), leading to its rejection. First, while the establishment of legal and political frameworks is essential for market development, these frameworks do not necessarily translate into immediate financial benefits or support mechanisms, particularly within the Turkish context. When examining the observable variables under the financial factors, it becomes evident that most of them are macroeconomic indicators. In contrast, the observable variables of legal and political factors have only a minimal influence on these macroeconomic aspects, especially within the specific dynamics of Turkey. Although Bertoldi and Boza-Kiss (2017) [39] stated that governmental commitment and supportive energy policies facilitate the mechanism of third-party financing for ESCO projects, this does not fully align with the Turkish market context [39]. This discrepancy arises because, in Turkey, despite the presence of energy policies and governmental initiatives, macroeconomic challenges such as high inflation, volatile currency fluctuations, and elevated interest rates significantly undermine the accessibility and reliability of third-party financing mechanisms. Additionally, during the interview's experts emphasized the limited integration of financial institutions into the ESCO market further hampers the potential benefits of supportive legal frameworks, making third-party financing a less viable option in practice.

5.1.2. Financial Factors

Financial factors represent another critical dimension in evaluating the development of the ESCO market, particularly in the context of the Turkish market, where economic volatility and limited access to financing pose significant challenges. The factor loadings of the observable variables associated with Financial Factors-FIN1 (Inflation

and Currency Fluctuations, 0.773), FIN2 (Interest Rates, 0.910), and FIN3 (Support from Financing Organizations, 0.810)-highlight the substantial impact of macroeconomic conditions and institutional support on this latent construct. The high loading of FIN2 highlights the significance of economic stability, including high inflation, fluctuating exchange rates, and elevated borrowing costs, which are prevalent in Turkey. The high loading of the FIN3 reflects the importance of accessible financial mechanisms and institutional backing for the ESCO market, emphasizing the need for stronger engagement from financial institutions to support project financing. Furthermore, three hypotheses were constructed to assess the influence of financial factors, with the results providing valuable insights into the relationships between these variables and the broader ESCO market dynamics.

Three hypotheses were formulated concerning financial factors. The first hypothesis (H2a) proposed that legal factors have a direct influence on market-related factors. However, H2a was found to be statistically insignificant ($\beta = 0.227$, $t = 1.456$, $\alpha = 0.146$) and was therefore rejected. Despite Bertoldi *et al.* (2014) [3] suggesting that financial factors could significantly influence the market dynamics of the ESCO sector, an unstable and unpredictable economy may have adversely impacted their effectiveness and influence. In the Turkish context, the persistent economic volatility marked by increased inflation, unpredictable currency movements, and high interest rates has established considerable obstacles to financial predictability. Moreover, the current suppression of the exchange rate through macroeconomic strategies could have disrupted the natural correlation between macroeconomic indicators, such as inflation and interest rates, and their dependents, like energy prices and transaction costs, thus weakening the expected relationship between financial factors and market-related factors in the Turkish ESCO market. Furthermore, experts have reached a consensus that transaction costs and market facilitators have a minimal financial impact on the residential ESCO market. The second hypothesis (H2b), which posits that financial factors influence ESCO market development, has been accepted ($\beta = 0.319$, $t = 2.163$, $\alpha = 0.031$), confirming the significant role of financial factors in driving the growth and development of the ESCO market. Bertoldi *et al.* (2006) [28] assert that finance

elements are critical for the expansion of the ESCO industry, since the availability of financial resources and advantageous financing structures are vital for the sector. Moreover, the establishment of a long-term ESCO market relies on financial tools such as concessional loans, credit guarantees, and assistance from financial authorities [62]. Nearly all experts emphasized the financial factors' influence on ESCO market development, highlighting that accessible financing mechanisms, stable economic conditions, and supportive financial institutions are essential for fostering growth and ensuring the sustainability of energy efficiency projects.

The final hypothesis, which examines the influence of financial factors on client characteristics, has been accepted with statistically significant results ($\beta = 0.374$, $t = 3.097$, $\alpha = 0.002$), confirming the strong relationship between financial considerations and client engagement in the ESCO market. There is a clear and predictable relationship between financial parameters and their impact on individuals' decision-making processes and risk perceptions [67]. This result underscores the pivotal role financial factors play in shaping client characteristics within the ESCO market. Economic stability and easily available financing channels have a direct impact on clients' interest to engage with ESCO initiatives, according to the considerable association between financial parameters and client attributes. Since interest rate and currency volatility have long been obstacles in the Turkish ESCO sector, this is of paramount importance there. To reduce client reluctance and increase participation in energy-saving programs, it is important to provide targeted financial assistance mechanisms and create favorable economic conditions, since these variables have a significant impact on customer involvement.

5.1.3. Market Related Factors

Market-Related Factors constitute a vital dimension in understanding the dynamics of the ESCO market, particularly in the Turkish context, where market structures and facilitators significantly shape the operational environment. The factor loadings of the observable variables associated with Market-Related Factors-MAR1 (Transaction

Costs, 0.806), MAR2 (Energy Prices, 0.835), and MAR3 (Market Facilitators, 0.824)-underscore the varying levels of influence these factors exert on the latent construct. The high loading of MAR2 reflects the pivotal role of energy prices in driving client interest and shaping demand for energy efficiency services. In contrast, the lower impact of MAR1 suggests that while transaction costs are a consideration, their influence may be mitigated by other market dynamics in the Turkish ESCO market. Similarly, the significant loading of MAR3 highlights the importance of market facilitators in bridging gaps and fostering an enabling environment for ESCO activities. To further understand these dynamics, two hypotheses were constructed to explore the relationship between Market-Related Factors and other dimensions, providing valuable insights into their role within the broader market framework.

The first hypothesis (H3a), which aimed to evaluate the direct influence of Market-Related Factors on ESCO market development, was found to be statistically insignificant and consequently rejected ($\beta = 0.029$, $t = 0.099$, $\alpha = 0.834$). This result indicates that Market-Related Factors do not exert a significant direct impact on the development of the ESCO market. In contrast, the second hypothesis (H3b) was accepted, demonstrating a statistically significant influence of Market-Related Factors on Client Characteristics ($\beta = 0.350$, $t = 2.470$, $\alpha = 0.014$). This finding suggests that Market-Related Factors indirectly contribute to ESCO market development by shaping and influencing client characteristics, highlighting their intermediary role in driving market growth. According to De La Houssaye (2004) [66], market-related factors play a pivotal role in the expansion and sustainability of the ESCO market by shaping the demand for energy efficiency services. These factors significantly impact the demand side by influencing clients' risk perception, interest, and willingness to engage in energy-saving solutions, thereby fostering greater adoption of ESCO initiatives. For example, according to De La Houssaye (2004) [66], clients may be put off from signing energy efficiency contracts if they view high transaction costs as lowering the total financial value of energy savings. By offering structured support, such as streamlining contractual processes and providing accessible resources, market facilitators can help bridge the gap between potential clients and ESCO providers, ultimately fostering a more conducive

environment for energy efficiency initiatives [65]. Moreover, according to Bertoldi and Boza-Kiss (2017) [39], clients' interest in ESCO services can be greatly influenced by structural and market developments, such as changes in energy costs and the recovery of important industries. In the Turkish context, where energy prices have historically been high, this serves as a supportive factor, driving demand for energy efficiency solutions as businesses and individuals seek to mitigate energy-related expenses.

Therefore, findings highlight that the influence of Market-Related Factors on ESCO market development is primarily driven by their impact on client characteristics. This indirect relationship underscores the critical role of Market-Related Factors in shaping client perceptions, particularly in terms of risk and decision-making processes. By addressing key demand-side elements such as client awareness, interest, and willingness to adopt energy-saving solutions, Market-Related Factors effectively reduce barriers and foster greater confidence in ESCO services.

5.1.4. Client Characteristics

Client Characteristics represent another significant dimension in understanding the dynamics of the ESCO market, particularly within the Turkish context, where client perceptions, awareness, and collaboration significantly shape market potential. The factor loadings of the observable variables associated with Client Characteristics-CLN1 (Perception of Risk, 0.825), CLN2 (Level of Awareness, 0.770), and CLN3 (Landowner Consensus on Energy Efficiency, 0.861)-underscore the varying levels of influence these components exert on the latent construct. The high loading of CLN3 emphasizes the critical role of landowner consensus in advancing energy efficiency projects, particularly in residential and shared-ownership contexts. Similarly, the substantial loading of CLN1 reflects the significant impact of clients' risk perception on their decision-making processes and willingness to engage in energy-saving initiatives. The moderate loading of CLN2 highlights the importance of raising awareness among clients to foster an informed and receptive market environment. To evaluate the influence of Client Characteristics on ESCO market development and other dimensions, single hypotheses

were constructed, providing deeper insights into their intermediary and direct impact on the ESCO market development.

The constructed hypothesis (H4) has been accepted ($\beta = 0.318$, $t = 2.029$, $\alpha = 0.042$) as obtaining the highest impact among other hypothesis. The demand for energy efficiency services and the effectiveness of project execution are strongly impacted by client desire and active involvement, which are important drivers of ESCO market development in many countries [65]. The results showed that the ESCO market in Turkey like in many countries is demand oriented.

This results also underscores the importance of addressing client-specific factors to enhance the market's receptiveness to ESCO solutions. Observable variables such as Perception of Risk (CLN1), Level of Awareness (CLN2), and Landowner Consensus (CLN3) significantly contribute to this dynamic. The high factor loading of CLN3 indicates that securing consensus among landowners, particularly in residential and shared spaces, is crucial for the success of energy efficiency projects. This aligns with Panev *et al.* (2018) [58], who emphasized the critical role of landlord consensus in the development of the ESCO market within the residential sector, highlighting it as a key initiating factor for successful ESCO project implementation. Apart from that, CLN1 reflects how clients' risk perceptions can either encourage or deter their participation, making it essential to address concerns about project reliability and financial outcomes. Additionally, CLN2 highlights the necessity of awareness-raising campaigns to improve client understanding of energy efficiency benefits, thereby fostering greater market engagement. Hopper *et al.* (2007) [70] indicated that it is not enough for clients to be aware of ESCOs and its benefits; clients' perceptions of risk also have a major role in their level of participation. These findings collectively emphasize the central role of client characteristics in driving ESCO market development in Turkey.

5.1.5. Technical Factors

Technical Factors represent another critical dimension in evaluating the development of the ESCO market, particularly in the Turkish context, where technology and technical tools play a significant role in operational efficiency and project success. The factor loadings of the observable variables associated with Technical Factors-TEC1 (Tools, Models, and Handbooks, 0.983), TEC2 (Technology Maturation and Support, 0.745), and TEC3 (Energy Saving Monitoring Infrastructure, 0.523)-highlight the varying levels of influence these components exert on the latent construct. The extremely high loading of TEC1 underscores the importance of standardized tools, models, and handbooks in ensuring consistency, reliability, and guidance across ESCO projects. On the other hand, the moderate loading of TEC2 reflects the relevance of technological advancements and support systems in enabling the implementation of energy efficiency measures. However, the relatively low loading of TEC3, which was found to be insignificant and therefore rejected, in this analysis, suggests that energy-saving monitoring infrastructure may not have significant influence in residential ESCO projects in Turkey. This variable was proposed by experts during the interviews to be included in the model. However, it was found to be insignificant, likely due to its limited adoption, underdeveloped infrastructure, and the relatively low complexity of residential projects.

To evaluate the influence of Technical Factors on other dimensions, one hypothesis (H5) was constructed, providing a deeper understanding of their role within the broader framework of ESCO market development. The hypothesis H5 is rejected ($\beta=0.076$, $t=0.188$, $\alpha=0.698$) by showing the technical factors insignificance on ESCO market development. It is a fact that a major factor driving the expansion of ESCO markets in various countries is the development of more efficient energy-saving technologies [39]. However, according to experts' opinion the technical factors' impact on ESCO market development is not dominant since the residential projects has not fully integrated advance technological solutions particularly energy-saving monitoring infrastructure (TEC3), as evidenced by its low factor loading (0.523). This may stem

from the relatively low complexity and limited scale of residential projects, where such infrastructure is not deemed a priority. According to survey results by Acuner *et al.* (2021) [1], experts in the residential ESCO market in Turkey highlighted that the scope of ESCO projects for residential applications predominantly includes heat insulation, the adoption of EV technologies, and efficiency improvements in lighting systems, as well as heating, ventilation, and air conditioning (HVAC) systems. One other reason of the rejection of hypothesis could be the economic instability, including high inflation and fluctuating currency rates, could deter investments in advanced technical systems, with stakeholders prioritizing cost-saving measures over technological enhancements. According to expert insights, current ESCO companies in Turkey tend to focus on lower-cost projects with shorter payback periods, such as heat insulation and lighting system efficiency improvements. This preference diminishes the demand for advanced technologies, as these simpler and more affordable solutions are sufficient to meet project requirements, leaving little incentive to invest in or adopt more sophisticated technological advancements.

6. CONCLUSION

Drawing from the detailed analysis of the model, which initially proposed 10 hypotheses, 4 were rejected (H1c, H2a, H3a, H5) along with one observable variable (Energy Saving Monitoring Infrastructure). This emphasizes the complex and delicate interaction of legal, financial, market-related, technical, and client-related dimensions in shaping the Turkish ESCO market.

The research underscores that legal and political factors, particularly dedicated ESCO legislation and a strong energy policy framework, play a pivotal role in shaping market dynamics. Observations revealed high factor loadings for regulatory frameworks, reflecting their critical importance in fostering trust, reducing transaction costs, and facilitating market entry. However, the influence of long-term governmental commitment was relatively moderate, attributed to Turkey's historical challenges with policy continuity amidst political fluctuations. The results align with global literature emphasizing the need for clear legal structures to sustain ESCO market growth.

Financial factors emerged as a significant determinant of ESCO market development. Notably, "Interest Rates" exhibited the highest factor loading, highlighting the importance of macroeconomic cost of money in fostering ESCO projects. Despite this, hypotheses exploring the interplay between financial factors and market-related dimensions were rejected, likely due to Turkey's macroeconomic instability, unnatural economic interventions, characterized by high inflation, volatile exchange rates, and elevated borrowing costs. These findings underline the need for financial reforms, targeted assistance, and strengthened collaboration with financial institutions to enhance the sector's stability and growth. Moreover, the results indicate that financial factors exert the greatest impact on client characteristics, signifying that economic considerations such as access to financing, interest rates, and financial stability play a pivotal role in shaping clients' decisions, risk perceptions, and overall willingness to engage in ESCO projects.

Market-related factors were shown to indirectly influence ESCO market development through their impact on client characteristics. High energy prices and market facilitators emerged as critical enablers, reflecting their role in reducing barriers and fostering demand for energy efficiency services. Conversely, the influence of transaction costs was found to be less significant, suggesting a complex market dynamic where cost barriers may be overshadowed by other critical factors in the Turkish context. The findings indicate that although market facilitation and high energy prices can strengthen client confidence and foster greater adoption of ESCO solutions in residential projects their impact is relatively low compared with commercial and industrial projects.

Client characteristics were identified as a cornerstone of ESCO market development, with client perceptions, awareness, and collaboration significantly shaping market potential. Observations highlighted the critical importance of achieving landowner consensus, particularly in residential sectors, where shared ownership often complicates project execution. Risk perception and awareness levels were also pivotal in determining client engagement, underscoring the need for targeted awareness campaigns and assurance mechanisms to reduce hesitation and foster participation. An important insight from expert opinions highlights the challenges in implementing ESCO contracts in Turkey, particularly when clients, including public entities, lack a mature energy management system such as ISO 50001. Without such a foundational framework, the necessary infrastructure for managing ESCO contracts is absent, making it exceptionally difficult to reach consensus and execute projects effectively. Furthermore, the lack of a free market environment in Turkey limits the development of innovative business models, with the sector largely dominated by equipment vendors. This structural limitation underscores the need for systemic reforms and capacity-building initiatives to establish a conducive environment for the growth and success of ESCO projects. Lastly, the findings reveal that client characteristics have the most significant impact on ESCO market development, underscoring that the Turkish ESCO market, similar to many other markets globally, is highly demand-oriented. This emphasizes that the success of ESCO projects in Turkey largely depends on clients' awareness, willingness, and engagement. A demand-driven market highlights the necessity of addressing client

needs and perceptions, such as reducing perceived risks, increasing trust in ESCO solutions, and ensuring clear communication of financial and energy-saving benefits. Building client confidence and fostering a supportive environment for decision-making are critical steps toward driving market growth and adoption of energy efficiency measures in Turkey.

Technical factors, while theoretically vital for operational efficiency, demonstrated limited impact within the Turkish ESCO market. The low factor loading for “Energy Saving Monitoring Infrastructure” and its subsequent exclusion from the final model reflects the current underutilization and limited adoption of advanced technologies. This finding aligns with expert insights suggesting that Turkish ESCO companies prioritize low-cost, short payback solutions such as heat insulation and lighting efficiency, over more sophisticated technological advancements. The result highlights the need for a shift in market focus and investment priorities to integrate advanced technologies into mainstream ESCO solutions.

6.1. Contribution of the Study

This study provides significant insights into the development of the ESCO market, with a focus on the Turkish context, where unique economic, legal, and social dynamics shape the market’s evolution. By adopting a comprehensive model, which integrates multiple dimensions such as legal and political factors, financial factors, market-related factors, technical factors, and client characteristics, this research offers a holistic view of the determinants influencing the ESCO market. The findings contribute to bridging the gap between theoretical understanding and practical implementation, making this study relevant both academically and practically.

One of the key theoretical contributions of this study lies in its integration of multiple dimensions into a single, comprehensive model for evaluating the ESCO market. While previous research has often focused on isolated factors, this study bridges the gap by exploring the relationships between diverse latent constructs. By employing latent

variables such as financial factors, legal and political factors, market-related factors, technical factors, and client characteristics, the study highlights the interconnectedness of these determinants. This multi-faceted approach not only broadens the scope of existing ESCO market theories but also provides a more nuanced understanding of the dynamics influencing market development. Additionally, the study identifies the varying levels of significance and influence of observable variables within these dimensions. For example, the high factor loading of “Support from Financing Organizations” within the financial factors construct underscores the critical role of institutional backing in fostering ESCO market growth. Similarly, the identification of “Energy Saving Monitoring Infrastructure” as an insignificant variable within technical factors offers theoretical insights into the limited role of advanced technologies in certain contexts, particularly in developing economies.

The study makes a methodological contribution by employing Partial Least Squares Structural Equation Modeling (PLS-SEM) to test its hypotheses and validate the proposed model. PLS-SEM is particularly suitable for small sample sizes and complex models, making it an ideal choice for this research [87]. By applying this technique, the study not only ensures the robustness of its findings but also demonstrates the effectiveness of PLS-SEM in analyzing niche markets like ESCOs. This methodological innovation serves as a reference point for future researchers aiming to study similar markets with limited data availability.

Another significant theoretical contribution is the study’s focus on the Turkish ESCO market, which has unique characteristics shaped by economic volatility, regulatory challenges, and client behaviors. By tailoring its analysis to this specific context, the study adds a new dimension to the global literature on ESCO markets. The findings highlight how local economic and regulatory conditions can influence the dynamics of market development, offering insights that are transferable to other emerging markets with similar challenges. Table 6.1 presents the key theoretical advancements derived from this research, highlighting its contributions to the existing body of knowledge in the ESCO market, including the identification of critical factors influencing market

development, the validation of a customized model specific to the Turkish context, and the provision of empirical evidence supporting the relationships between legal, financial, market-related, technical, and client-related dimensions.

Table 6.1. Overview of the study's theoretical contributions.

Theoretical Contribution	Description
Advancement of ESCO Market Theory	Integrates multiple dimensions (legal, financial, market-related, technical, and client-related factors) into a single comprehensive model, expanding the theoretical understanding of ESCO markets.
Application of PLS-SEM Methodology	Demonstrates the effectiveness of PLS-SEM for analyzing complex models with small sample sizes, setting a benchmark for future research in niche markets.
Context-Specific Insights	Focuses on the Turkish ESCO market, providing localized perspectives on the influence of economic, regulatory, and client-related dynamics.
Role of Legal and Political Frameworks	Highlights the importance of dedicated ESCO legislation and energy policies in fostering trust, reducing transaction costs, and facilitating market growth.
Emphasis on Client Characteristics	Establishes client awareness, risk perception, and willingness to engage as critical demand-side determinants of ESCO market development.
Refinement of Market-Related Factors	Identifies the indirect influence of market-related factors through client characteristics, offering a nuanced perspective on market dynamics.

Table 6.1 Overview of the study's theoretical contributions. (cont.)

Theoretical Contribution	Description
Critique of Advanced Technologies	Challenges the universal applicability of advanced technologies in emerging markets, emphasizing the preference for cost-effective solutions.
Financial Integration Challenges	Highlights the limitations of macroeconomic indicators in volatile economies like Turkey, stressing the importance of institutional financial support.
Holistic Framework for Analysis	Provides a multidimensional framework for understanding ESCO market development, encouraging interdisciplinary research.

This study not only enriches the theoretical understanding of the ESCO market but also offers several valuable practical contributions, particularly for stakeholders operating within the Turkish ESCO market. By addressing the unique challenges and opportunities presented by Turkey's economic, regulatory, and market-specific environment, the findings provide actionable insights that can guide policymakers, ESCO practitioners, financial institutions, and other relevant entities in fostering market development.

One of the most significant practical contributions is the study's detailed identification and analysis of key factors influencing ESCO market development. By examining legal and political, financial, market-related, technical, and client characteristics, the research sheds light on the critical areas requiring intervention to stimulate market growth. For instance, the findings reveal the pivotal role of legal and political factors, such as the necessity for dedicated ESCO legislation and a strong energy policy framework. Policymakers can leverage these insights to design clear, enforceable regulations and establish standardized procedures that reduce transaction costs and facilitate trust among market participants. Establishing such a legal infrastructure could address bar-

riers related to contract complexity and enforcement, thereby fostering a more reliable environment for ESCO operations.

From a financial perspective, the study underscores the importance of support from financial organizations and macroeconomic stability in encouraging ESCO projects. The identification of “Support from Financing Organizations” as the most impactful financial factor suggests that financial institutions must play a more active role in providing accessible and affordable financing mechanisms for energy efficiency projects. ESCO practitioners can use this insight to advocate for concessional loans, credit guarantees, and other financial incentives tailored to the Turkish market’s specific needs. Additionally, the findings highlight the challenges posed by Turkey’s volatile economic environment, including high inflation and fluctuating exchange rates, emphasizing the need for macroeconomic reforms to create a more predictable and supportive financial landscape for ESCOs.

Client characteristics emerged as the most significant factor influencing ESCO market development, particularly in demand-driven markets like Turkey. The study highlights the importance of client awareness, risk perception, and consensus among landowners in driving project adoption. These findings provide a roadmap for ESCO practitioners to design targeted awareness campaigns that address client hesitations and misconceptions about energy efficiency projects. By emphasizing the financial and energy-saving benefits of ESCO solutions, practitioners can build client confidence and foster greater engagement.

Lastly, the research’s emphasis on the interdependencies between factors offers practical insights for integrated market development strategies. For example, the study shows that financial factors significantly influence client characteristics, highlighting the need for holistic approaches that simultaneously address financial, regulatory, and market-related barriers. Policymakers and practitioners can use this integrated perspective to design multi-dimensional interventions that align with the unique dynamics of the Turkish market. For instance, combining financial incentives with targeted

awareness campaigns and robust regulatory frameworks can create a more supportive ecosystem for ESCO projects.

Table 6.2. Overview of the study's practical contributions.

Practical Contribution	Description
Policy and Regulation Development	Provides insights for creating dedicated ESCO legislation and a strong regulatory framework to reduce transaction costs and establish market trust.
Financial Mechanism Enhancement	Highlights the importance of financial support mechanisms like concessional loans and credit guarantees to mitigate the impact of economic instability.
Market Facilitation Improvement	Emphasizes the role of market facilitators in reducing barriers, fostering client confidence, and enhancing the adoption of energy efficiency projects.
Client Engagement Strategies	Suggests targeted awareness campaigns and trust-building measures to improve client perceptions, reduce risk aversion, and secure landowner consensus.
Advancement in Technological Adoption	Recommends investing in advanced tools, models, and energy-saving monitoring systems to improve project performance and transparency.
Strategic Integration	Encourages aligning financial, legal, and market strategies to create a comprehensive support system for ESCO market development.

The results of this study provide valuable insights that can benefit a wide range of stakeholders involved in the ESCO market. Policymakers stand to gain a deeper understanding of the legal and regulatory reforms needed to create an enabling environment for ESCO market growth. By leveraging the findings, they can design policies and frameworks that address current barriers, foster trust, and reduce complexities in the market. Financial institutions, such as banks and investment firms, can utilize the study's insights to develop tailored financing mechanisms, such as concessional loans and credit guarantees, which can incentivize investment in energy efficiency projects and mitigate risks associated with market volatility.

ESCO companies and practitioners, including engineers, project managers, and financial managers, can benefit from the detailed analysis of client characteristics and market-related factors. These insights can help them develop more targeted strategies to engage potential clients, design customized energy solutions, and build stronger relationships with stakeholders. Additionally, the study provides actionable recommendations for addressing the challenges posed by economic instability, offering ESCOs a clearer pathway to navigate financial and operational risks. Academics and researchers focusing on energy efficiency and sustainable development can also benefit from the study as it expands the body of knowledge on ESCO market dynamics in emerging economies like Turkey. The interdependencies between factors highlighted in this research offer a foundation for further studies and comparative analyses in different regional and economic contexts.

Finally, private sector clients and energy consumers can indirectly benefit from the study's findings as they inform initiatives to enhance client awareness, reduce risk perceptions, and improve access to financial resources. By fostering a more transparent and supportive market environment, these stakeholders can better understand the advantages of ESCO solutions and feel more confident in adopting energy efficiency measures. In sum, this study serves as a vital resource for driving collaborative efforts among policymakers, financial institutions, practitioners, and researchers to advance the ESCO market and promote sustainable energy.

6.2. Limitation of the Study and Future Work

One of the primary limitations of this study is the limited number of participants. This constraint arises due to the specific requirements for participant profiles, which narrows the pool of eligible respondents. To address this limitation, Partial Least Squares Structural Equation Modeling (PLS-SEM) has been employed, as it is well-suited for analyzing data with smaller sample sizes. Nevertheless, a larger sample size would likely yield more reliable and generalizable results. Additionally, the study relies heavily on survey responses and expert opinions. While these sources provide valuable insights, they are inherently subjective and may introduce potential biases that could influence the findings. Finally, the impact of unconventional macroeconomic strategies, such as government interventions in currency markets, could further shape experts' perspectives and evaluations. These interventions, including artificial suppression of currency values, may affect how respondents perceive and assess the relationships among the studied factors, potentially influencing the robustness of the results.

Building on the findings of this study, future research could focus on several key areas to further enhance understanding of the factors influencing the development of the ESCO market in Turkey. First, expanding the sample size and participant diversity could provide more robust and generalizable results, enabling a deeper exploration of sector-specific or regional variations within the ESCO market. Second, longitudinal studies could be conducted to examine how the relationships between the identified factors evolve over time, particularly in response to changing regulatory, economic, and technological conditions. Third, integrating qualitative methods, such as in-depth interviews or case studies, could complement the quantitative approach, offering richer insights into the barriers and enablers of market development. Additionally, future studies could explore sector-specific applications of the ESCO model, such as its potential in industrial or commercial projects, to identify tailored strategies for market growth. Comparative studies between Turkey and other countries with more developed ESCO markets could also provide valuable lessons and best practices. Finally,

incorporating advanced data analysis techniques, such as machine learning or predictive modeling, could improve the precision of future models and provide actionable insights for policymakers and stakeholders. These extensions would help address the limitations of this study and contribute to the broader literature on energy efficiency and ESCO market development.



REFERENCES

1. Acuner, E., R. Cin, and S. Onaygil, “Energy Service Market Evaluation by Bayesian Belief Network and SWOT Analysis: Case of Turkey”, *Energy Efficiency*, Vol. 14, No. 6, pp. 62-80, 2021.
2. Akkoç, H.N., S. Onaygil, E. Acuner, and R. Cin, “Implementations of Energy Performance Contracts in the Energy Service Market of Turkey”, *Energy Sustainable Development/Energy for Sustainable Development*, Vol. 1, No. 1, pp. 76-92, 2023.
3. Bertoldi, P., B. Kiss, S. Panev, and N. Labanca, *The European ESCO Market Report 2013*, Publications Office of the European Union, Luxembourg, 2014.
4. Marino, A., P. Bertoldi, S. Rezessy, and B. Boza-Kiss, *Energy Service Companies Market in Europe*, European Commission, London, 2010.
5. Goldman, C.A., N.C. Hopper, J.G. Osborn, and T.E. Singer, “Review of U.S. ESCO Industry Market Trends: An Empirical Analysis of Project Data”, *Lawrence Berkeley National Laboratory*, Vol. 33, No. 3, pp. 387–405, 2003.
6. Annual Activity Report, “Publications Office of the European Union”, European Commission, London, 2023.
7. Okay, N., and U. Akman, “Analysis of ESCO Activities Using Country Indicators”, *Renewable and Sustainable Energy Reviews*, Vol. 14, No. 9, pp. 2760-2771, 2010.
8. Dursun, E., and P. Bertoldi, “ESCO market in Turkey: Challenges and opportunities”, *Institute of Electrical and Electronics Engineers IEEE*, Vol. 1, No. 1, pp. 150-165, 2015.
9. Öncü, E., S. Onaygil, and R. Cin, “Risk Assessment of Energy Performance Contracting in Türkiye Utilizing Best-Worst Method”, *Energy Efficiency*, Vol. 17, No.

- 7, p. 74-90, 2024.
10. Duzgun, B., and G. Komurgoz, “Turkey’s Energy Efficiency Assessment: White Certificates Systems and Their Applicability in Turkey”, *Energy Policy*, Vol. 65, No. 1, pp. 465-474, 2014.
 11. ICF International, *Introduction to Energy Performance Contracting*, U.S. Environmental Protection Agency, 2007.
 12. Limaye, D.R., and E.S. Limaye, “Scaling Up Energy Efficiency: The Case for a Super ESCO”, *Energy Efficiency*, Vol. 4, No. 2, pp. 133-144, 2011.
 13. IEA, “Energy Service Companies (ESCOs)”, 2018, <https://www.iea.org/reports/energy-service-companies-escos-2>, accessed on November 09, 2024.
 14. Lindseth, L.R., *EPC in the Nordic Countries*, Nordic Council of Ministers, Villanova, 2015.
 15. Hansen, S. J., *Performance Contracting: Expanding Horizons*, River Publishers, New York, 2020.
 16. Duplessis, B., J. Adnot, M. Dupont, and F. Racapé, “An Empirical Typology of Energy Services Based on A Well-Developed Market: France”, *Energy Policy*, Vol. 45, No. 1, pp. 268-276, 2012.
 17. Eutukhova, T., O. Kovalko, O. Novoseltsev, and E. Woodroof, “Energy Services: A Proposed Framework to Improve Results”, *Energy Engineering*, Vol. 117, No. 3, pp. 99–110, 2020.
 18. Akman, U., E. Okay, and N. Okay, “Current Snapshot of the Turkish ESCO Market”, *Energy Policy*, Vol. 60, No. 1, pp. 106-115, 2013.
 19. Okay, E., N. Okay, A.E. Ş. Konukman, and U. Akman, “Views on Turkey’s Impend-

- ing ESCO Market: Is it Promising?”, *Energy Policy*, Vol. 36, No. 6, pp. 1821-1825, 2008.
20. Kirigin, D., M. Mihić, and I. Završki, “ESCO Models for Improving Energy Efficiency in the Construction Industry”, *In 12th International Conference*, Zagreb, pp. 452-470, 2015.
 21. Doz, L., *Energy Service Companies and The Energy Performance Contracting in Europe*, M.S. Thesis, Linkopings University, 2014.
 22. Klinke, S., “The determinants for Adoption of Energy Supply Contracting: Empirical Evidence from the Swiss Market”, *Energy Policy*, Vol. 118, No. 1, pp. 221-231, 2018.
 23. Stuart, E., C.A. Goldman, P. Larsen, and D. Gilligan, *The US ESCO Industry: Recent Trends, Current Size and Remaining Market Potential*, Lawrence Berkeley National Laboratory, California, 2014.
 24. Stuart, E., N. L. Hanus, J. P. Carvallo, and P. H. Larsen, *US ESCO Industry: Industry Size and Recent Market Trends*, Lawrence Berkeley National Laboratory, California, 2021.
 25. IEA, “Breakdown of ESCO revenue by country”, 2018, <https://www.iea.org/data-and-statistics/charts/breakdown-of-esco-revenue-by-country-most-recent-year-available>, accessed on November 13, 2024.
 26. Goldman, C.A., J.G. Osborn, N.C. Hopper, and T.E. Singer, *Market Trends in the U.S. ESCO Industry: Results from the NAESEO Database Project*, Lawrence Berkeley National Laboratory, California, 2002.
 27. Fawkes, S., *Outsourcing Energy Management: Saving Energy and Carbon through Partnering*, First Edition, Aldershot, England, 2007.

28. Bertoldi, P., S. Rezessy, and E.Vine, “Energy Service Companies in European Countries: Current Status and A Strategy to Foster Their Development”, *Energy Policy*, Vol. 34, No. 14, pp. 1818-1832, 2006.
29. Bertoldi, P. *The JRC ESCOs Report 2018, Directorate C.2 Energy, Transport and Climate* 24 Energy Efficiency and Renewable Energies Unit, London, 2018.
30. Keegan, N., *Country Report on the Energy Efficiency Services Market and Quality: United Kingdom*, Qualit EE Project, London, 2017.
31. EPC markets and ESCO business in Finland, *Final Draft of the Country Report*, Motiva Oy, New York, 2007.
32. Moles-Grueso, S., P. Bertoldi, and B. Boza-Kiss, *Energy Performance Contracting in the EU–2020-2021*, Publications Office of the European Union, Luxembourg, 2023.
33. Bertoldi, P., V. Berrutto, M. de Renzio, J. Adnot, and E. Vine, *How are EU ESCOs Behaving and How to Create A Real ESCO Market*, The European Council for an Energy Efficient Economy, Italy, 2003.
34. Ürge-Vorsatz, D., S. Köppel, C. Liang, B. Kiss, G. Nair, and G. Celikyilmaz, *An Assessment of Energy Service Companies (ESCOs) Worldwide*, World Energy Council, Germany, 2007.
35. Wargert, D., *Energy Contracting Models in Germany and Sweden*, M.S. Thesis, Lunds University, 2011.
36. Hermann L., A.C. Plüschke, *Market Report on the German EPC Market*, Berliner Energieagentur GmbH, Germany, 2018.
37. IEA, “ESCO Revenues by Contract Type”, 2018, <https://www.iea.org/data-and-statistics/charts/esco-revenues-by-contract-type>, accessed on November 23, 2024.

38. Schulze-Sturm, S., and C. Esseling, *Country Report on the Energy Efficiency Services Market and Quality Germany*, QualitEE Project, Germany, 2018.
39. Bertoldi, P., and B. Boza-Kiss, “Analysis of Barriers and Drivers for the Development of the ESCO Markets in Europe”, *Energy Policy*, Vol. 107, No. 1, pp. 345-355, 2017.
40. Sijben, A., *Country Report Netherlands*, IEA DSM Task X, London, 2003.
41. Goorden, G., and J. Coolen, *Country Report on the Energy Efficiency Services Market and Quality*, QualitEE Project, Germany, 2018.
42. Roskam, S., T. Piessens, and I. Thijssen, *Market Report on the Dutch EPC Market*, Netherlands Enterprise Agency, Stockholm, 2020.
43. Fagernæs, A., and M. Citi, *Barriers and Enablers to Energy Efficiency in Existing Buildings*, M.S. Thesis, Copenhagen Business School, 2016.
44. Patlitzianas, K. D., H. Doukas, and J. Psarras, “Designing an Appropriate ESCOs’ Environment in the Mediterranean”, *Management of Environmental Quality: An International Journal*, Vol. 17 No. 5, pp. 538-554, 2006.
45. *Status of Energy Performance Contracting in Italy*, Ambiance, Italy, 2020.
46. Ballesteros, S., “Spanish ESCO Market – trends and Barriers”, *European ESCO Conference*, Frankfurt, Vol. 1, No. 1, pp. 345-367, 2022.
47. Ortis, A., *Annual Report on Regulatory Activities and the State of Services*, Autorità per L’energia Elettrica Eilgas, Italy, 2005.
48. Sabbatucci, N., and N. Labanca, *National Report on the Energy Efficiency Service Business*, Italy, 2009.

49. Luque, P.L.E., and A.R. Ruiz, *Country Report on the Energy Efficiency Services Market and Quality*, QualitEE Project, London, 2018.
50. Xiaoliang, S., and Z. Lin, *China's ESCO Industry, Saving More Energy Everyday Through the Market*, London, 2011.
51. Qiu, P., *Development of Technological Capabilities in Chinese Energy Service Companies (ESCOs)*, Ph.D. Thesis, Aston University, 2018.
52. Nakagami, H., and C. Murakoshi, *Recent Activities of ESCO Industry in Japan, China and Thailand*, In The Yellow Sea Rim International Exchange Meeting on Building Environment and Energy, Kumamoto, 2009.
53. Ma, D., *Energy Service Companies (ESCOs) in China: Barriers and Drivers from ESCOs' Perspective*, M.S. Thesis, Aalto University, 2013.
54. IEA, "Evolving Energy Service Companies in China", 2021, <https://www.iea.org/reports/evolving-energy-service-companies-in-china>, accessed on November 25, 2024.
55. Stuart, E., P.H. Larsen, C.A. Goldman, and D. Gilligan, "A Method to Estimate the Size and Remaining Market Potential of the US ESCO (Energy Service Company) Industry", *Energy*, Vol. 77, No. 1, pp. 362-371, 2014.
56. Turkish Republic Ministry of Treasury and Finance, "Sustainable Finance Framework", 2023, <https://ms.hmb.gov.tr/uploads/2021/11/Republic-of-Turkey-Sustainable-Finance-Framework.pdf>, accessed on November 24, 2024.
57. *The Development of Renewable Energy in Turkish Electricity Markets*, Türkiye Bilimsel ve Teknolojik Araştırma Kurumu, Vol. 25, No. 1, pp. 328-346, 2023.
58. Panev, S., P. Bertoldi, B. Boza-Kiss, and V. Palermo, *Report for Development of the ESCO Market in the EU Enlargement and Neighboring Countries*, Publications

Office, European Union, 2018.

59. Kalangos, C, “Barriers and Policy Drivers to Energy Efficiency in Energy Intensive Turkish Industrial Sectors”, *International Journal of Energy Economics and Policy*, Vol. 7, No. 3, pp. 110-120, 2017.
60. Okay, E., N. Okay, A. E. Ş. Konukman, and U. Akman, “Views on Turkey’s Impending ESCO market: Is it Promising?”, *Energy Policy*, Vol. 36, No. 6, pp. 1821-1825, 2008.
61. Boza-Kiss, B., S. Panev, and P. Bertoldi “The European ESCO Market: Recent Trends, Market Sizes, Barriers and Drivers and the Remaining Market Potential”, *The European Council for an Energy Efficient Economy (ECEEE)*, Vol. 2015, No. 1, pp. 445-454, 2015.
62. Ellis, J., *Energy Service Companies (ESCOs) in Developing Countries*, International Institute for Sustainable Development, New York, 2010.
63. Okay, N., and U. Akman, “Analysis of ESCO Activities Using Country Indicators”, *Renewable and Sustainable Energy Reviews*, Vol. 14, No. 9, pp. 2760-2771, 2010.
64. Wang, Y., and K. Liu, “Barriers Analysis and Risk Assessment Methodology of an Energy Services Company in China”, *International Conference on Construction and Real Estate Management (ICCREM)*, Vol. 1, No. 1, pp. 702-710, 2015.
65. Bleyl, J.W., N. Adilipour, M. Bareit, G. Kempen, S.H. Cho, and L. Vanstraelen, “ESCO Market Development: A role for Facilitators to Play“ *International Conference on Construction and Real Estate Management (ICCREM)*, Vol. 1, No. 1, pp. 102-110, 2013.
66. De La Houssaye, M., *Growth and Development of ESCO Markets*, M.S. Thesis, The International Institute for Industrial Environmental Economics, 2004.

67. Bilgin, M.S., *The Relationship between the Construction Industry and Economic Growth in Turkey*, M.S. Thesis, Sakarya University, 2023.
68. Gunhan, S., and D. Arditi, "Factors Affecting International Construction", *Journal of Construction Engineering and Management*, Vol. 131, No. 3, pp. 273-282, 2005.
69. Badi, S., "Facilitating ESCO Market Development through Value Co-Creation: Role of Utility Sector Intermediaries", *Energy Efficiency*, Vol. 14, No. 6, p. 56, 2021.
70. Hopper, N., C. Goldman, D. Gilligan, T.E. Singer, and D. Birr, *A Survey of the US ESCO Industry: Market Growth and Development from 2000 to 2006*, Lawrence Berkeley National Laboratory, California, 2007.
71. Safari, M., S. Asadi, and J. Freihaut, "Business Development in Small Commercial Building Energy Retrofit Projects-A Review on Current Industry Practices", *American Society of Civil Engineers*, Vol. 1, No. 1, pp. 1366-1374, 2020.
72. Safari, M., and D. Riley, "Framework for Building Energy Retrofit Project Development Using Risk Analysis", *In Construction Research Congress*, Vol. 1, No. 1, pp. 769-779, 2018.
73. Bellido, J.M., and B.P. Romero, "ESCO Formation as Enabling Factor for Smart Cities Development in European Union (UE): Spain Case Analysis", *Independent Journal of Management & Production*, Vol. 6, No. 4, pp. 866-884, 2015.
74. Hwang, B.G., L. Zhu, and J.T.T. Ming, "Factors Affecting Productivity in Green Building Construction Projects: The Case of Singapore", *Journal of Management in Engineering*, Vol. 33, No. 3, pp. 1-21, 2017.
75. Chan, A.P., D. Scott, and A.P. Chan, "Factors Affecting the Success of A Construction Project", *Journal of Construction Engineering and Management*, Vol. 130, No. 1, pp. 153-155, 2004.

76. Zeng, N., Y. Liu, P. Gong, M. Hertogh, and M. König, “Do Right PLS and do PLS Right: A Critical Review of the Application of PLS-SEM in Construction Management Research”, *Frontiers of Engineering Management*, Vol. 8, No. 1, pp. 356-369, 2021.
77. Durdyyev, S., A. Ihtiyar, A. Banaitis, and D. Thurnell, “The Construction Client Satisfaction Model: a PLS-SEM Approach”, *Journal of Civil Engineering and Management*, Vol. 24, No. 1, pp. 31-42, 2018.
78. Rosseel, Y., “Small Sample Solutions for Structural Equation Modeling”, *In Routledge eBooks*, Vol. 1, No. 1, pp. 226–238, 2020.
79. Manzoor, B., I. Othman, J.M. Kang, and Z.W. Geem, “Influence of Building Information Modeling (BIM) Implementation in High-Rise Buildings towards Sustainability”, *Applied Sciences*, Vol. 11, No. 16, pp. 7626, 2021.
80. Yücel, B., *Evaluating Factors Affecting Construction Technology Start-Up Investments and Investor Behavior*, M.S. Thesis, Boğaziçi University, 2022.
81. Demirdogen, G., and Z. Isik, “Structural Equation Model of the Factors Affecting Construction Industry Innovation Success”, *Teknik Dergi*, Vol. 32, No. 2, pp. 10717-10738, 2019.
82. Unegbu, H.C., D.S. Yawas, and B. Dan-asabe, “Structural Equation Model of the Relationship between Project Performance Measures and the Critical Success Factors of Construction Projects: A Case of the Nigerian Construction Industry”, *Jurnal Mekanikal*, Vol. 43, No. 2, pp. 33-51, 2020.
83. Kline, R. B., *Principles and Practice of Structural Equation Modeling*, Fifth Edition, Guilford Publications, New York, 2023.
84. Ullman, J.B., and P.M. Bentler, *Structural Equation Modeling*, Second Edition, Handbook of Psychology, California, 2012.

85. Thakkar, J.J., *Structural Equation Modelling: Application for Research and Practice*, First Edition, Springer, Warsaw, 2021.
86. Mardani, A., D. Streimikiene, E.K. Zavadskas, F. Cavallaro, M. Nilashi, A. Jusoh, and H. Zare, "Application of Structural Equation Modeling (SEM) to Solve Environmental Sustainability Problems: A Comprehensive Review and Meta-Analysis", *Sustainability*, Vol. 9, No. 10, p. 1814, 2017.
87. Kaur, J., N. Mohamed, and A.R. Ahlan, *Modeling the Impact of Information Technology Governance Effectiveness Using Partial Least Square*, In 2012 International Conference on Statistics in Science, Langkawi, Vol. 2, No. 1, pp. 345-378, 2012.
88. Aibinu, A.A., F.Y.Y. Ling, and G. Ofori, "Structural Equation Modelling of Organizational Justice and Cooperative Behaviour in the Construction Project Claims Process: Contractors' Perspectives", *Construction Management and Economics*, Vol. 29, No. 5, pp. 463-481, 2011.
89. Alsugair, A.M., "Cost Deviation Model of Construction Projects in Saudi Arabia using PLS-SEM", *Sustainability*, Vol. 14, No. 24, p. 16391, 2022.
90. Darko, A., A. P. C. Chan, Y. Yang, M. Shan, B. J. He, and Z. Gou, "Influences of Barriers, Drivers, And Promotion Strategies on Green Building Technologies Adoption in Developing Countries: The Ghanaian case", *Journal of Cleaner Production*, Vol. 200, pp. 687-703, 2018.
91. Alashwal, A. M., and H. Abdul-Rahman, "Using PLS-PM to Model the Process of Inter-Project Learning In Construction Projects", *Automation in Construction*, Vol. 44, No 1, pp. 176-182, 2014.
92. Hair, J.F., R.E. Anderson, R.L. Tatham, and W.C. Black, "Multivariate Data Analysis", *Englewood Cliff*, Vol. 5, No. 3, pp. 207-2019, 1998.
93. Hulland, J., "Use of Partial Least Squares (PLS) in Strategic Management Re-

- search: A Review of Four Recent Studies”, *Strategic Management Journal*, Vol. 20, No. 2, pp. 195-204, 1999.
94. Andreev, P., T. Heart, H. Maoz, and N. Pliskin, *Validating Formative Partial Least Squares (PLS) Models: Methodological Review and Empirical Illustration*, Independent Commodity Intelligence Services (ICIS), London, 2009.
 95. Cha, J., *Advance Methods of Marketing Research*, First Edition, Massachusetts, 1994.
 96. Nunnally, J.C., and I.H. Bernstein, *Psychometric Theory*, Third Edition, New Yorks, 1994.
 97. Vinzi, V.E., W.W. Chin, J. Henseler, and H. Wang, *Handbook of Partial Least Squares: Concepts, Methods and Applications*, First Edition, Springer Berlin Heidelberg, Berlin, 2009.
 98. Kumar, K., “Partial Least Square (PLS) Analysis: Most Favorite Tool iIn Chemo-metrics to Build A Calibration Model”, *Resonance*, Vol. 26, No. 1, pp. 429-442, 2021.
 99. Esposito Vinzi, V., and G. Russolillo, “Partial Least Squares Algorithms and Methods”, *Wiley Interdisciplinary Reviews: Computational Statistics*, Vol. 5, No. 1, pp. 1-19, 2013.
 100. Nawaz, M., and F. Pangil, “The Relationship Between Human Resource Development Factors, Career Growth and Turnover Intention: The Mediating Role of Organizational Commitment”, *Management Science Letters*, Vol. 6, No. 2, pp. 157-176, 2016.

APPENDIX A: QUESTIONNAIRE SURVEY

Appendix A presents the questionnaire survey designed to collect data on factors influencing ESCO market development from industry professionals.

Subject: Evaluating Factors Affecting ESCO Market Development

Thank you for participating in this survey, which aims to evaluate the key factors affecting the development of the Energy Service Company (ESCO) market in Turkey, with a specific focus on residential energy service projects. The study examines a range of factors categorized into five key areas: Legal and Political Factors, Financial Factors, Market Factors, Technical Factors, and Client Characteristics.

In the following sections, you will find a detailed depiction of the model used in this study, along with descriptions of each factor for your review and input. Your insights are invaluable in helping us understand the dynamics shaping the ESCO market, and we greatly appreciate your time and expertise.

A.1. PART 1: Respondent Information

1. Company name

.....

2. Position in the company

.....

3. Education level

☐ Less than high school ☐ High school ☐ Bachelor's Degree

☐ Master's ☐ Phd

4. Educational Background

☐ Engineering ☐ Economics and Business Administration ☐ Finance

☐ Legal ☐ Multidisciplinary

5. Age of respondents

☐ 20 – 30 years ☐ 31 – 40 years ☐ 41 – 50 years ☐ 51 – 60 years

☐ More

6. Experience in ESCO market

☐ No experience ☐ Less than 2 years ☐ 2 – 5 years ☐ 6 – 10 years

☐ More than 10 years

A.2. PART 2: Project and Market Information

In this section, we aim to gather comprehensive insights about your company's involvement in energy service projects and your perspective on the current state of the ESCO market. The questions focus on the types of clients your company has worked with, the nature of contracts and project areas you have engaged in, as well as your assessment of the overall development of the ESCO market in your country, considering key factors such as market size, client awareness, financing options, policy support, and technological readiness.

1. What types of clients has your company worked with in energy service contracts?
☐ Public Companies ☐ Private Companies ☐ Individuals (Tenants)

2. In which areas of energy service project execution has your company been involved?
☐ Industrial ☐ Commercial ☐ Residential

3. What types of contracts has your company been involved in for energy service projects?
☐ Guaranteed Savings ☐ Shared Savings ☐ Energy Supply ☐ Chauffage
☐ Other (Specify)

4. How would you rate the current level of development of the ESCO market in your country, considering factors related to market environment, client characteristics, financing mechanisms, policy and regulatory mechanisms, and technological environment?
☐ Very Low ☐ Low ☐ Moderate ☐ High ☐ Very High

A.3. PART 3: Factor Evaluation

In this final section, various factors influencing the development of the ESCO market in Turkey will be evaluated with a focus on residential energy service projects. These include Legal and Political, Financial, Market-related, Technical, and Client Characteristics. Your responses will be used to gain insights regarding influence level of these factor on the ESCO market development. Please review model framework, factor descriptions of each factor carefully and provide your assessment based on your professional experience.

1. Please evaluate the following factors considering the institutional, political and regulatory environment affecting ESCO market development.

Table A.1. Part one.

Legal and Political Factors	Very Low	Low	Medium	High	Very High
Dedicated ESCO Legislation, Measures and Service Standards	☐	☐	☐	☐	☐
National Energy Policy	☐	☐	☐	☐	☐
Long-term, manifested and credible commitment by the public administration	☐	☐	☐	☐	☐

2. Please evaluate following factors considering the financial and economic parameters affecting ESCO market development.

Table A.2. Part two.

Financial Factors	Very Low	Low	Medium	High	Very High
Inflation and currency fluctuations	☐	☐	☐	☐	☐
Support from financing organizations	☐	☐	☐	☐	☐
Interest rate	☐	☐	☐	☐	☐

3. Please evaluate following factors considering the market related parameters affecting ESCO market development.

Table A.3. Part three.

Market Factors	Very Low	Low	Medium	High	Very High
Transection costs	☐	☐	☐	☐	☐
Energy prices	☐	☐	☐	☐	☐
Market facilitators	☐	☐	☐	☐	☐

4. Please evaluate following factors considering the technical and technological environment affecting ESCO market development.

Table A.4. Part four.

Technical Factors	Very Low	Low	Medium	High	Very High
Availability of tools, models and handbooks	☐	☐	☐	☐	☐
Technological maturation and support	☐	☐	☐	☐	☐
Energy saving monitoring infrastructure	☐	☐	☐	☐	☐

5. Please evaluate following factors considering the client characteristics of ESCO market.

Table A.5. Part five.

Client Characteristics	Very Low	Low	Medium	High	Very High
Client's perception of risk	☐	☐	☐	☐	☐
Client's level of awareness	☐	☐	☐	☐	☐
Landlord consensus on energy efficiency	☐	☐	☐	☐	☐

APPENDIX B: SMARTPLS 4 MODEL

Below Figure B.1 illustrates the SmartPLS 4 Model used in the study, highlighting the relationships between Market-Related Factors, Technical Factors, Legal and Political Factors, Financial Factors, Client Characteristics, and ESCO Market Development.

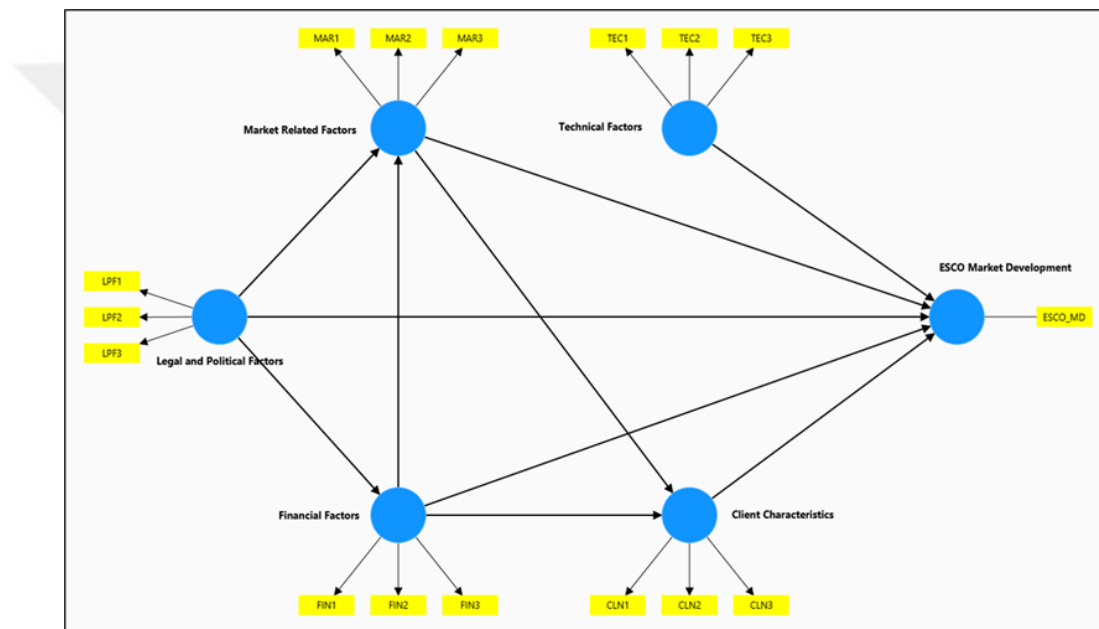


Figure B.1. SmartPLS 4 model.