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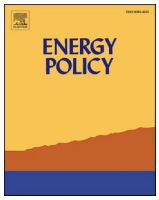

Switching on ESCOs: Barriers, challenges and opportunities for the development of Australia's ESCO market

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ABSTRACT

Energy service companies (ESCOs) are key players in reducing energy consumption for businesses, recognized globally by the International Energy Agency for their role in promoting energy efficiency. Despite this, the Australian ESCO market remains in its nascent stages. This study aims to gain an understanding of barriers hindering the development of the ESCO market, along with potential actions to support the development of the ESCO market. This study examined previous literature and conducted 54 interviews with operators in the ESCO market and final users within Australia to identify the barriers and drivers to support ESCOs. The study highlights that the main barriers to ESCO market development stem from a lack of trust, complex business models, and lack of information on costs and benefits. However, these challenges can be addressed through drivers like ESCO project investment funds, tax incentives, and performance-based energy contracts, which enhance both financial viability and trust. This study concludes with key policy recommendations to strengthen the ESCO market: developing mechanisms for strategic factor allocation, establishing an accreditation system to enhance market credibility, and prioritizing capacity-building initiatives for long-term sustainability.

1. Introduction

Climate change, driven by CO_2 emissions presents a serious threat, and energy efficiency, often called the "first fuel," is a critical solution to deal with the anthropogonic emissions (Ding et al., 2024). Yet, despite its crucial role in addressing this crisis, its adoption remains low, contributing to what is termed the "*energy efficiency gap*" (Backlund et al., 2012). Energy Service Companies (ESCOs) play a pivotal role in advancing global energy efficiency agendas by offering services designed to reduce energy consumption for businesses (Kindström and Ottosson, 2016). ESCOs offer a broad range of services spanning from energy analysis & audits, energy management, project design & implementation, maintenance and operation, monitoring and evaluation of savings, property management, energy & equipment supply, conducting energy audits, retrofitting, and executing performance contracts to integrating renewable energy solutions (Bertoldi et al., 2006), (Vine et al., 1999).

Furthermore, combining technical expertise with financial solutions, ESCOs act as potent facilitators capable of assuming financial risks and delivering tangible benefits that accelerate the implementation of energy-saving initiatives (Sorrell, 2007). Globally recognized by the International Energy Agency (IEA), ESCOs are essential contributors to promoting energy efficiency and hold significant potential to contribute towards achieving United Nations Sustainable Development Goal 7, which aims to ensure universal access to affordable, reliable, sustainable, and modern energy for all (IEA, 2024). Beyond achieving energy savings, ESCOs provide multiple benefits such as enhanced productivity, competitiveness, and sustainability (Bertoldi et al., 2006).

In scientific literature, scholars have explored various facets of ESCOs. For instance, Fang et al. discussed the impact of ESCOs on energy consumption (Fang et al., 2012). Hannan et al. provided insights into the ESCO model, highlighting several characteristics (Hannon and Bolton, 2015). Stuart et al. underscored the market potential of the ESCOs in the United States (Stuart et al., 2014). More recently, Qiu et al. delved into the technological capabilities of ESCOs in China (Qiu et al., 2022). Similarly, several studies have focused on European Union (EU) countries, in particular, Bertoldi et al. (2006), and Moles-Grueso et al. (2023) argued about the ESCO status and energy performance contracting in EU countries. Similarly, Suhonen and Okkonen analysed ESCO business models within the context of Finland (Suhonen and Okkonen, 2013). However, these studies primarily focused on business models and operational characteristics, often within specific geographical contexts,

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which have limited insights into ESCOs. Furthermore, the studies have largely overlooked at looking at barriers and drivers to support ESCOs in the countries.

Interestingly, studies have also looked into characterizing industrial energy services. For example, Cagno et al. argued about the characterization of energy services, focusing on their operational definitions and frameworks (Cagno et al., 2022). Hasan et al. also highlighted characterization of energy services, nonetheless particularly emphasizing their impact on production resources (Hasan et al., 2022). However, these studies often overlook the perspective of ESCOs, thereby neglecting crucial insights into the adoption barriers and drivers specific to ESCOs providing their services in industry. In contrast, Nurcahyanto et al. discussed the opportunities and challenges facing ESCOs in Indonesia (Nurcahyanto et al., 2020). Gan Da-li examined barriers to ESCO implementation and proposed mitigation strategies (Da-li, 2009). Moreover, studies have delved into barriers specific to ESCOs within industries such as steel (Hasan et al., 2018), textiles (Hasan et al., 2019a), and small and medium enterprises (SMEs) in developing countries (Hasan et al., 2019b). However, these investigations tend to be narrowly focused on particular sectors, lacking a holistic view that encompasses broader ESCO frameworks. Furthermore, the literature has predominantly discussed ESCOs in the context of energy efficiency, rather than explicitly exploring the broader activities of ESCO and linking distinct challenges and opportunities associated with ESCO business models.

Australia lags significantly behind other major developed economies in terms of energy efficiency, ranking 18th out of 25 in the American Council for an Energy Efficient Economy (ACEEE) Energy Efficiency Scorecard (International Energy Efficiency Scorecard, 2022). In fact, Australia's market remains at its infant nascent, without a set of formalised stakeholders, and struggling to fully leverage its potential to drive energy efficiency, decarbonization, and sustainability. The consequences of this lag are stark: missed opportunities to reduce greenhouse gas emissions and deliver substantial economic benefits. For example, to meet its targeted 40% productivity increase by 2030, Australia needs to achieve an efficiency improvement rate of approximately 2.3% per year from 2015 to 2030. Under a net-zero pathway, as outlined in the IEA's global net-zero roadmap, which calls for an average 4.2% efficiency improvement annually from 2020 to 2030, Australia could achieve a 57% increase in productivity over the same period. Furthermore, the 53% improvement mentioned in the National Greenhouse Gas Inventory aligns more closely with global requirements for achieving net-zero emissions (IEA, 2023). Achieving these targets will require accelerated action, with intensified industry efforts, policies, and programs to drive performance in line with global net-zero emissions goals. In this context, the ESCO sector could be highly instrumental, offering a powerful solution to enhance energy efficiency, accelerate decarbonization, and unlock significant economic opportunities (DCCEEW, 2024). By scaling up ESCO-related initiatives, Australia can better position itself in the global energy transition while driving both environmental and economic benefits (Accenture, 2022).

Given the initial background, this study aims to investigate the followings.

- Identify the major barriers hindering the growth and maturity of the ESCO market in Australia.
- Identify the key drivers to overcome these barriers and ensure the effective deployment of ESCOs in Australia.
- Highlight policy recommendations to accelerate its growth and effectiveness in Australia.

In defining the scope, this study has focused on capturing the challenges and opportunities across both the commercial and industrial sectors, without targeting any specific domain. The novelty of this research lies in its in-depth analysis of the complex interrelationships between the barriers and drivers of ESCO market development, with specific reference to services offered to industrial end-users. Unlike previous studies that often treat these barriers in a generic or isolated manner for other countries, this study delves into their intricate nature, examining the correlations and interactions among them. In fact, such a thorough and nuanced approach is especially critical in markets where the ESCO sector remains relatively immature. By offering fresh insights from multiple perspectives, this research highlights the importance of considering these factors holistically, providing a more comprehensive understanding of the challenges and opportunities within Australia's ESCO market.

In the broader academic discussion, this study contributes by critically examining the underdeveloped market of energy services in Australia, offering transformative insights to guide researchers and policymakers in reshaping and advancing the sector. The Australian ESCO market's stagnation is not just a missed opportunity—it underscores a broader perspective to harness energy efficiency as a cornerstone of industrial decarbonization. By analysing the factors that either drive or obstruct the adoption of energy services, this research aims at exploring and pointing out suggestions and recommendations to stakeholders, designed to overcome systemic barriers and catalyse meaningful market growth. Besides, other countries which have an underdeveloped industrial ESCO market could benefit from the findings and major considerations of this study. In fact, by framing the insights within the context of a struggling market, the study offers a nuanced understanding of how similar barriers can be dismantled in other underperforming markets. As such, the research serves as both a catalyst for Australia's industrial energy transition and a global reference point for advancing energy efficiency and decarbonization strategies.

The paper is organized as follows: Section 2 discusses the state of the art comprising business models of ESCO, accreditation experience of ESCO, current status of ESCO, and barriers and drivers to ESCO. Research methods are presented in Section 3, followed by results in Section 4. Discussion is presented in Section 5, leaving conclusions and suggestions for further research in Section 6.

2. Literature background

2.1. Business models of ESCO

There are traditional business models (e.g. shared savings contract model, guaranteed savings contract model, Chauffage) and emerging business models (e.g. energy-as-a-service, outcome-as-a-service, innovative asset financing) (Accenture, 2022). The following section briefly discuss the business models, summarised in 'Supplementary material A' section.

2.1.1. Traditional business models

The *shared savings* model is a collaborative strategy where ESCOs cover the upfront costs of energy efficiency upgrades, and clients repay them from the achieved energy savings over a specified period. This arrangement allows clients to enhance efficiency without upfront expenses while incentivizing ESCOs to maximize savings, aligning interests for mutual benefit (Sorrell, 2007). In contrast, *guaranteed savings* contracts involve ESCOs committing to deliver specified energy savings through efficiency measures, assuming financial risk to assure clients of effective solutions. ESCOs guarantee to cover any shortfall in savings, aligning interests but risking financial losses if savings targets are missed (IEA, 2024). Similarly, *Chauffage* contracts are energy service agreements where ESCOs provide specified energy services like heating and lighting, managing fuel and electricity procurement. Clients pay based on energy bill savings, with shared or guaranteed savings elements to incentivize efficiency gains. Chauffage is more commonly used in residential settings due to simpler systems and smaller scale, though applicable to both industrial and residential sectors.

2.1.2. Emerging business models

The *energy-as-a-service* (EaaS) model is gaining popularity for efficient energy management, expanding ESCOs' traditional roles to offer comprehensive end-to-end solutions. This includes energy supply, management systems, renewable integration, demand response, and energy monitoring. EaaS promotes continuous efficiency improvements through advanced technologies and ongoing data analysis. Targeting commercial and industrial customers, EaaS models offer turnkey solutions with ongoing charges, avoiding upfront costs for financing, installation, and management of energy assets. Originating from energy performance savings contracts, EaaS ensures specific energy savings for a fee, allowing ESCOs to retain or pass on the savings to customers.

Similarly, heating, cooling and lighting as a service exemplify the single *outcome-as-a-service* (OaaS) approach in commercial and industrial sectors. These models offer cost-free installation or upgrades to energy-efficient heating and lighting systems, followed by ongoing service for a fee to ensure consistent operation. In contrast, innovative commercial models are being used in residential, commercial and industrial sectors to reduce the upfront costs of on-site energy assets, such as solar or EV charging infrastructure leasing or providing the benefits of

Table 1
Synopsis of the selected studies related to ESCOs.

Author and year	Study area	Country	Findings	Remark	References
Vine et al., 1998	ESCO business opportunities are discussed.	Japan	Financing for ESCOs is identified as major barrier; different drivers are identified including educating concern stakeholders about ESCOs, financing mechanism, standardization of contracts, ESCO demonstration project, ESCO certification.	Focus on financial aspects mainly; barriers are not considered broadly	Vine et al. (1998)
Goldman et al., 2002	Discusses the market report focusing mainly energy efficiency	USA	Financial drivers including incentives, promoting performance contract are highlighted.	Barriers and drivers are not comprehensive discussed.	Goldman et al. (2002)
Painuly et al., 2003	Financing ESCOs are discussed.	South Korea	In adequate access to appropriate financing mechanisms is one of the key barriers.	Lack of focus on drivers to ESCOs.	Painuly et al. (2003)
Lee et al., 2003	ESCO business in Korea is discussed	South Korea	Highlights the role of public sector to create ESCO market; emphasises on the capacity building for local ESCOs as a driver.	Lack of detailed focus at barriers and drivers	Lee et al. (2003)
Murakoshi and Nakagami, 2009	Focuses on ESCO market situation and development programs	Japan, China, Thailand, India, the Philippines.	Identifies skill development, public awareness campaign, financial support as major drivers.	Limited focus at broader perspective of ESCO services; barriers are not discussed comprehensively.	Murakoshi and Nakagami (2009)
Vine, 2005	Key sectors targeted by ESCOs; major barriers are identified.	38 countries (e.g. Brazil, Egypt, Kenya, South Africa)	Financial barriers, lack of policy, perception of risk, information barrier, lack of expertise, and lack of trust to ESCOs are identified as major barriers.	Very little focus on the drivers.	Vine (2005)
Akman et al., 2013	Financial facts are mostly highlighted of ESCOs.	Turkey	Financial investment as a major driver.	Inadequate focus on technical and policy barriers and drivers.	Akman et al. (2013)
Bertoldi and Boza-Kiss, 2017	ESCO characteristics are highlighted linking with market size, market volume, structure.	EU countries	ESCO markets were driven by market forces as much as by dedicated policy measures; drivers are similar in many countries; leading barriers are diverse.	Barriers and drivers are thematically studied.	Bertoldi and Boza-Kiss (2017)
Panev et al., 2014	ESCO market report for non-EU countries	China, India, Japan, Singapore, Vietnam, Thailand, Egypt, Iran, Lebanon, Canada, Argentina etc.	Diverse array of barriers and drivers are identified including financial, technical, policy, and market.	Barriers and drivers are discussed very generically without deeper analysis.	Panev et al. (2014)
Pätäri et al., 2014	Enabling and hindering factors to ESCO	Finland	Financial situation and high transaction costs are seen as major challenges; information sharing is seen as a major driver.	Lack of deeper analysis of the barriers and drivers.	Pätäri et al. (2016)
Roshchanka and Evans, 2016	Energy performance contracts are highlighted.	Russian Federation	High risk and transaction cost are major barriers; policy mechanism is identified as a key driver.	Barriers and drivers are not discussed comprehensively.	Roshchanka and Evans (2016)
Kindström et al., 2017	ESCO implementation phases are highlighted.	Sweden	Major barriers are intra-organizational issues, lack of knowledge, and lack of trust on ESCOs; key drivers include increased customer demand, top management strategic direction, and financial benefits; policy implications are discussed.	Lack of detailed analysis of the barriers and drivers.	Kindström et al. (2017)
Hasan et al., 2021a, b	Study is focused on energy management practices in the energy intensive industries.	Bangladesh	Key barriers include lack of information about ESCOs, and high payment for service.	Very little discussion about ESCO drivers.	Hasan et al. (2021a)
Peñate-Valentín et al., 2021	ESCO business models discussed through public procurement.	Spain	Major barriers include inadequate funding, lack of resources & capabilities, and lack of information.	Limited focus on the drivers to ESCOs.	Peñate-Valentín et al. (2021)
Siddique et al., 2022	ESCOs are discussed with specific focus to paper industries.	Bangladesh	Lack of standardized procedure and high fees of services are identified as top barriers.	Barriers are discussed without detailed analysis; very little focus on drivers.	Siddique et al. (2022)

on-site assets virtually through a virtual power plant (VPP) model by aggregating and managing distributed energy resources (DER) to provide grid services.

2.2. Barriers and drivers to ESCOs

This section discusses the existing studies highlighting ESCOs and their associated barriers and drivers. Table 1 presents a summary of these existing studies.

In the domain of ESCO, studies have mostly focused on the current status and market potential of ESCO. For instance, Vine et al. argued about the evolution of ESCO industry for USA (Vine et al., 1999). Stuart et al. discussed the market potential of ESCO in USA (Stuart et al., 2014). Carvallo et al. highlighted the investment trend of ESCO (Carvallo et al., 2019). Similarly, Qiu et al. argued about the technical capabilities model for Chinese ESCOs (Qiu et al., 2022). Studies have also looked at ESCOs and their nexus with energy conservation (Kostka and Shin, 2013), and industrialization and urbanization (Zheng et al., 2021). In contrast, Recalde argued about the barriers to ESCOs with specific focus to country specific conditions (Recalde, 2020). However, these studies have largely overlooked the categorical barriers and drivers to support ESCO. Furthermore, the intricate dynamics and contextual factors that influence the drivers and barriers of remain underexplored.

Upon reviewing the existing literature on the barriers and drivers to ESCOs, several critical observations emerge that warrant further discussion and investigation. For instance, most studies of ESCOs predominantly focus on developed economies where the concept of ESCOs is matured. However, the same cannot be said for Australia. Despite being a developed economy, the concept of ESCOs is still not firmly established. Given Australia's distinct energy landscape, and market structure, it is imperative to conduct targeted research that can provide actionable insights for stakeholders in the region.

Moreover, while much of the current research focuses on ESCO business opportunities and their link to financing mechanisms, it largely treats barriers in a simplistic, generalized way. This narrow approach fails to capture the specific challenges ESCOs face, limiting the relevance of these studies for practitioners and policymakers seeking real, actionable solutions. Given the complex and interdependent nature of barriers and drivers, it is not enough to rely on basic statistical values. A more in-depth examination is required to reveal how these factors influence one another—understanding which barriers hinder specific drivers and how these relationships shape energy efficiency and decarbonization efforts. Without this deeper analysis, any strategy will remain insufficient to address the nuanced realities ESCOs confront to broader domain of industrial decarbonization initiatives.

In summary, although existing studies offer a foundational understanding of the barriers and drivers to ESCOs, they fall short in several critical areas, thereby limiting their relevance and applicability. This study addresses a critical gap not only in the maturity of the ESCO market but also in the broader realm of energy efficiency and decarbonization, both of which are falling significantly short of global targets. By analysing barriers and drivers together and examining their correlations, this research offers a novel perspective on the intricate challenges of ESCOs. In fact, given the complexity of these barriers and drivers, the use of correlation and multivariate analysis provides a more holistic understanding of how these factors interconnect. Traditional methods often overlook these interactions; however, this approach strengthens the analysis, providing deeper insights into how to effectively support ESCOs in their efforts to promote energy efficiency and drive industrial decarbonization initiatives.

3. Research methods

The methodological framework of this study consists of a literature review, followed by the identification and listing of barriers and drivers to ESCOs, data collection, data analysis, and finally, the presentation of results. Fig. 1 illustrates the methodological framework of this study.

3.1. Research design

This study adopted case study research approach to investigate the factors hindering the growth of the ESCO market in Australia and identify strategies to support its development. Case study research is particularly suitable for in-depth examination of complex phenomena within real-life contexts (Yin, 2009). In fact, given the unique combination of regulatory, financial, and technological factors at play, a case study approach enables a comprehensive exploration of these issues within the specific Australian context (Eisenhardt, 1989). Furthermore, case studies provide the flexibility to examine multiple perspectives from key stakeholders, offering a more holistic understanding of the barriers and drivers to ESCO market growth. This approach also aligns with established practices in energy service research, where case studies are frequently used to investigate multifaceted, context-specific challenges and generate actionable insights (Hasan et al., 2021a), (Tulkens et al., 2023), (Nascimento et al., 2023).

3.2. Literature review

The first phase of the study revolved around a thorough literature review about ESCO which was specifically designed to foster an understanding of various dimensions within the ESCO domain. The literature review covered an extensive array of topics, including business models, barriers to ESCOs, and drivers to support ESCOs. The overview of barriers and drivers to ESCOs are presented in Table 2. The review covered a diversified range of sources, including scientific databases including Scopus & Web of Science, and industrial and policy reports. The emphasis extended beyond regions where ESCOs have established a robust presence, encompassing countries where the ESCO market is in its early stages of expansion.

3.3. Data collection

In this study, we examine the factors influencing the uptake of ESCOs within the Australian market, focusing specifically on the industrial manufacturing sector. The rationale behind selecting Australian manufacturing companies as case studies lies in their substantial energy consumption footprint and their potential as key adopters of energy efficiency technologies and services (Australian Bureau of Statistics, 2022). The selection criteria for interviewees were methodically structured around two major cohorts. Firstly, experts affiliated with entities specializing in delivering energy services to industrial and commercial consumers. Second, experts affiliated with major commercial and industrial enterprises possessing firsthand experience in implementing energy service solutions. The empirical investigation involved conducting a meticulously planned series of 54 in-depth interviews (see 'Supplementary material B' about the interviews). Fig. 2 presents the major statistical information about the interviewees.

In terms of data collection, the study engaged with a diverse range of companies without being confined to specific industrial sectors. While the primary focus was on industries in Australia, achieving a balanced representation of stakeholders was not the objective. Although a diverse range of stakeholders was approached, the number of industrial manufacturing companies among the respondents was higher than that of commercial entities. This distribution aligns with the broader industrial reality in Australia (Jobs and Skills, 2025). Furthermore, the sectoral distribution of participants among the final users emerged organically, considering that Australia's industrial manufacturing activity is clustered in specific sectors, with the food and beverage sector being one of the dominant manufacturing industries (DEWR, 2025), (Energy, 2022).

Given the exploratory nature of this research, the data collection focuses on conducting in-depth interviews with experts in the Australian

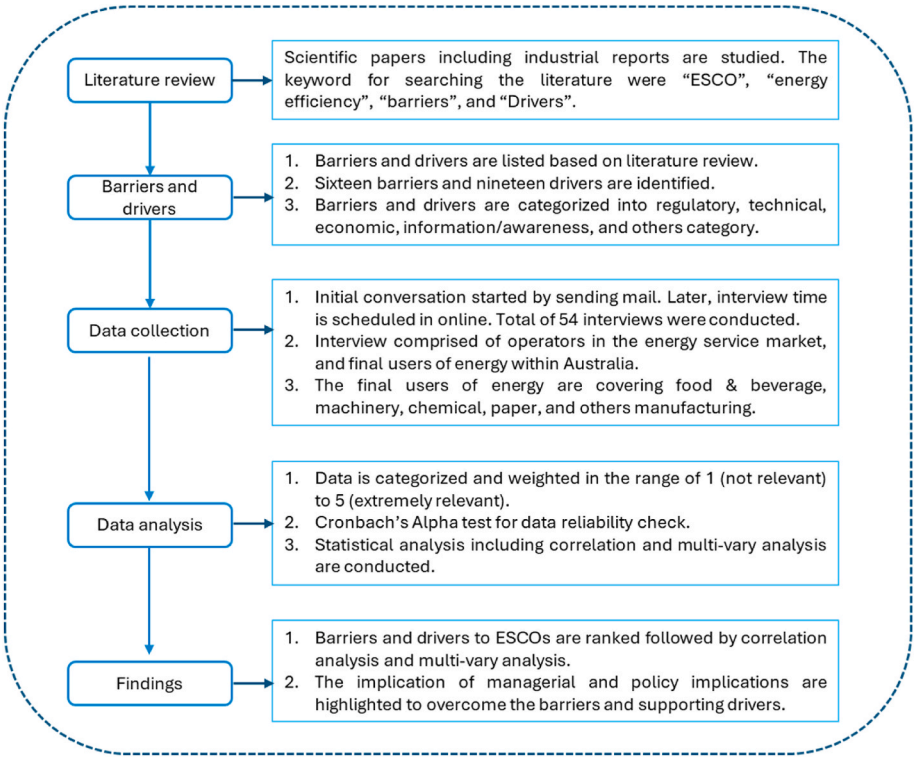

Fig. 1. Methodological framework of the study.

energy services market to gain a comprehensive understanding of the major barriers hindering the development of a well-functioning energy services market. Consequently, the emphasis is not on the statistical generalizability of the findings, rather on extracting valuable insights and formulating potential policy recommendations for an emerging market. While we acknowledge the importance of a larger sample size, it is important to note that similar sample sizes have been successfully employed in energy management and service-related studies by other scholars (Roshchanka and Evans, 2016), (Hannon et al., 2015), (Baek and Bhamra, 2022; Okay and Akman, 2010), demonstrating their effectiveness in addressing the research objectives.

For the data collection, invitations were formally extended via email subsequent to initial phone contact, ensuring purposeful outreach. Following this, an informed consent form provided detailed information on the anonymization of all identifiable data and adherence to a strict confidentiality protocol. Each interview, averaging 1 h in duration, was structured to achieve diverse objectives, specifically focusing on detailed perceptions of ESCOs within the Australian context. This systematic approach facilitated a detailed exploration of critical viewpoints, thereby helping to collect substantive contributions from interview participants (Yin, 2009).

The initial segment of the semi-structured interviews centred on identifying barriers that impede ESCO adoption in Australia. Drawing on the rich experiences of the interviewees, including insights from those with international ESCO collaborations, this study categorized barriers identified in existing literature into distinct groups: regulatory, technical, economic, and informational/awareness. Participants were actively engaged in ranking the relevance of these barriers on a scale ranging from 1 (not relevant) to 5 (Extremely relevant). Subsequently, the focus shifted to actionable strategies derived from existing literature aimed at promoting ESCO growth in Australia. Following the initial round of discussion over drivers, a consolidated list of these strategies was distributed to participants for ranking and prioritization.

To ensure the accuracy and consistency of the interview records, the study employed a structured coding process to categorize responses uniformly across all interviews. This approach minimized subjective interpretation and maintained the reliability and validity of the data. In cases where responses were unclear or ambiguous, the research team contacted interviewees following up with additional requests of clarification, ensuring the accurate capture of their intent and preventing misinterpretation. Additionally, a standardized interview protocol was followed, providing clear instructions and consistent questioning techniques to further ensure uniformity across all interviews. Any discrepancies in responses were carefully addressed through follow-up clarifications, safeguarding the integrity of the data and minimizing potential bias.

3.4. Data analysis

The third phase involved the analysis of the feedback received from the interviews and the consolidation of the findings. In doing that this study employs a thematic analysis approach (Braun and Clarke, 2006). To familiarise themselves with the data, the researchers transcribed the recorded interviews in the first instance, which allowed them to develop initial thoughts of their own. This process involved condensing extensive information into pertinent quotes or paragraphs aligned with the research themes. Subsequently, a rigorous examination of barriers and drivers ensued, ensuring alignment with the study's goals and objectives, and grounding them in pertinent literature. This process involved a detailed review and synthesis of existing research to provide a comprehensive context for the analysis. To assess the reliability of the respondents' answers, a Cronbach's alpha test was conducted. The reliability result was 0.712. This statistical measure assesses the internal consistency of a dataset. A Cronbach's alpha value of 0.70 or higher is generally considered acceptable for reliable data (Cortina, 1993).

Whilst the exploratory nature of the research is acknowledged, to effectively identify and understand the major barriers and drivers in the data, a combination of statistical techniques was employed, including statistical means, correlation analysis, and multivariate analysis. The use of statistical means, such as averages and measures of frequency, provided a quantitative overview of the data, offering insights into general trends and the spread of responses (Hu et al., 2019). However,

Table 2
Overview of barriers and drivers to ESCOs.

Category	Barriers and notations	Remark	Drivers and notation	Remark
Regulatory	Lack of legal framework to support ESCO activities (B1)	Insufficient or absent laws and regulations that facilitate and govern the operations of ESCOs (Lütken, 2022).	Performance-based energy contracts framework (D1)	Agreements where payment and terms are directly tied to the energy performance improvements achieved, incentivizing efficiency and cost savings (Sorrell, 2007), (Liu et al., 2023).
	Unclear mechanism in licensing and accreditation Requirements (B2)	Lack of well-defined processes & criteria for obtaining licenses and accreditation (Lütken, 2022).	ESCO accreditation program (D2)	A certification process that validates companies' capabilities to provide effective energy efficiency services, ensuring they meet established industry standards and performance criteria (Carvallo et al., 2019), (Lütken, 2022).
			Regulatory compliance assistance (D3)	Support services that help organizations understand and adhere to relevant laws, regulations, and standards within their industry to avoid legal penalties and ensure operational integrity (Lütken, 2022).
			Energy efficiency policy alignment (D4)	The process of harmonizing organizational practices and strategies with governmental and industry regulations and goals aimed at enhancing efficiency (Akman et al., 2013), (Lütken, 2022).
			Government-led ESCO initiatives (D5)	Refer to programs and policies implemented by governments to promote and support ESCO in delivering energy efficiency projects and services (Hannon et al., 2015).
Technical	Lack of knowledge and expertise (B3)	Insufficient level of understanding and skill in a particular field, which can impede effective decision-making, performance, and problem-solving (Hasan et al., 2019a), (Trianni et al., 2016).	ESCO training and certification programs (D6)	Educational and credentialing initiatives designed to equip individuals and organizations with the necessary skills, and qualifications to deliver energy efficiency services effectively (Bertoldi and Boza-Kiss, 2017).
	Technologies and energy services are not adequate (B4)	Available technologies and energy-related services are insufficient or outdated, failing to meet current needs and standards effectively (Hasan et al., 2019b).	Technical assistance platforms (D7)	Resources and services that provide expert guidance, tools, and support to help organizations and individuals solve technical problems, implement best practices (Qiu et al., 2022).
	Technologies and energy services are not available (B5)	Necessary technologies and energy-related services are not accessible or provided (Siddique et al., 2022), (Hannon et al., 2013).	Research and development (R&D) collaborations (D8)	Partnerships between organizations, institutions, or companies to jointly conduct research and innovate, aiming to develop new technologies, products, or processes (Qiu et al., 2022).
Economic	Competition with investment subsidies (B6)	The challenge businesses face when they have to compete against others that receive financial support or incentives from the government (Hasan et al., 2018), (Brunke et al., 2014).	ESCO project investment funds (D9)	Financial resources allocated specifically for supporting and financing energy efficiency projects undertaken by ESCOs (Painuly et al., 2003), (Lee et al., 2003).
	Limitations or difficulties in combining grants with EnPC or its off-balance options (B7)	Challenges in integrating financial grants with Energy Performance Contracts (EnPC) or related accounting methods, which can complicate funding and financial management (Bertoldi et al., 2006).	Guarantee schemes for ESCO projects (D10)	Financial mechanisms that ensure energy savings or performance targets are achieved in energy service contracts, providing assurance and reducing risk for investors and stakeholders (Sorrell, 2007), (Nurcahyanto et al., 2020).
	Complexity of the business model (B8)	The structure and operations of the business are intricate and difficult to understand or manage, which can pose challenges for implementation and scalability (Qiu et al., 2022), (Panev et al., 2014).	ESCO performance-based financing programs (D11)	Funding arrangements where payments are tied to the actual energy savings or performance improvements achieved by an ESCO (Sorrell, 2007), (Zheng et al., 2024), (Zhang et al., 2020).
	Subsidized energy prices, market size (B9)	Refers to the government-supported lower energy prices on the size and dynamics of the energy market, potentially discouraging investment in energy efficiency and alternative energy solutions due to distorted market signals (Sorrell, 2007), (Moles-Grueso et al., 2023).	Tax incentives and rebates (D12)	Financial benefits offered by governments to reduce the cost of investments in energy efficiency by lowering tax liabilities or providing direct cash returns (Painuly et al., 2003).
	Lack of affordable financing (B10)	Refers to a situation where individuals or businesses cannot access loans or credit at reasonable interest rates, making it difficult to fund essential activities or investments (Hossain et al., 2020).	Public-private partnerships (D13)	Collaborative arrangements between government entities and private companies to finance, build, and operate projects or services, combining public oversight with private sector expertise and investment (Bertoldi and Boza-Kiss, 2017).
			Green bonds (D14)	Financial instruments specifically used to fund projects with positive environmental impacts (Zhang et al., 2020).
Information/ awareness	Lack of information on costs and benefit (B11)	Inadequate data or understanding about the financial implications and advantages of a decision or investment (Bertoldi et al., 2006), (Bertoldi and Boza-Kiss, 2017).	Energy efficiency benchmarking platform (D15)	Tool or system that compares and evaluates the energy performance of facilities, or systems against industry standards or peer performance, helping identify areas for improvement and track progress (Lee et al., 2003), (Zheng et al., 2024).

(*continued on next page*)

Table 2 (*continued*)

Category	Barriers and notations	Remark	Drivers and notation	Remark
	Lack of trust in ESCO (B12)	Skepticism or doubt about the reliability and integrity of ESCOs that provide energy solutions (Vine, 2005), (Lütken, 2022), (Baek and Bhamra, 2022).	ESCO information portal/database (D16)	A centralized online resource that provides detailed information about ESCOs, including their services, performance data, case studies, and contact information (Goldman et al., 2002).
	Lack of trust in business models (B13)	Refers to doubts about the reliability of a company's approach to managing operations and generating revenue (Vine et al., 1998).	Energy efficiency showcase events (D17)	Exhibitions or conferences that highlight successful energy-saving technologies, practices, and projects, providing a platform for sharing best practices, and networking (Bertoldi and Boza-Kiss, 2017).
	Lack of awareness on energy efficiency and decarbonization (B14)	Insufficient understanding or knowledge about strategies and practices that reduce energy consumption and carbon emissions (Lütken, 2022).	ESCO support agencies (D18)	Organizations that provide assistance and resources to ESCOs, including guidance on project development, financing, regulatory compliance, and technical expertise (Okay and Akman, 2010).
			ESCO network or association (D19)	A professional organization that connects ESCOs, industry experts, and stakeholders to share knowledge, best practices, and resources, and to advocate for policies that promote energy efficiency (Bertoldi and Boza-Kiss, 2017).
Other	Other prioritised action/ activities (B15)	Refer to tasks that are deemed more important or urgent compared to others (Nurcahyanto et al., 2020), (Kindström et al., 2017).		

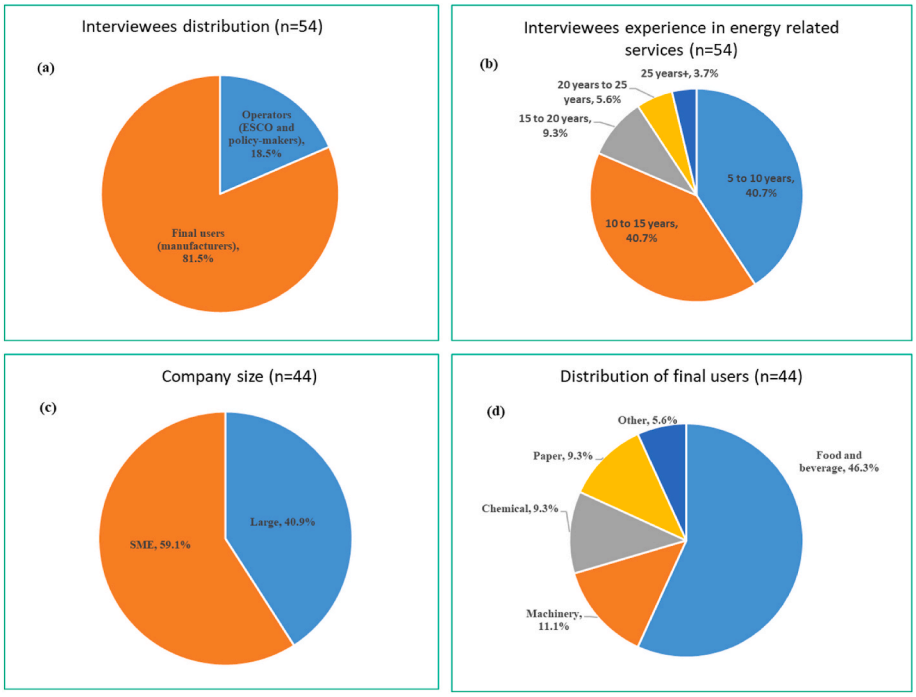

Fig. 2. Descriptive statistics comprising (a) interviewee distribution; (b) interviewee experience in energy related services; (c) company size of final users; (d) distribution of final users.

the preliminary statistics have been corroborated and integrated with extensive comments and insights from the interviews, offering a deeper understanding and enriching the corpus of findings (Leung, 2015). Furthermore, to explore the relationships between different drivers and barriers in more depth, statistical correlation was conducted, which allowed for the identification of significant associations between variables. Additionally, multivariate analysis was used to examine the interplay between multiple variables simultaneously. This approach is justified as it allows the researchers to control for confounding factors and better understand the combined impact of various drivers and barriers (More and Wolkersdorfer, 2024). The final phase encompassed presenting critical barriers to ESCOs in Australia and outlining the drivers to support their growth based on the statistical analysis.

4. Results and findings

4.1. Barriers to ESCOs

4.1.1. Analysis of barriers by average value

When delving into the barriers to ESCOs, it becomes evident that these challenges are multifaceted. Fig. 3 presents the barriers to ESCOs. The results indicate that the primary barriers include "*Lack of trust*", "*Complexity of the business model*", "*Lack of trust in business models*", "*Lack of information on costs and benefits*", and "*Lack of trust in business models*". Furthermore, other significant barriers include "*Other priority actions*", "*Lack of interest in energy efficiency*," and "*Lack of Legal Framework to* Support *ESCO*". The top ranked barriers are discussed in the following section.

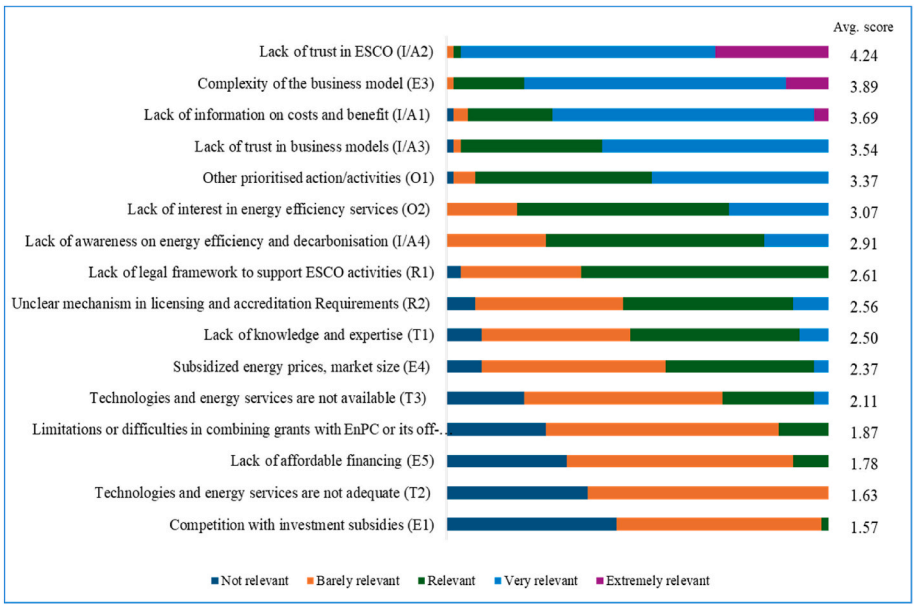

Fig. 3. Barriers to ESCO (average value and frequency of responses).

4.1.1.1. Lack of trust in ESCO. This investigation provided clear markers of one prevalent issue that emerged with stark clarity: lack of trust in ESCO. Interviewees consistently highlighted this issue, citing uncertainties surrounding ESCO credibility, reliability and transparency as key deterrents to potential stakeholders embracing energy performance contracting. This hesitancy is often rooted in past experiences with unreliable contractors or concerns about hidden costs and unclear guarantees. The case firm from the energy final users emphasised this issue in the quote below:

> *' … Lack of trust in ESCOs is a prevailing issue in Australia. This skepticism can be attributed to instances where energy performance contracts have gone awry, resulting in disputes overachieved savings.'* (C5- Food and beverage company; Sustainable Technologies Manager)

Now, further highlighting the issue of lack of trust towards ESCO and integrating ESCOs into core operations, a few other concerns have emerged. The apprehension primarily revolves around the aversion to taking risks. Even if ESCOs offer valuable services, companies hesitate to introduce potential disruptions to their production processes. This fear acts as a major deterrent, with companies preferring to maintain control, allowing them to promptly address any issues without relying on external entities. This cautious approach is particularly pronounced for companies situated in remote areas, where the scarcity of experienced personnel compounds the challenges. In this regard, respondents expressed to be open to collaborate with ESCOs, provided the activities do not significantly impact their core production processes. The willingness to work with ESCOs is contingent upon these entities avoiding interference with critical processes. One key industry interviewee expressed this clearly:

> *'We're all about keeping things in-house, especially when it comes to our core operations. Trusting ESCOs to handle our energy needs feels like stepping into a grey territory – we'd rather keep our production game strong without depending too much on externals.'* (C8- Chemical; Senior Manager)

4.1.1.2. Complexity of the business models. Another critical barrier emerged in this study is the 'complexity of the business model'. ESCO engagements often involve energy-saving measures, financial models, and technical aspects that may appear daunting to both service providers and clients. Most of the participants highlighted the length of the contracts as a significant aspect tied to the complexity of the business models. Interestingly, ESCOs for longer contracts, suggesting durations of at least seven to eight years (Sorrell, 2007). One of the interviewees from ESCO said:

> *'The reluctance of industries to commit to longer contract periods poses a challenge for us as service providers. While they seek flexibility, it becomes a hindrance to unlocking the full potential and benefits that come with extended partnerships.'* (C31- ESCO; Energy lead)

Contrastingly, final users express a distinct preference for shorter contract durations, often leaning towards periods of two to three years, and placed a high premium on flexibility within the contractual terms. The emphasis on shorter timeframes and adaptable agreements is driven by the desire for agility and responsiveness to changing needs or circumstances. Interviewee articulated this perspective, noting that:

> *'A 15/20-year contract for ESCOs requires board-level approval, making it a significant decision for the board to deliberate. Convincing arguments and compelling evidence would be essential to garner the necessary support for such a long-term commitment.'* (C13- food and beverage company; Director)

Furthermore, the struggle of companies with longer-term contracts relates to the substantial uncertainty surrounding the future of their businesses. The prevailing uncertainty about the future of manufacturing companies does not work in favour of ESCOs, as many companies are hesitant to enter into long-term commitments. An interviewee from final user expressed this concern, stating that, *"… if I don't even know if I'll be around in three to five years, how can I commit on long-term contracts?'* (C18- Packaging company; Manager).

Moreover, the innovative business models proposed by ESCOs (or supposedly so, as in other countries have been in place for years) may conflict with traditional business models in Australian industries. Respondents from final user's group highlighted in several instances along similar lines:

> *'We prefer to keep energy and machinery management in-house. Furthermore, their ability to simplify our complex operations, turn a profit, and beat our in-house efficiency remains uncertain'.* (C10- Paper manufacturing; Senior Engineer)

Additionally, even though the exploratory of this investigation and the limited sample size did not allow for very detailed and extensive

statistical analyses, we have analysed responses by cluster of respondents, i.e. operators in the ESCO market and end users, further divided in SMEs and LEs. Interestingly, yet somewhat expected, ESCOs highlighted a lower relevance of this barrier compared to end users, demonstrating how Australian sampled experts do not have much familiarity with the proposed business models of operators in the ESCO market. Considering that some of the operators in the market effectively have projects in more developed ESCO markets, this pattern seems to suggest that Australian ESCO market is far to be mature and represents a major opportunity for business model innovation.

4.1.1.3. Lack of information on cost and benefits. This study finds a substantial lack of awareness among many individuals regarding ESCOs and their portfolio of services. While large organizations belonging to international groups demonstrate familiarity with ESCOs—owing to their operations in markets where ESCOs are well-known players in the energy sector—the scenario shifts significantly when it comes to Australian-based companies, particularly medium and small-sized enterprises. Among these local entities, a notable lack of awareness persists. ESCOs often find themselves in the position of educators, taking on the responsibility of enlightening company managers about their role and the benefits they bring to the business. Several interviewees from ESCOs provided comments alike:

> *'Many companies in Australia are still in the dark about the breadth of services ESCOs offer. We often need to educate before discussing anything about the project.' (*C53- ESCO; Director*)*

This educational burden highlights a critical issue: the potential for energy savings and efficiency improvements through ESCOs is vastly underutilized due to this informational gap. The lack of awareness is not just a minor hurdle but a significant barrier to market penetration and the broader adoption of energy-saving measures. Australian medium and small-sized enterprises, which form a substantial part of the economy, are missing out on opportunities for cost savings and sustainability improvements due to this ignorance.

4.1.1.4. Lack of trust in business model. From the final user's perspective, there is a concern about the transparency of ESCO business models, wondering how external entities could deliver services efficiently and profitably when internal teams might handle tasks more cost-effectively. Such lack of clarity on the operational and financial aspects of ESCOs contributed to a general skepticism towards a fruitful collaboration with ESCOs. One interviewee from final user group remarked that, *'It's not clear how ESCOs can get the job done and still make a profit, especially when our internal teams can handle things at a lower cost.'* (C29- Food and beverage company; Operation Manager).

One important point to observe here is that the typical business models of ESCOs, which rely heavily on Energy Performance Contracts (EPCs), are often criticized for their complexity and inherent risks. These models require ESCOs to guarantee energy savings, placing them at financial risk if the anticipated savings are not realized. This uncertainty can be unsettling for both clients and service providers (Marino et al., 2011). Additionally, the long-term nature of these contracts, frequently extending over a decade, can be problematic as they may become outdated due to technological advancements or fluctuations in energy prices (Sorrell, 2007). Furthermore, the substantial capital investment needed for these projects often demands debt financing, which can be a significant obstacle, especially in uncertain economic climates. The upfront costs and extended payback periods frequently discourage potential clients from committing to ESCO contracts (Bertoldi and Boza-Kiss, 2017). The effectiveness of ESCOs also depends heavily on supportive regulatory frameworks and government incentives, which can be volatile and susceptible to political changes, adding another layer of uncertainty to the ESCO business model (Hannon et al., 2013).

Somewhat linked to the challenges around business model complexity, interviewed experts from SMEs expressed major concerns around trust towards the proposed business models of ESCOs. Even though the sample size does not allow for robust statistical analysis, this pattern could suggest that SMEs present a larger risk aversion and inertia to the proposed business models, similarly to what observed to previous research around barriers to energy efficiency (Trianni and Cagno, 2012).

4.1.1.5. Other prioritised actions over energy efficiency. 'Other prioritised actions' represents a significant barrier to the ESCOs. In numerous instances, potential clients and stakeholders may have competing priorities within their organizations, diverting attention and resources away from considering and adopting energy efficiency solutions offered by ESCOs. This barrier often emerges when decision-makers are confronted with other pressing issues, ranging from operational challenges to strategic initiatives. In the face of these competing priorities, the adoption of ESCO services may be deprioritised or overlooked. As industry participants noted:

> '*Energy ranks as the fifth or sixth input cost in our production, resulting in less emphasis on energy-related considerations within our overall operational focus.*' (C37- Machinery; Manager)

Moreover, the challenge posed by the 'lack of interest in energy efficiency' stands as another barrier to ESCOs. In certain instances, potential clients may not accord due priority to energy efficiency within the framework of their organizational objectives. This lack of enthusiasm is attributed to several factors, including a limited understanding of the potential benefits, the presence of competing priorities demanding immediate attention, or a perception that energy efficiency measures may not deliver substantial returns. Additionally, the contemporary emphasis on renewable energy has further diverted attention and resources. Consequently, when faced with the choice between investing in renewables or energy efficiency, management tends to lean towards renewable energy, compounding the challenges faced by ESCOs in gaining traction to energy efficiency. One interviewee from ESCOs commented:

> *'In today's projects, the spotlight is shifting toward renewables, where the 'decarb stamp' often carries more weight than traditional energy efficiency initiatives.'* (C31- ESCO; Energy Lead)

4.1.1.6. Lack of legal framework to support ESCO activities. In discussions with ESCO representatives, the challenges pertaining to contractual agreements and dispute resolution mechanisms surfaced as a noteworthy barrier. Notably, the integration mechanism of ESCOs into companies lacks clarity, posing uncertainties in navigating these partnerships. It was clearly stated:

> *'There are still uncertainties for ESCO integration within companies, particularly in navigating contractual complexities and ensuring legal frameworks align with the dynamic nature of energy services.'* (C46- ESCO; Head of Engineering)

Such issue could be likely attributable to a lack of legal frameworks to scope ESCO activities. Interviewees with visibility over the international ESCO market (belonging to either ESCOs or final users operating outside Australia) confirmed such major concern:

> *'In Australia, the absence or unclear mechanism poses a hurdle, leaving the ESCO community without a structured support system, unlike other countries (*e.g.*, EU countries) that have established frameworks.'* (C23- ESCO; Business Development Manager)

ESCOs, particularly those operating overseas, such as in France and the USA, highlighted the contrasting scenario in the European Union and the United States. In these regions, a well-defined framework delineates how ESCOs can operate and seamlessly integrate into businesses (Moles-Grueso et al., 2023), (Lütken, 2022). Government guidelines in

these areas provide crucial support for ESCOs, offering a structured approach to their activities. Moreover, some respondents referred to a lack of consistency in energy policies, without a clear and guaranteed commitment at different levels regarding the energy policy (state and federal), explicitly calling for a more coordinated effort to tackle such issues at the backbone of Australian industrial decarbonization.

4.1.2. Correlation analysis of the barriers

Table 3 presents the detailed correlation analysis of the barriers. The correlation analysis reveals that the barriers have overall low correlations. However, one notable finding emerges that warrant further discussion due to their potential implications on ESCOs. Particularly, the analysis reveals a noticeable correlation (0.708) between the lack of awareness on energy efficiency and decarbonization (B14) and the lack of interest in energy efficiency services (B16). This correlation between B14 and B16 highlights a direct consequence of limited public understanding and misinformation. In fact, this deficiency in knowledge is further exacerbated by misconceptions about the costs, complexities, and potential disruptions associated with implementing EEMs (Hasan et al., 2022), (Hasan et al., 2021b). As a result, individuals and organizations often fail to recognize the long-term benefits of EE, including substantial non-energy benefits (e.g. cost savings, reduced environmental impact, enhanced energy security) (Hasan and Trianni, 2020).

On the other hand, several low correlations exist. For instance, the low correlation (0.02) between "Limitations or difficulties in combining grants with EnPC or its off-balance options (B7)" and "Lack of awareness on energy efficiency and decarbonization (B14)" likely arises because these barriers address distinct challenges in energy efficiency initiatives. While B7 pertains to financial and institutional complexities in integrating grants with EnPC mechanisms, which are structural and policy-related, B14 reflects behavioural and informational gaps among stakeholders. Studies suggest that financial mechanisms like grants and off-balance-sheet options often require specialized expertise and institutional alignment, which may not directly intersect with the general lack of awareness about energy efficiency benefits and technologies (Bertoldi et al., 2006), (Vine, 2005).

Similarly, another low correlation (0.01) between "Unclear mechanisms in licensing and accreditation requirements (B2)" and "Technologies and energy services are not adequate (B4)" highlights the distinct nature of these barriers within the energy efficiency ecosystem. B2 pertains to regulatory and administrative uncertainties, which can create delays or inconsistencies in enabling businesses to operate within the energy efficiency market. In contrast, B4 reflects technical and operational challenges, such as the limited availability or performance of energy-efficient technologies and services. These two barriers likely operate independently, as regulatory clarity does not directly address technological inadequacies, and conversely, improving technology does not inherently resolve licensing challenges (Bertoldi and Boza-Kiss, 2017).

4.1.3. Multi-Variate analysis of the barriers

Fig. 4 shows the Multi-Variate analysis of the barriers. In the evaluation of each barrier, distinct trends become apparent, revealing critical gaps in stakeholder perceptions and knowledge. Notably, the range between the maximum and minimum values for B12 (lack of trust) is noticeable, suggesting a widespread consensus on this issue across diverse respondent groups, including end users, and operators in energy services market. This convergence is concerning, as it underscores a profound lack of trust that could hinder the adoption of energy efficiency initiatives (Nurcahyanto et al., 2020). Besides, the consistent identification of B8 (complexity of the business model) as a critical barrier highlights the inherent challenges in the ESCO market structure. The complexity arises from the multifaceted nature of the ESCO business model, which involves various stakeholders, financial arrangements, and long-term contractual commitments that may not be immediately apparent to potential clients (Moles-Grueso et al., 2023). This complexity can deter businesses from engaging with ESCOs, as the perceived difficulty in understanding or managing these intricate arrangements becomes a significant obstacle. In fact, the perceived complexity of the business model often leads to hesitancy in adoption, particularly in markets where stakeholders may lack the resources or capacity to navigate such structures (Suhonen and Okkonen, 2013).

Another notable observation is that B11 (lack of information on costs and benefit) exhibits a diverse range between its maximum and minimum values. Despite the potential for energy efficiency projects to yield significant savings and environmental benefits, the absence of transparent, accessible, and accurate information on the costs and benefits associated with these projects can prevent stakeholders from making informed decisions. This barrier is particularly evident in markets where energy efficiency is still an emerging concept, and the financial metrics related to such projects are often not well understood or communicated. As noted by Brown et al. this lack of clarity around financial outcomes can deter businesses from investing in energy efficiency solutions, as potential clients are unable to accurately assess the financial viability and long-term returns (Brown et al., 2022). Moreover, Bertoldi et al. argue that the absence of detailed cost-benefit analysis tools or standardized methodologies for calculating energy savings and operational costs further exacerbates the issue (Bertoldi et al., 2006). Furthermore, Sorrell et al. emphasize that, in addition to the initial capital cost of energy efficiency measures, stakeholders are often unaware of the full range of operational and maintenance savings that could be realized over time (Sorrell, 2007). This lack of comprehensive information can lead to a failure to capture the true value of energy efficiency investments.

Table 3
Statistical correlation analysis of the barriers.

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16
B1	1.00	0.46	0.24	0.29	0.41	0.07	0.29	0.09	0.18	0.24	0.11	0.23	0.20	0.41	0.04	0.28
B2	–	1.00	0.38	0.01	0.34	0.10	0.04	0.05	0.31	0.07	0.33	0.09	0.08	0.07	0.07	0.10
B3	–	–	1.00	0.05	0.19	0.02	0.10	0.24	0.62	0.12	0.51	0.11	0.48	0.28	0.04	0.29
B4	–	–	–	1.00	0.46	0.69	0.53	0.01	0.03	0.61	0.15	0.01	0.05	0.13	0.25	0.20
B5	–	–	–	–	1.00	0.16	0.51	0.03	0.17	0.50	0.17	0.23	0.09	0.06	0.24	0.13
B6	–	–	–	–	–	1.00	0.40	0.09	0.08	0.58	0.09	0.15	0.13	0.16	0.13	0.14
B7	–	–	–	–	–	–	1.00	0.04	0.03	0.58	0.12	0.04	0.13	0.02	0.11	0.07
B8	–	–	–	–	–	–	–	1.00	0.01	0.02	0.41	0.29	0.40	0.03	0.24	0.07
B9	–	–	–	–	–	–	–	–	1.00	0.11	0.28	0.19	0.43	0.28	0.14	0.18
B10	–	–	–	–	–	–	–	–	–	1.00	0.19	0.17	0.12	0.14	0.16	0.13
B11	–	–	–	–	–	–	–	–	–	–	1.00	0.19	0.56	0.35	0.17	0.46
B12	–	–	–	–	–	–	–	–	–	–	–	1.00	0.19	0.17	0.12	0.14
B13	–	–	–	–	–	–	–	–	–	–	–	–	1.00	0.08	0.19	0.22
B14	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00	0.08	0.708
B15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00	0.23
B16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00

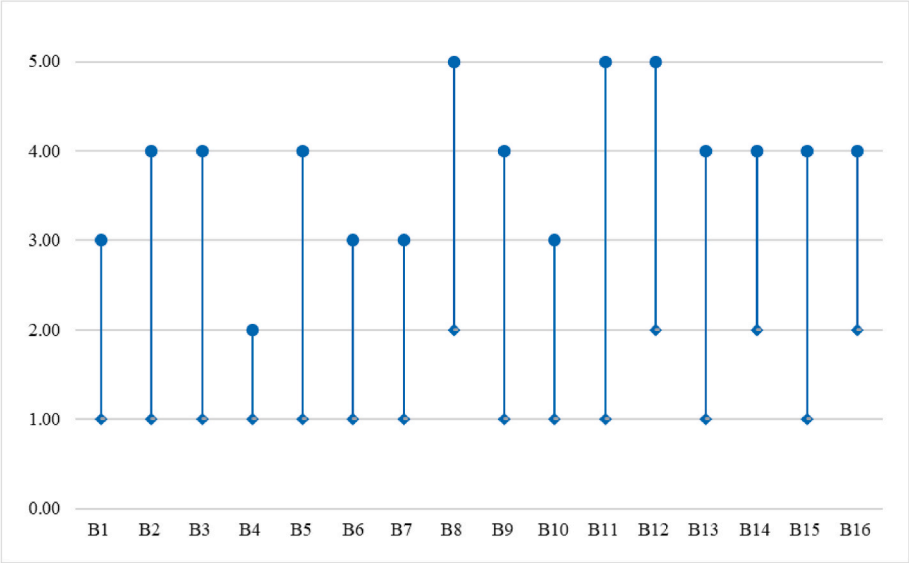

Fig. 4. Multi-Variate analysis of the barriers.

On the contrary, when looking at the lower value of the barrier "Technologies and energy services are not adequate (B4)," it becomes clear that stakeholders do not perceive this as a critical issue. In fact, when discussing this barrier, stakeholders believe that suitable technologies are available. However, they argue that other barriers, such as financial constraints and market conditions, hinder the uptake of these available technologies and services.

4.2. Drivers to ESCOs

In examining the existing literature, various types of actions to support ESCOs are discussed, and it is evident that these actions vary from country to country. Developing economies often find financial related actions more effective in supporting ESCOs, while other nations may lean towards regulatory measures along with financial issues for greater efficacy.

Considering Australia's unique energy landscape, a combination of actions from different domains may be necessary. In fact, this fact was reinforced during discussions with industry experts who emphasised the importance of a multifaceted approach to support ESCOs. Quoting one interviewee:

> '*Supporting ESCOs in Australia requires a tailored strategy that integrates different measures to address the specific challenges within our energy sector.*' (C47- ESCO; Business Development Manager)

4.2.1. Analysis of drivers by average value

When examining the drivers that support ESCOs, it is evident that

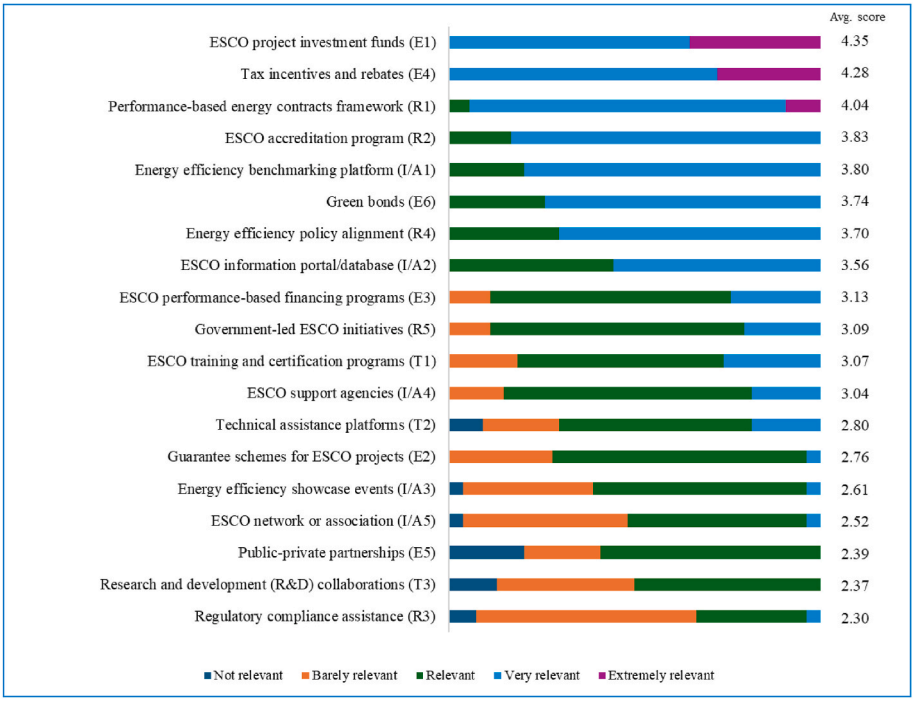

Fig. 5. Drivers to ESCO (average value and frequency of responses).

funding is crucial. "*ESCO project investment* funds" are identified as the top driver, emphasizing the necessity for substantial financial backing to sustain projects. This is followed by "*Tax incentives and rebates*" which mitigate costs and enhance project feasibility. The "*Performance-based energy contracts framework*" is another significant factor, aligning incentives for all stakeholders. An "*ESCO accreditation program*" further bolsters market credibility and trust. Fig. 5 reports the aggregated findings from the interviews.

4.2.1.1. ESCO project investment fund and tax incentives & rebates. One key aspect highlighted by the industry participants is the lack of trust towards ESCOs and as a result potential reluctance of organizations exist, especially larger ones, to integrate ESCOs into their internal operations. This hesitation often stems from uncertainties about the financial benefits derived from energy savings and the perceived value of ESCO services. Interviewees highlighted that, to overcome this challenge, a strategic approach may involve collaborating with relevant government agencies to establish a variety of instruments, in particular, ESCO project investment funds. A preliminary finding, worth of further exploration and investigation, is that financing for ESCO projects is not deemed to be an insuperable issue for what concerns is the upfront cost. However, a detailed discussion brought to light certain uncertainties pertaining to the investment process as well as the longer-term stability of energy policies in support of ESCO projects, particularly from the final user's perspective. Indeed, the interviewees, particularly, the final users highlighted that while financing itself may not be a primary concern, there exists a notable apprehension regarding the investment for ESCO projects in terms of adaptation to potential changes in the main company business. An expert from the group of final users confirmed:

> *"If there is separate funding working for ESCO, it will help in the long run. For shorter years, like two to three years, financing is not a big issue. But, if a company changes their business plan and move after certain years, it becomes an issue. So, if we know that there are external resources to cover, it supports the future uncertainty about investment.' (*C35- Food & beverage company; Senior Manager*)*

Besides, this study finds that participants highlighted the need to reduce the uncertainties around ESCO projects and tackle trust issues in the business model particularly for final users, who are unsure whether their investment will yield the expected return. One participant noted:

> *' … We are capable to managing things internally. So, it is not profitable engaging externals unless there are additional financial gain. If there is rebate or incentive for engaging externals like ESCO, we can think of that.'* (C41- Plastic manufacturing company; Senior Engineer)

It is within this context that the role of project investment funds or tax incentives or even green bonds gains prominence. Establishing a dedicated system, such as an ESCO project investment fund, can be effective in mitigating these concerns and risks (Moles-Grueso et al., 2023). Some incentives come with conditions or guarantees that help mitigate risks associated with ESCO projects. For example, performance-based incentives may provide assurance to investors and end-users that the project's energy savings will meet specified targets. This reduces uncertainty related to the project's performance and return on investment, improving cost predictability. This awareness would assuring final users that there are specific financial mechanisms in place to support ESCO initiatives and for a longer-term perspective. This stability reduces uncertainty about long-term viability and success of the project (Carvallo et al., 2019).

Moreover, such incentive mechanisms for ESCO projects would provide a pathway for businesses and organizations to align with environmental and sustainability agendas, which is critical considering the unique energy landscape in Australia, as highlighted by participants. Additionally, the existence of financial mechanisms can attract additional private investments into ESCO projects, leveraging additional funds for energy efficiency initiatives (Bertoldi and Boza-Kiss, 2017). In this regard, increased confidence in the project's outcomes improves the likelihood of securing necessary funding and support. In this regard, the existence of incentives would encourage long-term commitments: incentives that are designed for long-term projects encourage ESCOs and end-users to make a sustained commitment to energy efficiency initiatives (Carvallo et al., 2019). This stability reduces uncertainty about the long-term viability and success of the project.

4.2.1.2. Performance based energy contracts. In the investigation of regulatory actions that could support for ESCOs, two interesting perspectives were found. Most of interviewees with international experience highlighted the importance of established frameworks to more straightforwardly navigate through regulatory processes and work with final users. Nonetheless, a key concern raised by interviewees (ESCO and final energy users) is the necessity for regulatory actions tailored specifically to support ESCOs in Australia. This is particularly crucial in a country where end-users may not be as familiar with ESCOs (Zhang et al., 2024). Performance-based contract frameworks emerged as a potential solution in such cases. By establishing a performance-based contract framework, it can facilitate a structured approach that not only encourages ESCOs to operate efficiently but also educates final users about the contract structure, performance indicators, measurement protocols, and dispute resolution mechanism (Sorrell, 2007).

> *'There's a lot of lack of regulation, and I think in Australia, in terms of minimum performance to be met. In terms of regulation for the ESCOs, the end users ask for whether they're certified.'* (C46- ESCO; Head of Engineering)

4.2.1.3. ESCO accreditation program. The participants underscored the importance of implementing an ESCO accreditation program, arguing that such a framework is essential for establishing industry-wide standards and enhancing the accountability and reliability of service providers. However, the accreditation helps to streamline the certification and regulatory process, it could also inadvertently lengthen the regulatory approval timeline, creating barriers to entry that might discourage new market participants and foreign companies from engaging in the ESCO sector (Bertoldi and Boza-Kiss, 2017). This could potentially stifle competition and innovation, both of which are crucial for the dynamic evolution of the energy services market.

Despite these reservations, a majority of participants maintained that the benefits of an accreditation program outweigh the potential drawbacks. They argued that the absence of standardized accreditation could lead to a fragmented market, where varying levels of service quality and performance could undermine consumer trust and sectoral growth. Furthermore, they emphasised that a well-designed accreditation system could mitigate risks by ensuring only qualified entities operate within the sector, thereby fostering a more robust and sustainable market environment. Ultimately, while acknowledging the concerns regarding market entry barriers, the discussion highlighted a consensus on the necessity of such a program to enhance operational efficiency, uphold high-quality standards, and support the long-term stability and credibility of the ESCO industry.

> *'Accreditation they have over there in US, you know they have stronger frameworks than we have in Australia. The Energy Efficiency Council is maintaining some accreditation of engineers. I would say, you need to have someone with those accreditations. I know that we're reviewing the system, but there's just not a lot of engagement.'* (C44- Dairy product manufacturing company; Operation Engineer)

4.2.2. Statistical correlation analysis

Table 4 shows the statistical correlation of drivers in detailed. Upon a preliminary examination of the correlation data, we observe a few

Table 4
Statistical correlation analysis of the drivers.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19
D1	1.00	0.04	0.04	0.06	0.19	0.06	0.19	0.09	0.23	0.05	0.06	0.26	0.13	0.06	0.17	0.18	0.02	0.09	0.08
D2	–	1.00	0.05	0.69	0.16	0.13	0.07	0.40	0.12	0.21	0.19	0.17	0.15	0.76	0.14	0.50	0.04	0.11	0.11
D3	–	–	1.00	0.05	0.08	0.03	0.01	0.16	0.04	0.49	0.05	0.28	0.10	0.01	0.12	0.06	0.65	0.07	0.70
D4	–	–	–	1.00	0.04	0.01	0.01	0.12	0.05	0.07	0.08	0.05	0.24	0.91	0.03	0.40	0.08	0.11	0.05
D5	–	–	–	–	1.00	0.84	0.20	0.23	0.16	0.12	0.89	0.05	0.33	0.18	0.02	0.15	0.05	0.86	0.02
D6	–	–	–	–	–	1.00	0.26	0.18	0.21	0.17	0.89	0.12	0.09	0.13	0.06	0.27	0.02	0.87	0.04
D7	–	–	–	–	–	–	1.00	0.43	0.31	0.20	0.24	0.15	0.06	0.11	0.12	0.05	0.17	0.13	0.06
D8	–	–	–	–	–	–	–	1.00	0.06	0.20	0.21	0.03	0.03	0.17	0.06	0.06	0.26	0.17	0.22
D9	–	–	–	–	–	–	–	–	1.00	0.34	0.17	0.50	0.03	0.17	0.59	0.20	0.02	0.02	0.05
D10	–	–	–	–	–	–	–	–	–	1.00	0.15	0.28	0.00	0.20	0.12	0.09	0.41	0.03	0.45
D11	–	–	–	–	–	–	–	–	–	–	1.00	0.15	0.31	0.21	0.11	0.26	0.01	0.82	0.03
D12	–	–	–	–	–	–	–	–	–	–	–	1.00	0.15	0.08	0.01	0.03	0.08	0.03	0.31
D13	–	–	–	–	–	–	–	–	–	–	–	–	1.00	0.29	0.16	0.12	0.23	0.23	0.37
D14	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00	0.02	0.49	0.03	0.11	0.12
D15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00	0.47	0.09	0.03	0.17
D16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00	0.14	0.12	0.15
D17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00	0.04	0.89
D18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00	0.10
D19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00

intriguing insights.

- ESCO accreditation program (D2) and green bonds (D14): (0.76)
- Regulatory compliance assistance (D3) and ESCO network or association (D19): (0.70)
- Energy efficiency policy alignment (D4) and green bonds (D14): (0.91)
- Government-led ESCO initiatives (D5) and ESCO training and certification programs (D6): (0.84)
- Government-led ESCO initiatives (D5) and ESCO performance-based financing programs (D11): (0.89)
- Government-led ESCO initiatives (D5) and ESCO support agencies (D18): (0.86)
- ESCO training and certification programs (D6) and ESCO performance-based financing programs (D11): (0.89)
- ESCO training and certification programs (D6) and ESCO support agencies (D18): (0.87)
- ESCO performance-based financing programs (D11) and ESCO support agencies (D18): (0.82)
- Energy efficiency showcase events (D17) and ESCO network or association (D19): (0.89)

A synergetic relationship exists between green bonds (D14) and energy efficiency policies (D4). Of course, green bonds, that are designed to fund environmentally friendly projects, can drive governments and businesses to adopt bolder energy efficiency policies by providing essential funding. Conversely, robust energy efficiency policies can stimulate the issuance of green bonds by creating a pipeline of eligible projects and enhancing investor confidence.

Similarly, the relationship between government-led ESCO initiatives (D5) and ESCO performance-based financing programs (D11) is fundamentally synergistic. Indeed, government-led initiatives are critical and capable of providing essential support to create a favourable environment for ESCOs to operate and grow. This, in turn, could reduce market risks and attracts investment into performance-based financing programs that reward actual energy savings. On the other hand, the success of performance-based financing programs can validate government efforts by demonstrating tangible energy savings and financial returns, encouraging further policy support and investment (Zheng et al., 2021).

The correlation between ESCO training and certification programs (D6) and ESCO performance-based financing programs (D11), emphasizing the pivotal role of capacity building in enabling effective financial mechanisms. Certification programs equip ESCOs with the technical and managerial expertise necessary to design and manage performance-based contracts, which are heavily reliant on measurable outcomes and transparent reporting. As Mills et al. (2006) argue, such training enhances ESCO credibility, fostering trust among financial institutions that are often cautious about funding projects with uncertain performance metrics. Similarly, Sarkar and Singh (2010) argue that the operational capacity developed through certification is critical for securing and executing performance-based financing, reinforcing the need for integrated capacity-building and financial frameworks to drive energy efficiency initiatives.

Building on this, the correlation between government-led ESCO initiatives (D5) and ESCO training and certification programs (D6), emphasizing the critical role of coordinated government intervention in fostering the development of the ESCO market. This correlation suggests that government initiatives, such as policy support, or subsidies are closely tied to the establishment of robust training and certification programs, which are essential for standardizing practices, building trust among stakeholders, and enhancing the competence of ESCOs (Bertoldi and Boza-Kiss, 2017). Furthermore, Vine (2005) highlights that government-led policies, when combined with capacity-building efforts, can significantly reduce market barriers by addressing both technical skill gaps and regulatory uncertainties.

Furthermore, the relationship between ESCO support agencies (D18) and ESCO training and certification programs (D6) underscores the potential impact of coordinated capacity-building efforts on enhancing the effectiveness and growth of the energy efficiency sector. In fact, ESCO support agencies play a vital role in developing the ESCO market by providing resources, guidance, and advocacy that help build a strong foundation for energy service companies (Carvallo et al., 2019).

Meanwhile, the synergy between ESCO networks or associations (D19) and energy efficiency showcase events (D17) highlights the potential of these networks to organize events that promote energy efficiency solutions. These showcase events serve as a platform to disseminate valuable information about energy efficiency technologies and practices, thereby raising awareness and interest among stakeholders. Interestingly, when considering barriers—particularly information barriers—such correlations can significantly impact overcoming the lack of awareness and misinformation about energy efficiency. By fostering a well-informed market through events and targeted training, these coordinated efforts can break down information barriers, enhance market confidence, and drive the adoption of energy-efficient technologies and practices (Bertoldi and Boza-Kiss, 2017).

On the contrary, several low correlations exist in the statistical analysis of individual drivers. For instance, a lower correlation (0.01) is observed between regulatory compliance assistance (D3) and technical assistance platforms (D7). Regulatory frameworks focus on ensuring compliance, while technical platforms are primarily concerned with

providing operational support, which may not always align with regulatory needs. As Bertoldi et al. (2006) highlight, the effectiveness of regulatory measures can be limited without accompanying technical guidance, but these two aspects may function independently, explaining the observed disconnect. Similarly, another low correlation (0.01) exists between tax incentives and rebates (D12) and energy efficiency benchmarking platforms (D15). This suggests that while tax incentives and rebates are critical drivers for promoting energy efficiency, they have very little direct synergies with benchmarking platforms. Tax incentives focus on providing financial motivation, whereas benchmarking platforms aim at assessing and comparing energy performance. As noted by Sorrell (2007), financial incentives can drive investment but do not necessarily influence the adoption or use of tools like benchmarking platforms, which require a separate focus on performance evaluation and data analysis.

4.2.3. *Multi-Variate analysis of the drivers*

Fig. 6 presents the Multi-Variate analysis of the drivers. In analysing each driver, two significant findings are observed. The feedback range for ESCO project investment funds (D9) and tax incentives and rebates (D12) indicates that these drivers are consistently prioritised by all stakeholders, including end-users, and operators in energy service market. This prioritization suggests a strong consensus on the importance of financial incentives in driving energy efficiency initiatives. However, it is noteworthy that the greatest barrier, as revealed by statistical averages, is a lack of trust. This lack of trust is closely tied to financial uncertainty, highlighting a critical area that requires attention. The argument can be made that if financial uncertainties and mechanisms are transparently articulated, they would significantly enhance trust among stakeholders (Bertoldi and Boza-Kiss, 2017). Moreover, establishing clear and reliable financial frameworks is not merely beneficial but essential for mitigating the perceived risks associated with energy efficiency projects. In this context, robust financial mechanisms are not just supportive but could play a pivotal role in fostering stakeholder confidence and commitment, thereby driving the successful implementation of such initiatives (Moles-Grueso et al., 2023).

On the contrary, whilst looking at the low value marked by stakeholders, both “Research and Development (R&D) collaborations (D8)" and “Public-private partnerships (D13)" were deemed of low critical importance. While these drivers are generally recognized as valuable, stakeholders’ perceptions indicate that they are not seen as immediate priorities in addressing the challenges facing the market. This suggests that, despite their long-term potential, the urgency of other drivers—such as financial actions are more pressing, and thus overshadow the perceived need for further R&D collaborations or public-private partnerships at this stage.

5. Discussion

The prevailing discourse on ESCO market development places a strong emphasis on financial barriers as the primary obstacle to widespread adoption. While studies such as Akkoç et al. (2023) and Bertoldi and Boza-Kiss (2017) highlight the difficulties of securing financing for EnPCs, this perspective risks oversimplifying a more intricate reality. Financial constraints, while significant, do not operate in isolation. The assumption that unlocking capital will automatically drive ESCO growth overlooks deeper structural issues—most notably, trust deficits and the complexity of ESCO business models.

This study offers a different perspective, suggesting that financing, while important, is not necessarily the most decisive factor in ESCO expansion. Instead, trust appears to be a more immediate and persistent barrier. Kindström et al. acknowledge this issue but frame it within intra-organizational dynamics, reinforcing the idea that skepticism toward ESCOs is not just a market failure but a fundamental credibility problem (Kindström et al., 2017). Many businesses hesitate to engage with ESCOs not simply due to a lack of funding but because of concerns over performance risks, contractual ambiguities, and misaligned incentives. The ESCO model requires long-term commitment and technical understanding—factors that many companies, even in advanced economies, find difficult to navigate.

While Australia’s economic context differs from other markets, this study aligns with research on developing economies where ESCO adoption remains slow (Hasan et al., 2019b), (Siddique et al., 2022). In many of these markets, a lack of information on cost and benefits is often cited as a major barrier, making ESCO projects appear financially unfeasible for businesses. Interestingly, Australia faces a similar challenge—not in terms of absolute cost but in the uncertainty surrounding cost structures and long-term benefits. The absence of standardized pricing mechanisms and transparent value propositions makes it difficult for businesses to assess the financial viability of ESCO engagement, leading to hesitation despite the availability of capital. This suggests that the issue is not just about affordability but about how ESCOs communicate value and manage risk perception.

Furthermore, other studies bring attention to the role of regulatory frameworks and market conditions in shaping the ESCO market. Akman et al. discuss how Turkey’s efforts to develop a more competitive market are reflected in its regulatory approach to ESCOs (Akman et al., 2013). However, regulatory barriers still remain a significant impediment,

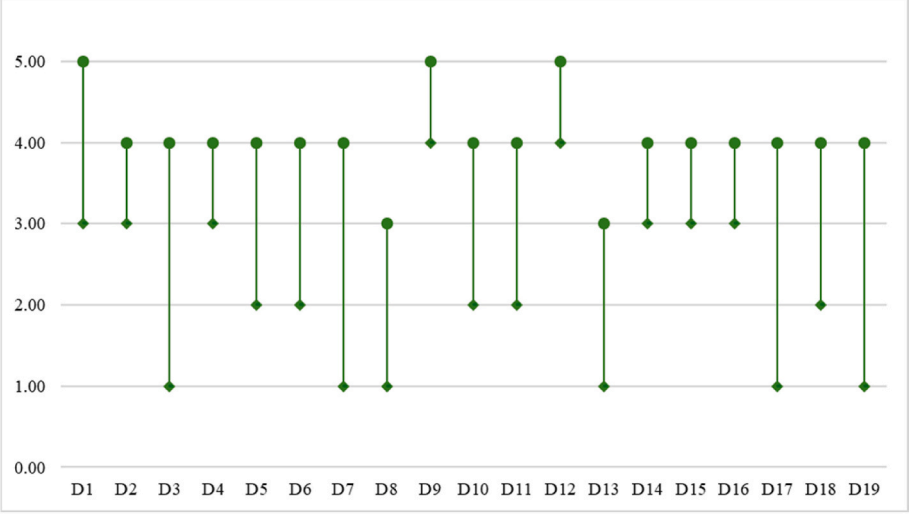

Fig. 6. Multi-Variate analysis of the drivers.

particularly in developing economies (Brown et al., 2022). Similarly, scholars also argue that ESCO market still faces challenges related to insufficient sector coverage and stakeholder knowledge (Akkoç et al., 2023). This is contrasted with Bertoldi and Boza-Kiss's view, which suggests that in some regions, such as the EU, ESCO markets are propelled not only by regulatory measures but also by market forces, where increasing consumer demand for energy efficiency can stimulate market growth independently of policy support (Bertoldi and Boza-Kiss, 2017).

In addition, several studies highlight the lack of standardized practices as barriers to market development. Brown et al. discuss how regulatory fragmentation and inconsistent implementation of policies contribute to market inefficiencies (Brown et al., 2022). Hasan et al. (2019b) and Siddique et al. (2022) also point out that in the developing countries, the lack of standardized practices exacerbates the difficulty in scaling the ESCO model. This underscores the importance of both education and standardization in the countries, where the ESCO concept is still relatively new and not well understood by key stakeholders.

Whilst looking at the results in this study more deeply, particularly the top barriers and drivers to the effective development of ESCOs, it becomes clear that information/awareness, along with economic factors, are identified by most respondents as the most critical. However, this focus on informational and financial challenges overlooks the equally significant role of managerial and policy issues, which are inextricably linked to these primary categories. In fact, the critical role of managerial perspective and policy implications becomes evident, as addressing these issues necessitates not only enhanced informational resources but also strategic managerial interventions and policy measures to bridge the awareness gap and facilitate ESCO adoption effectively (Bertoldi and Boza-Kiss, 2017), (Lütken, 2022).

For instance, interviewee highlighted the prevalent issue of trust regarding ESCOs, leading companies to be reluctant in delegating responsibilities related to operational management. This skepticism arises from concerns about the perceived risks of outsourcing critical human resource functions. Consequently, companies often hesitate to fully embrace ESCOs for comprehensive management tasks, opting instead to limit their roles to more peripheral functions. In this context, managerial intervention can play a crucial role by strategically defining the scope of ESCO involvement and ensuring clear boundaries around human resource management (Backlund and Eidenskog, 2013). In fact, it is critical to carefully delineate the scope of ESCO involvement to mitigate potential complications from a managerial standpoint.

Besides, when examining the barriers faced by ESCOs, a critical challenge identified in the Australian context is the pervasive lack of awareness among organizations about the role and operational scope of ESCOs. This lack of understanding is not only a barrier to market growth but a reflection of deeper systemic issues that hinder the full potential of ESCOs (Trianni and Cagno, 2012). Studies emphasize how this knowledge gap undermines the effectiveness of ESCOs, with respondents from ESCOs highlighting the need for educating clients on their activities and benefits (Hasan et al., 2019a), (Bertoldi and Boza-Kiss, 2017). This gap in awareness is not an isolated issue but part of a broader pattern observed across various markets, where the energy efficiency concept remains misunderstood by key stakeholders, further entrenching market inefficiencies (Chai and Yeo, 2012).

One essential intervention to address this challenge is the role of managers in disseminating knowledge about ESCOs within their organizations By leveraging their positions, managers can act as critical change agents, advocating for the integration of ESCO solutions into their organizational strategies (Pätäri and Sinkkonen, 2014). In fact, senior managers, due to their authoritative positions, are uniquely positioned to disseminate accurate and comprehensive information about the benefits and functions of ESCOs. This top-down approach can help to ensure that information is effectively communicated but also lends greater legitimacy and trust to the message, as it comes from a recognized and respected source within the organization (Da-li, 2009).

In addition to managerial implications, the impact of policy is equally crucial in driving the adoption of ESCOs. In fact, financial mechanisms like tax incentives, rebates, ESCO project investment funds, and green bonds, while essential, are deeply intertwined with policy frameworks that prioritize sustainability. (Bertoldi and Boza-Kiss, 2017). Similarly, the establishment and growth of ESCO project investment funds and green bonds require a supportive regulatory environment that ensures transparency, reliability, and investor confidence (Lütken, 2022). Fig. 7 shows the managerial and policy implications on supporting the drivers to ESCOs.

The regulatory framework becomes even more critical particularly dealing the pervasive lack of trust issues in ESCOs. For instance, when end-users are uncertain about engaging with ESCOs, especially regarding financial investments and dispute resolution, government-approved, performance-based energy contracts can provide the necessary assurance. In addition, accreditation programs could be aligned with national and regional energy policies to ensure that only ESCOs meeting rigorous standards are eligible for government-supported initiatives and incentives. Furthermore, accreditation, backed by policy, would serve as a formal endorsement of an ESCO's capabilities, addressing issues related to trust and reliability (Lütken, 2022). Besides, government recognition of accredited ESCOs through public awareness campaigns and official endorsements would not only boost the reputation of these companies but also increase public confidence in energy efficiency projects. This, in turn, would encourage more businesses and individuals to engage with ESCOs, knowing that these companies operate within a regulated framework that prioritizes quality and integrity (Bertoldi and Boza-Kiss, 2017), (Marino et al., 2011).

6. Conclusions and policy implications

The aim of this study is to explore the barriers and drivers that are influencing the development of the Australian ESCO market. This research is particularly novel, as there is a notable scarcity of studies that have looked into the barriers and drivers of ESCOs within the Australian context. In fact, this study represents a pioneering effort to fill this gap in the scientific literature. Furthermore, the academic contribution of this research lies in its in-depth analysis of the factors that either impede or promote the growth of ESCOs in Australia, offering critical insights that can inform both policy and practice. By addressing this underexplored area, the study provides a foundation for future research and highlights the need for targeted strategies to foster a more robust and competitive ESCO market in Australia.

This study finds that the "*lack of trust*", "*complexity of business models*", and "*lack of trust in business models*" are the top barriers to the growth of the ESCO market in Australia. In contrast, key drivers supporting the market include the "*ESCO project investment* fund", "*tax incentives and rebates*", and the "*performance-based energy contracts framework*". The study also identifies strong correlations between "unclear mechanisms in licensing and accreditation requirements" and "lack of trust in business models". Additionally, significant correlations were observed between "lack of awareness of energy efficiency and decarbonization" and "lack of interest in energy efficiency services". In terms of drivers, the study reveals "government-led ESCO initiatives" correlates with "ESCO performance-based financing programs," while "green bonds" is strongly linked to "energy efficiency policy alignment".

The findings of this study highlight the necessity for developing targeted policy recommendations. ***Firstly***, a formulation of policy mechanism where the policymakers could consider several key factors, including the allocation of different factors—whether on a project basis, per end-user, or across an entire sector—and the precise criteria that determine eligibility for support. Additionally, policies should establish clear procedures for monitoring the effectiveness of these instruments, including methods for verifying energy savings and assessing financial impacts (Nurcahyanto et al., 2020). In doing that policies could anticipate potential risks related to both ESCO performance and end-user compliance. For instance, policies should specify repercussions if an

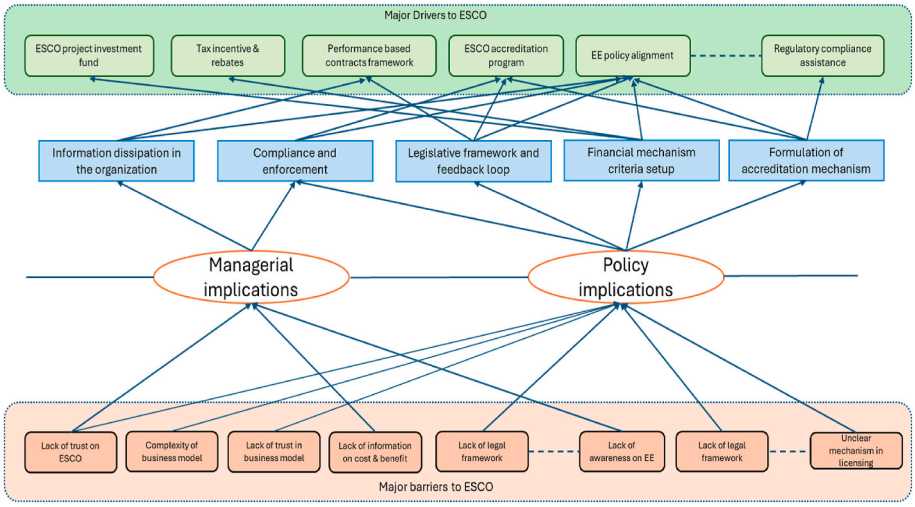

Fig. 7. Managerial and policy implications on supporting the drivers to ESCOs (source: author's design) (Moles-Grueso et al., 2023), (Nurcahyanto et al., 2020), (Bertoldi and Boza-Kiss, 2017).

ESCO fails to meet its service commitments, such as penalties, performance bonds, or guarantees. These safeguards are essential for protecting the interests of end-users and maintaining confidence in the ESCO model. Similarly, for end-users who default on contract modalities, policies should include appropriate measures to ensure financial obligations are met, thus minimizing risk for ESCOs also (Tzani et al., 2023). In this regard, this preliminary investigation confirmed that the Australian market of energy services is far from being mature. For this reason, the development of a proper framework for performance-based contracts seems in this regard an essential element to tackle the lack of trust towards the innovative business models for energy services – extensively implemented in other countries, especially for smaller energy users, which may have limited exposure to international experiences.

Secondly, policies could be tailored to support an accreditation system for ESCOs as empirical evidence across multiple countries underscore its critical role in shaping the success of energy service markets (Didden and D'haeseleer, 2003), (Leffel, 2022). Notably, countries such as the United States, China, Italy, Japan, and Singapore have implemented accreditation frameworks that not only enhance the credibility and trustworthiness of ESCOs but also significantly influence their capacity to secure contracts and access financing (Bertoldi and Boza-Kiss, 2017), (Lütken, 2022), (Didden and D'haeseleer, 2003). This study highlights that the absence of a structured accreditation system represents a critical gap in the development of the ESCO market in Australia. Hence, policies should address the standardization of the accreditation process, adhere auditing standards, and clear benchmark ensuring that it is transparent, and fair. This includes clearly defining the requirements for accreditation and specifying the benefits that accredited ESCOs receive. Policymakers should consider whether accreditation could be mandated for ESCOs to participate in government-funded energy efficiency projects, or to qualify for tax incentives and subsidies (Lütken, 2022).

Thirdly, the findings seem to suggest that policymakers should focus on capacity-building initiatives, such as targeted training and certification programs for ESCOs, which are critical to the sector's long-term sustainability and effectiveness (Otrachshenko et al., 2023). Designing policies that systematically integrate capacity-building measures is essential for ensuring that ESCOs can effectively implement cutting-edge solutions (Kim, 2018). In fact, with the rapid advancement of digital technologies – increasingly seen as critical decarbonization enablers due to their capacity to optimize energy use, enhance automation, and enable human-robot collaboration—these initiatives are crucial for helping ESCOs integrate these advanced systems (Chiarello et al., 2021). Besides, ESCOs should be building capacity in other decarbonization technologies, including renewable energy integration, carbon capture & storage, and low-carbon fuels. Aligning these efforts with supportive policies and regulatory frameworks is essential for enabling ESCOs to offer comprehensive solutions that not only improve energy efficiency but also drive deep decarbonization across industries.

By looking more closely at the Australian energy policy context, we can see that it is characterised by a set of specific factors which may have contributed to the findings emerged in the current study. Firstly, there is an inconsistency of energy policies and approaches with respect to different States. There are some virtuous examples in the energy efficiency domain, such as e.g. the Victorian energy efficiency certificates scheme (Victorian energy efficiency certificates, 2024) - similar to the white certificate schemes broadly adopted in several countries (IEA, 2025), currently there is not an Australian energy policy to address those matters across all States. Secondly, Australia has recently developed and published a National Energy Performance Strategy (DCCEEW, 2024) to promote energy efficiency and decarbonization across various sectors. However, when it comes to energy efficiency in businesses, suggested actions are at moment limited to promoting the uptake of energy efficiency technologies (mentioning potential future incentives for e.g. industry 4.0, heat recovery, heat pumps, etc.), with no mention of energy efficiency services. Therefore, whilst the Australian energy service market is far from being mature, a close coordination between Federal and State levels is deemed to be crucial to avoid conflicts and redundancies between proposed policy initiatives, ultimately to ensure an effective implementation of consistent policies to promote energy services in the Australian context.

On a separate note, regarding the operational steps and implementation procedures for policy recommendations, it is crucial to highlight the importance of a meticulously planned framework. More importantly, these operational steps should be guided by policymakers in Australia to ensure alignment with national priorities and regulations. In doing so, policymakers could draw on international models. For example, the EN 15900 standard for energy services provides a well-established certification structure, including detailed operational steps in Europe (.). Similarly, Italy's UNI CEI 11352 standard outlines the required skills and expertise for energy management professionals, also incorporating operational steps to ensure certification is effectively implemented (IMQ, 2025). Given these established practices, Australia could benefit from drawing inspiration from these models and adopting a similar operational approach, with clear guidance from policymakers.

Although this study makes a notable contribution by providing a detailed analysis of the barriers and drivers to ESCO with respect to

earlier literature, it is important to acknowledge its limitations. First, the relatively small sample size, though diverse in terms of stakeholder representation, may restrict the generalizability of the findings. Additionally, the uneven distribution of respondents and limited focus on commercial buildings or public sector could introduce potential biases into the data analysis. As a result, it is advisable to interpret the study's conclusions with caution and to consider the potential impact of these limitations on the overall validity of the results. In this regard, it should be noted that respondents have not been sampled to statistically represent the Australian population of ESCO-like business nor industries. For this reason, future quantitative research could on the one hand take inspiration from the current study and significantly increase the number of respondents; on the other hand, it could employ a different sampling technique (e.g. stratified sampling) to ensure statistical generalizability of the findings for the Australian context.

Given the study's limitations, several promising avenues for future research arise. First, including more samples could provide deeper insights into the underlying drivers and barriers. In this regard, a larger sample could also allow for important insights over potential moderating factors such as e.g. firm size, activity, energy intensity, etc. on the perception of barriers and drivers, with the purpose of supporting more tailored and specific energy policy approaches. Additionally, research could explore the contrasting perspectives of the commercial and manufacturing sectors, with findings providing more detailed insights for specific and tailored policies in support of the different sectors. Second, a longitudinal study could track changes in drivers and barriers over time, providing a dynamic understanding of the evolving landscape. Thirdly, given the relevance of barriers such as lack of trust in ESCO business model, future studies could explore the suitability of innovative business models for ESCOs and related services in Australia, with respect to their potential to mitigate financial and operational risks for businesses. This could be particularly relevant for the Australian context, where the low density and distance from major cities of businesses and related services could increase the operational risks in case of e.g. production disruptions. Finally, future research should focus on developing a comprehensive framework to support ESCOs in promoting energy efficiency and decarbonization. This would involve a detailed analysis of factors influencing ESCOs, leading to the creation of strategies that effectively address both barriers and drivers. In fact, it would be interesting to observe how such a framework interacts with techno-economic-regulatory-informative factors. Particularly, sectors with stringent regulatory requirements, such as energy-intensive manufacturing, the alignment between policy incentives and the economic feasibility of energy efficiency or decarbonization projects could be the decisive factor for ESCO success. Similarly, in regions where the ESCO market is still in its infancy, addressing the underlying factors that hinder maturity—such as limited regulatory support or fragmented markets—could drive significant progress. By examining these interdependencies, researchers can gain deeper insights into how different regions and industries can accelerate ESCO maturity.

CRediT authorship contribution statement

Andrea Trianni: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Jarrod Leak:** Writing – review & editing, Validation, Methodology, Investigation, Funding acquisition, Conceptualization. **A S M Monjurul Hasan:** Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Methodology, Investigation, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2025.114546.

Data availability

The data that has been used is confidential.

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