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Critical Success Factors in the Technology Commercialization Process: A Comparative Case Study of International Licensing Alliances among Small and Medium-Sized Enterprises

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Abstract: In contemporary academia and industry, the commercialization of technology through licensing has emerged as a prevalent strategy. This paradigmatic shift has prompted numerous industrial firms to intensify their focus on technology commercialization as a mechanism to optimize the returns on their research and development investments, while concurrently leveraging their comprehensive technology portfolios. However, despite growing interest in this area, there exists a conspicuous gap in scholarly literature exploring how small and medium-sized enterprises (SMEs) can effectively and efficiently capitalize on this opportunity in a global context. The objective of the present study is to fill this void by offering an in-depth analysis of the key determinants that contribute to the successful commercialization of technology via licensing. Employing a qualitative research methodology, this paper presents a comparative case study that explores four separate international licensing alliances, each formed between the same licensor, specializing in solar mounting system engineering, and four different licensees, all engaged in the production and marketing of this specialized technology. Data were meticulously gathered through a triangulated approach that incorporated interviews with both licensor and licensees, extensive desk research, and on-site observations. Our empirical findings reveal that the critical success factors identified in existing literature are not uniformly significant. Specifically, four elements—relational dynamics, cultural considerations, human capital, and resource allocation—emerged as pivotal in ensuring the successful implementation of technology commercialization strategies. By elucidating these nuanced factors, this study contributes to both academic discourse and practical applications, thereby serving as a valuable resource for SMEs aiming to navigate the complexities of technology commercialization in international settings.

Keywords: technology; commercialization; licensing; open innovation; research and development; critical success factors; small and medium-sized enterprises

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1. Introduction

Historically, industrial and technological organizations have predominantly focused on leveraging their in-house technological expertise for internal product development, thereby securing a competitive edge in the market. This insular approach to innovation, commonly referred to as "product development," has been the cornerstone of organizational strategies, often precluding the considerations of external technology transfer (Lichtenthaler 2011).

However, the landscape has evolved significantly over the past two decades, driven by factors such as globalization, heightened market competition, constrained financial resources, and limited technical capabilities. This evolution has catalyzed a transition from a closed innovation model to a more open, collaborative paradigm, frequently facilitated

through licensing agreements (Ayerbe et al. 2022; Enkel et al. 2009; Tomita 2022). Licensing serves as a conduit for outbound open innovation (Kutvonen 2011; Kim et al. 2021), wherein the licensor grants a third party—the licensee—the rights to produce, modify, market, and sell a particular technology or product in return for predetermined compensation. This strategic maneuver allows organizations to fully exploit their technology portfolios (Rivette and Kline 2000). Notably, some organizations have even adopted licensing as their primary revenue stream, recognizing the intrinsic value of research and development (R&D) as an independent value proposition. This shift aligns with the assertion that "not all the smart people work for us" (Chesbrough 2006), emphasizing the need for organizations to forge synergistic relationships and partnerships, often with external entities, to maintain competitiveness and drive innovation.

The existing academic research has thoroughly examined the role of licensing in technology commercialization and its critical success factors (Bigliardi and Galati 2016; Brown et al. 2022; Brunswicker and Ehrenmann 2013; Durst and Ståhle 2013; Lichtenthaler 2011; Min et al. 2022). However, Bigliardi and Galati (2016) identified a gap in understanding the specific barriers to adopting open innovation within small and medium-sized enterprises (SMEs). Lee et al. (2010) underscored this by highlighting SMEs' unique challenges in the innovation process, such as labor constraints, informational deficits, inadequate infrastructure, and financial limitations, proposing open innovation as a potential solution. Lichtenthaler (2011) concurred with this perspective, noting SMEs' reliance on licensing in the absence of assets necessary for a product-based business. These insights reveal an underexplored area in the literature: the practicalities and challenges that SMEs face in effectively leveraging licensing for technology commercialization, especially in international contexts. This gap is particularly evident in the existing research and necessitates further investigation, as also suggested by Portuguez-Castro (2023).

Consistent with the recommendations of seminal works by Bigliardi and Galati (2016) and Lichtenthaler (2011), and responding to Portuguez-Castro's (2023) call for deeper investigation into the strategies and practices that SMEs employ to successfully implement open innovation, this study aims to identify the critical factors that lead to the successful commercialization of technology through licensing. In particular, this study is focused on pinpointing those elements that are vital for SMEs when they engage in licensing activities within global markets. This involves a detailed exploration into how SMEs can maximize the benefits of licensing to enhance their technology commercialization efforts. Key aspects under examination include identifying the strategic approaches that SMEs adopt in licensing, understanding how they navigate the complexities of international market dynamics through licensing agreements, and uncovering the specific practices that contribute to successful outcomes in such ventures. By isolating and analyzing these factors, the study contributes valuable insights into the effective use of licensing as a tool for technology commercialization, particularly one tailored to the needs and contexts of SMEs operating on a global stage.

To this end, we conducted a rigorous comparative case study, examining four distinct international licensing alliances. We specifically examined the alliances between a single licensor, an expert in solar mounting system engineering, and four diverse licensees, all actively engaged in the production and marketing of this technology. It is crucial to emphasize that both the licensor and all licensees are classified as SMEs, ensuring the study's relevance to the SME context. To guarantee the validity and reliability of our findings, we employed data triangulation, a critical method in maintaining research rigor. This comprehensive approach included in-depth interviews with both the licensor and the licensees, supplemented by extensive desk research and on-site observations.

Our analysis predominantly centered on the licensees' perspective regarding the critical success factors in technology commercialization through licensing. This focus stemmed from the licensees' direct role in implementing and adapting the licensed technology across various markets, providing essential insights into operational challenges and success factors. Consequently, examining the diverse strategies adopted by the licensees, each shaped

by their unique organizational and market dynamics, offered a comprehensive view of the varied approaches to successful technology commercialization. In contrast, our analysis placed greater emphasis on the licensor's viewpoint to gain deeper insights into the background, specifics, and outcomes of each licensing alliance. As the central figure in all the alliances under study, the licensor offered a holistic perspective on their formation and management, as well as an assessment of whether each alliance resulted in success or failure. This dual approach, combining insights from both licensor and licensees, enriched our understanding of the dynamics inherent in international licensing alliances among SMEs, significantly contributing to the discourse on effective strategies for technology commercialization in a global context.

The research framework for this study is anchored by the following exploratory, open-ended research questions:

1. What are the primary factors that drive successful technology commercialization?
2. What factors are commonly linked to failures in technology commercialization?

The remainder of this paper is organized as follows: Section 2 offers a review of pertinent literature, thereby establishing the theoretical foundation for the study. Section 3 delineates the research methodology employed, while Section 4 presents salient findings derived from a cross-case comparative analysis. Finally, Section 5 concludes the paper and outlines avenues for future research.

2. Critical Success Factors in the Technology Commercialization Process through Licensing

Technology commercialization is conceptualized as an expansive process encompassing stages from planning to market entry via licensing (Jung et al. 2015; Lichtenthaler 2011). These pivotal stages are illustrated in Figure 1.

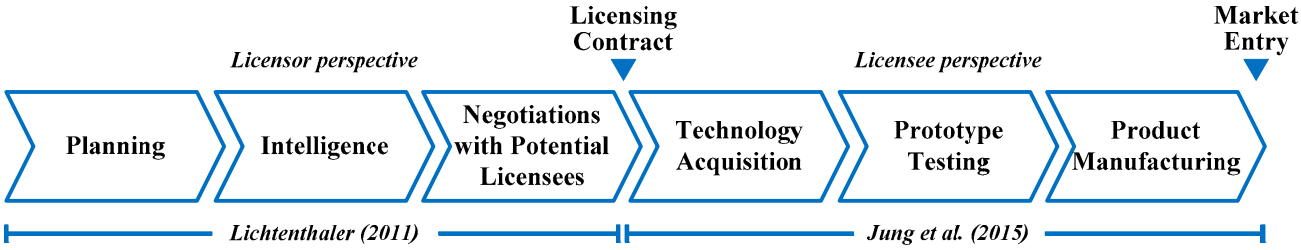

Figure 1. Stages of the technology commercialization process, adapted from Lichtenthaler (2011) and Jung et al. (2015).

While technology licensing offers mutual advantages for both licensors and licensees (Arora et al. 2001), the successful implementation of a licensing strategy necessitates the careful consideration of various critical elements (Megantz 2002; Verbano et al. 2011). As such, scholarly inquiries into the factors influencing the success or failure of technology commercialization through licensing are of considerable academic and practical significance.

In the present study, we scrutinize nine critical success factors as delineated by Durst and Ståhle (2013): relational issues, people, governance, facilitators, resources, strategy, technology commercialization process, leadership, and culture. These factors can be cohesively categorized into four overarching domains, as proposed by Bigliardi and Galati (2016): knowledge, collaboration, organizational, and financial and strategic. The ensuing section elaborates on the specific factors subsumed under each of these categories, culminating in a synthesized classification presented in Table 1.

The category of "Knowledge" encompasses both internal and external expertise pertinent to the commercialization of technology. This domain is integral to the success of a licensing venture, as it facilitates the incorporation of external specialized knowledge into the organization (Olawore et al. 2022; van de Vrande et al. 2009). Included within this category is the factor of the "Technology Commercialization Process", alternatively termed

"Open Innovation" or "Licensing", contingent upon the specific focus of the process in question. This factor necessitates a nuanced understanding of the various stages involved in technology commercialization (Colombo et al. 2011), the distinct phases of a technology's lifecycle (Buganza and Verganti 2009), and the idiosyncrasies inherent to each case with respect to process implementation (van de Vrande et al. 2009). A lack of comprehensive understanding in this area can result in ambiguous or overly complex processes, thereby undermining the efficacy of technology commercialization efforts.

Table 1. Classification of critical success factors for technology commercialization through licensing.

Category	Critical Factor	References
Knowledge	Technology commercialization process	(Buganza and Verganti 2009; Colombo et al. 2011; Olawore et al. 2022; van de Vrande et al. 2009).
Collaboration	Relational issues	(Arsanti et al. 2022; Bigliardi and Galati 2016; Brunswicker and Ehrenmann 2013; Buganza et al. 2011; de Oliveira et al. 2018; Grama-Vigouroux et al. 2020; Jung et al. 2015; Lee et al. 2023; Puck et al. 2007; Schiele 2012; van de Vrande et al. 2009; Verbano et al. 2011; Ziyadin et al. 2018).
	Facilitators	(Chiaroni et al. 2010; Durst and Ståhle 2013; Muller and Hutchins 2012; Puck et al. 2007; Whelan et al. 2011).
Organizational	People	(de Oliveira et al. 2018; Lichtenthaler 2009; Muller and Hutchins 2012; Ostergaard et al. 2011; van de Vrande et al. 2009; Verbano et al. 2011).
	Leadership	(de Oliveira et al. 2018; Lee et al. 2012; Verbano et al. 2011).
	Culture	(Ayerbe et al. 2022; de Oliveira et al. 2018; Grama-Vigouroux et al. 2020; Lichtenthaler 2011; Tranekjer and Knudsen 2012; Vanhaverbeke 2017; Verbano et al. 2011).
Financial and strategic	Resources	(Brunswicker and Ehrenmann 2013; Jung et al. 2015; Niehaves 2010; Schiele 2012; van de Vrande et al. 2009; Verbano et al. 2011).
	Governance	(Buganza et al. 2011; Chiaroni et al. 2010; de Oliveira et al. 2018; Lee et al. 2012; Mooi and Wuyts 2021; Muller and Hutchins 2012; Puck et al. 2007; van de Vrande et al. 2009; Verbano et al. 2011).
	Strategy	(Ahn et al. 2017; Buganza and Verganti 2009; Chen et al. 2023; de Oliveira et al. 2018; Grama-Vigouroux et al. 2020; Lichtenthaler 2011; Vanhaverbeke 2017; Verbano et al. 2011).

The category of "collaboration" pertains to partner behavior and consolidates two key factors: "relational issues" and "facilitators". The "relational issues" factor assesses the efficacy of inter-organizational network structures in fostering robust partnerships and close business affiliations (Brunswicker and Ehrenmann 2013; de Oliveira et al. 2018; Ziyadin et al. 2018). Along these lines, Bashir et al. (2023) emphasized the role of managerial ties in enhancing SME performance through business model innovation. This factor aims to optimize partner alignment (Bigliardi and Galati 2016; Grama-Vigouroux et al. 2020; Lee et al. 2023; van de Vrande et al. 2009). Trust and partner compatibility emerge as pivotal parameters within this context (de Oliveira et al. 2018; Jung et al. 2015). Additional considerations include the nature of the collaboration (Buganza et al. 2011), transparent and open communication (Puck et al. 2007; Schiele 2012), and a history of shared experiences between partners (Schiele 2012). Conversely, opportunistic behavior can undermine the effectiveness of a licensing partnership (Arsanti et al. 2022; de Oliveira et al. 2018; Jung et al. 2015). The "facilitators" factor encompasses the roles of innovation brokers (Whelan et al. 2011), relationship managers (Muller and Hutchins 2012), team trainers (Puck et al. 2007), and innovation champions (Chiaroni et al. 2010). These facilitators

serve to enhance the organizational performance by synergizing the diverse actors and their respective concerns, thereby fostering more efficient collaborative efforts (Durst and Ståhle 2013).

The "organizational" category encompasses managerial competencies and integrates three pivotal factors: "people", "leadership", and "culture". The "people" factor underscores the importance of assembling a diverse, multidisciplinary team—characterized by varied gender, age, educational backgrounds, and specialized skills—to engage in the technology commercialization endeavor (Lichtenthaler 2009; Ostergaard et al. 2011; van de Vrande et al. 2009). Additionally, team members must demonstrate a strong commitment to the project's objectives (de Oliveira et al. 2018; Muller and Hutchins 2012) and be adequately motivated to effectively contribute (van de Vrande et al. 2009; Verbano et al. 2011). The "leadership" factor pertains to the presence of leaders who are both willing and competent to guide the organization through transformative processes (de Oliveira et al. 2018; Lee et al. 2012; Verbano et al. 2011). The "culture" factor evaluates the extent to which an organization is receptive to change, open to external innovations, and fosters an environment that encourages experimentation, networking, and knowledge sharing (Ayerbe et al. 2022; de Oliveira et al. 2018; Grama-Vigouroux et al. 2020; Lichtenthaler 2011; Tranekjer and Knudsen 2012; Vanhaverbeke 2017; Verbano et al. 2011).

The "financial and strategic" category encompasses both economic and strategic dimensions, integrating three critical factors: "resources"; "governance"; and "strategy". The "resources" factor emphasizes an organization's capability to furnish the requisite resources for successful technology commercialization. These resources include not only high-caliber human capital but also adequate financial budgeting and time allocation (Jung et al. 2015; Niehaves 2010; Schiele 2012; van de Vrande et al. 2009; Verbano et al. 2011). Additionally, the organization should be prepared to invest in essential infrastructure, such as information technology systems (Jung et al. 2015; Brunswicker and Ehrenmann 2013; Schiele 2012). The "governance" factor posits that effective technology commercialization is facilitated by well-structured governance frameworks (Buganza et al. 2011; Lee et al. 2012; Mooi and Wuyts 2021; Verbano et al. 2011). This includes a clear delineation of roles, tasks, and responsibilities (van de Vrande et al. 2009), well-articulated objectives (Muller and Hutchins 2012), performance measurement systems (Chiaroni et al. 2010; Mooi and Wuyts 2021; Puck et al. 2007), and robust project and knowledge management systems (de Oliveira et al. 2018; Chiaroni et al. 2010). The "strategy" factor underscores the necessity for organizations to integrate technology commercialization within the broader contours of their corporate strategy (Ahn et al. 2017; Buganza and Verganti 2009; Chen et al. 2023; de Oliveira et al. 2018; Grama-Vigouroux et al. 2020; Lichtenthaler 2011; Vanhaverbeke 2017; Verbano et al. 2011).

3. Research Methodology

This section delineates the research design employed for this study, elaborating on the procedures for case selection, data collection, coding, and analysis.

3.1. Research Design

The primary aim of this study is to scrutinize the key determinants for successful technology commercialization via licensing, with a specific focus on the strategic exploitation of licensing by SMEs in international contexts. Given the intricate nature of the phenomenon under investigation, a multiple-case-study approach was deemed the most appropriate research methodology (Eisenhardt 1989; Yin 2009). This methodological choice is further substantiated by its alignment with the exploratory, open-ended research questions posited in this study (refer to Section 1), as it facilitates the extraction of rich, nuanced data. To systematically address these research questions, a classification framework was constructed based on an exhaustive review of the pertinent literature (see Table 1).

3.2. Case Selection

The methodology for case selection in multiple-case-study research typically employs non-random sampling techniques (Saunders et al. 2019). In the present study, the objective was to capture a diverse range of outcomes—both successful and unsuccessful—in technology commercialization projects involving licensing. To this end, a maximum variation sampling strategy was employed to ensure a heterogeneous selection of participating organizations (Palinkas et al. 2015; Chountalas et al. 2020).

From an initial pool of nine organizations within the solar photovoltaic sector, all engaged in similar technology commercialization endeavors—specifically, the commercialization of solar mounting systems from a common licensor, hereafter referred to as Company L—we selected a stratified purposeful sample of four licensees, hereafter referred to as Companies I, T, G, and M. This selection was based on criteria designed to capture a broad spectrum of experiences and strategies in technology commercialization. These criteria included the diversity of market presence, the scale of operations, the extent of engagement in licensing activities, and the unique challenges and successes each company encountered in their respective markets. This approach ensured a comprehensive analysis that reflects the varied landscape of SMEs in the solar photovoltaic sector.

The licensor and the four selected licensees willingly granted us access to a multifaceted dataset. Our focus was intentionally narrowed to SMEs to contribute to an area that remains relatively under-researched in contrast to the extensive literature available on larger organizations. It is worth noting that SMEs present unique challenges and opportunities in the realm of technology commercialization, necessitating specialized scholarly attention (Bigliardi and Galati 2016; Lee et al. 2010; Lichtenthaler 2011). The profiles of the participating organizations are delineated in Table 2, with names redacted to preserve confidentiality.

Table 2. Profiles of sample organizations.

Company	Role	Main Activities	Origin	Category [1]
Company L	Licensor	Engineering, sales, and marketing of solar mounting systems in the photovoltaic sector	Spain	Small
Company I	Licensee	Specialized electrical construction in the renewable energy sector	India	Medium
Company T	Licensee	Engineering, procurement, and construction with a specialization in photovoltaics	Turkey	Small
Company G	Licensee	Manufacturing of cable trays	Greece	Small
Company M	Licensee	Supplier of solar components	Mexico	Micro

[1] Size categories are based on the criteria for SME classification as stipulated by the European Union (2016).

3.3. Data Collection Procedures

To ensure robustness in the data collection process, a triangulated approach was employed, incorporating multiple methods such as interviews, desk research, and on-site observations. The objective of this triangulation is to corroborate the data, thereby enhancing the credibility of the research findings (Jick 1979; Shih 1998). Interviews were conducted using a semi-structured format, which allows for the emergence of new themes warranting further investigation (Saunders et al. 2019). The duration of these interviews varied, ranging from a minimum of one hour to a maximum of two hours. The interviews were structured to collect perspectives from both the licensor (i.e., Company L) and the licensees (i.e., Companies I, T, G, and M), aligning with our study's analytical focus. Our analysis primarily explored the viewpoints of the licensees to uncover critical success factors in technology commercialization. Additionally, we integrated the licensor's insights to gain a thorough understanding of each alliance's background, specifics, and outcomes.

The two questionnaires utilized for the semi-structured interviews with the licensor and the licensees are presented in Sections A and B, respectively. These interviews were conducted with key executives from each participating organization, as detailed below:

- Company L: Chief Executive Officer (CEO) and Legal Counsel (Conducted in-person);
- Company I: Head of Solar Department (Conducted via teleconference);
- Company T: Chief Operating Officer (COO) (Conducted via teleconference);
- Company G: Managing Director (Conducted in-person);
- Company M: Managing Director (Conducted via teleconference).

All interviews were meticulously audio-recorded and subsequently transcribed. To enhance the validity and reliability of the findings, the data obtained from these interviews were triangulated with the on-site observations of project procedures, where feasible, and corroborated through a comprehensive review of official company documentation, including datasheets, corporate presentations, and financial records. Prior to each interview, confidentiality protocols were explicitly discussed to facilitate candid discussions of sensitive topics. This precautionary measure aimed to ensure the integrity of the data by encouraging unreserved disclosures from the interviewees.

Table 3 provides a synthesized overview of the data sources utilized for each critical success factor, segmented by licensee, reflecting their unique experiences in their individual licensing alliances with Company L. The table incorporates a bubble chart to visually represent relative frequencies—specifically, the word count per factor for each interview respondent. Circles of varying diameters are used to denote these frequencies. Additionally, the table specifies the validation methods employed, indicating whether the interview data were corroborated through document review, on-site observations, or both.

Table 3. Overview of the data sources per critical success factor across different licensees.

		Company I			Company T			Company G			Company M		
		Interview	Interview Confirmed by:		Interview	Interview Confirmed by:		Interview	Interview Confirmed by:		Interview	Interview Confirmed by:	
	Critical Success Factors	Head of Solar Department	Review of Documents and Records	On-Site Observation	Chief Operating Officer	Review of Documents and Records	On-Site Observation	Managing Director	Review of Documents and Records	On-Site Observation	Managing Director	Review of Documents and Records	On-Site Observation
Knowledge	Technology commercialization process	●	✓		●			●			●		
Collaboration	Relational issues	●		✓	●	✓		●	✓		●		
	Facilitators	●	✓		●	✓		●			●		
Organizational	People	●		✓	●		✓	●		✓	●		✓
	Leadership	●			●			●			●		
	Culture	●			●			●			●		
Financial and strategic	Resources	●	✓	✓	●	✓	✓	●	✓	✓	●	✓	
	Governance	●	✓		●	✓		●	✓		●		
	Strategy	●	✓		●	✓		●	✓		●	✓	

The feasibility of conducting on-site observations was facilitated by our prior consultancy engagements with the organizations involved in these specific technology commercialization projects. Examples of these observations encompass: (i) specialized training sessions, including both technical and sales seminars conducted by the licensor; (ii) day-to-day operations within the departments responsible for technology commercialization

at the licensee organizations; and (iii) attendance at solar exhibitions where both licensor and licensees were present, providing them with an opportunity to evaluate their mutual compatibility.

3.4. Data Coding and Analysis

Data coding procedures were principally informed by the "start list" of codes proposed by Miles and Huberman (1994), and were executed with the aid of MAXQDA 2022 (Release 22.8.0) software, a specialized tool designed for computer-assisted qualitative data analysis. These codes were derived from the study's classification scheme and overarching research questions. Consequently, key factors were identified early in the research process, corroborated by the comprehensive literature review delineated in Section 2. This approach ensured a rigorous and systematic analysis, enhancing the credibility and validity of the study's findings.

3.5. Case Analysis Method

The coding of data primarily served to identify emergent patterns, particularly in the cross-case analysis phase of the research, as recommended by Campbell (1975). Yin (2009) advocates for the preparation of individual case reports prior to synthesizing cross-case conclusions, an approach that informed the framework depicted in Figure 2.

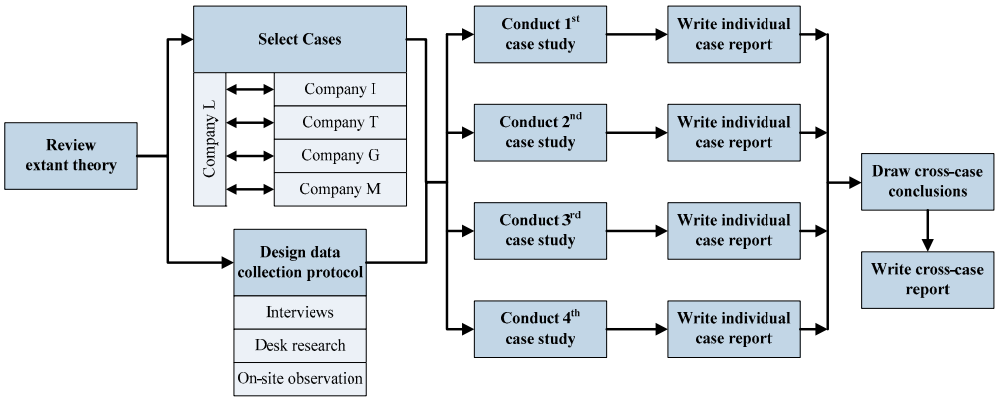

Figure 2. Adapted multiple-case study framework, based on Yin (2009).

The data analysis employed a dual approach, encompassing both within-case and cross-case analyses. Due to space constraints and in the interest of enhancing readability, this paper omits individual case reports, focusing instead on the aggregated data derived from each case's within-case analysis. These data are organized in the form of cross-case comparisons and are summarized in Table 4. Each entry in the table is categorized by its corresponding critical success factor, facilitating a more streamlined comparison between the empirical findings and existing literature, in accordance with the methodologies proposed by Eisenhardt (1989) and Baxter and Jack (2008).

Table 4. Cross-case summary of critical success factors for technology commercialization.

Critical Success Factors	Licensees			
	Company I	**Company T**	**Company G**	**Company M**
Technology commercialization process	Integrated and systematic approach aligned with overall business activities.	Partially integrated; operates alongside but not fully within business activities.	Partially integrated; operates alongside but not fully within business activities.	Absent; no specific process in place.
Relational issues	Synergistic and close business relationship with Company L.	Completed two successful projects with Company L's technology.	Over a decade-long manufacturing partnership with Company L.	No prior collaboration with Company L.

Table 4. *Cont.*

Critical Success Factors	Licensees			
	Company I	**Company T**	**Company G**	**Company M**
Facilitators	Engaged licensing trainers for project management.	Engaged licensing trainers for project management.	Absent; lacks expertise in managing collaborative relationships.	Absent; lacks expertise in managing collaborative relationships.
People	Multidisciplinary team; adequate number of highly skilled, project-dedicated employees.	Limited but highly skilled staff for all licensing projects.	Single highly skilled, project-dedicated employee.	Minimal shareholder involvement; insufficient dedicated time for the project.
Leadership	Active top management support for project and collaboration.	Active top management support for project and collaboration.	Limited top management engagement due to time constraints.	Top management preoccupied; minimal project involvement.
Culture	Open culture; history of successful licensing projects.	Predominantly open culture; prior familiarity with Company L's technology as a client.	Predominantly open culture; prior supplier relationship with Company L.	Closed culture; focus on immediate revenue without innovation investment.
Resources	Adequate budget; employee training at licensor facilities.	Adequate budget; constructed pilot solar system and attended solar exhibitions.	Limited budget; investment in sales training seminars.	Unwilling to invest without immediate revenue generation.
Governance	Clearly defined objectives and role distribution, both internally and with the licensor.	Clearly defined objectives and role distribution, both internally and with the licensor.	Complex governance mechanisms; willingness to adjust.	Ambiguous role distribution; excessive reliance on licensor support.
Strategy	Technology commercialization is integral to corporate strategy.	Technology commercialization is integral to corporate strategy.	Technology commercialization is integral to corporate strategy.	Absence of technology commercialization in corporate strategy.
Project result	Best practice	Largely successful	Partially successful	Failure

4. Results

The cross-case analysis reveals divergent outcomes among the four licensees examined in their technology commercialization endeavors through their individual alliances with Company L. Specifically, Companies I and T largely achieved success, Company G only realized partial success, and Company M unequivocally failed.

From the vantage point of Company L, the licensor, the overarching objective of these technology commercialization projects was to augment the market penetration of their specialized solar mounting systems in targeted geographic locales. These systems encompass a range of configurations, including fixed structures as well as one-axis horizontal multi-row and single-row trackers. Company L retains all engineering responsibilities in-house, encompassing technical reports, the bills of materials, and requisite schematics. However, for the manufacturing phase, they leverage local facilities to optimize the cost-efficiency. As articulated by the CEO of Company L, the prohibitive cost of utilizing Spanish suppliers and subsequently shipping products to international markets, such as Asia or North America, renders this approach economically unviable. Consequently, Company L strategically collaborates with licensees who possess both the willingness and capability to produce and market the technology within the designated geographic sectors. The CEO emphasized that Company L's core competency lies in the "design and development of these systems, underpinned by our extensive technical expertise, know-how, and experience". However, he candidly acknowledged the inherent complexities and frequent failures associated with technology commercialization via licensing. To mitigate these risks, Company L initially

targets potential licensees from within its pre-existing network, comprising partners or clients who have previously expressed satisfaction with their collaborations.

Company T emerged as a natural candidate for partnership with Company L, given their prior successful collaborations on two substantial projects in Turkey, with capacities of 5 MWp and 2.2 MWp, respectively. The COO of Company T attested to the mutual satisfaction derived from both the technological quality and the engineering support provided during the implementation phases. "Our firsthand experience with this technology made the decision to extend our partnership straightforward", the COO remarked. Recognizing the potential advantages of licensing, Company T engaged external licensing trainers to bolster the competencies of their staff. However, despite these proactive measures, the company's approach to technology commercialization remained relatively unstructured. Conversely, Company G had been a manufacturing collaborator with Company L for over a decade. When economic conditions in the Greek market began to improve following years of recession, Company L proposed a licensing partnership. The Managing Director of Company G posited that such an alliance would mutually benefit both entities through increased sales within the Greek market. Moreover, as the CEO of Company L articulated, this arrangement would obviate the need for Company L to "seek a new manufacturing partner in the region and expend superfluous resources on their accreditation". Company G, despite its long-standing manufacturing partnership with Company L, adopted a somewhat ad hoc approach to technology commercialization. Notably, the project lacked the involvement of external facilitators. In contrast, Company I, a newcomer to a partnership with Company L, was selected as a potential licensee due to its established network in India—a market where Company L had previously deployed its technology. This prior market presence significantly influenced Company I's decision to collaborate with Company L. Committed to the project's success, Company I instituted a rigorous technology commercialization process and engaged external licensing trainers to enhance the capabilities of its team. Company M presented a more complex scenario. As a market entrant seeking to establish initial synergies with reputable brands, Company M had yet to penetrate the Mexican market. Despite the inherent risks and uncertainties, Company L entered into a partnership with Company M, enticed by the prospective opportunities in this expansive market. Regrettably, the partnership proved unfruitful; Company M failed to implement a structured technology commercialization process, and no external facilitators were engaged to guide the project.

In terms of organizational factors, Company M's commitment to the project was notably lackluster. Despite initial plans for the active involvement of its three shareholders, they only allocated minimal time to the project in their daily operations. Compounding this issue was the company's culture, which exhibited a marked resistance to innovation and change. Contrastingly, Company G demonstrated an organizational culture amenable to innovation, a trait likely influenced by its longstanding supplier relationship with Company L. Although top management had limited time to actively participate in the project, the company allocated a dedicated full-time employee to oversee its execution. Company T exhibited a similar openness to innovation, fostered by its prior collaborations with Company L. The project benefited from the full-time commitment of two employees, and the top management provided both active guidance and robust support, further enhancing the project's prospects for success. Company I stood out for its exemplary organizational commitment. A team of five multidisciplinary employees was fully engaged in the project, backed by unequivocal support from top management. This strong internal alignment was likely influenced by the company's prior success in similar projects, which had generated significant licensing revenue.

The establishment and sustenance of a licensing program are undeniably resource-intensive endeavors. Licensees often grapple with escalating costs, particularly during the initial phases, which frequently exceed initial projections. Such financial strain can erode the licensee's commitment, leading to premature withdrawal from the venture. This was exemplified by Company M, whose Managing Director candidly acknowledged that

the requisite investment in both human and financial capital far outstripped the initial estimates. The challenges of client acquisition compounded the financial burden, proving both costly and time consuming. These financial constraints, coupled with the absence of a local manufacturing partner and a pre-existing client base, rendered the obstacles insurmountable. Consequently, the company never integrated technology commercialization into its corporate strategy and failed to establish clear governance mechanisms. In stark contrast, Companies I and T demonstrated that financial and strategic considerations could significantly influence project success. Both companies exhibited meticulous internal and external task distribution, involving all relevant stakeholders. The technology commercialization process was seamlessly integrated into their overarching corporate strategies, ensuring alignment and focus. Moreover, both companies allocated sufficient budgets to their licensing activities, thereby mitigating financial constraints and enhancing the likelihood of project success. It is noteworthy that Company T made a strategic investment at the inception of the licensing agreement by constructing a pilot solar energy system on their premises. This served dual purposes: it functioned as a commercial showroom and facilitated the homologation process for their local manufacturing partner. In addition to this, Company T actively engaged in marketing efforts, including participation in prominent local solar exhibitions such as Solarex Istanbul and EIF Ankara. Similarly, Company I adopted a proactive approach. All employees involved in the project underwent specialized training in licensing technology, participating in both sales and technical seminars conducted at the licensor's facilities. This investment in human capital not only enhanced the project's viability but also aligned it with the company's broader strategic objectives. In contrast, Company G adopted a more focused strategy due to budgetary constraints. Leveraging its pre-existing in-house manufacturing expertise, the company eschewed additional technical training. Instead, it prioritized the development of its sales activities, allocating its limited budget to sales training seminars. While the company faced complexities in corporate governance, it demonstrated adaptability by implementing the requisite changes to ensure the project's success.

In summary, Company I exemplified the effective implementation of all critical success factors delineated in this study, thereby setting a benchmark for best practices. Company T closely aligned with this model, fulfilling nearly all the critical success factors, albeit with room for improvement in the area of the technology commercialization process. Company G demonstrated moderate success, particularly excelling in relational issues, people, and culture. However, it fell short in the domains of technology commercialization process, facilitators, and governance. Conversely, Company M failed to capitalize on any of the critical success factors under investigation, rendering the failure of their project a foregone conclusion.

5. Discussion and Conclusions

The primary objective of this research was to scrutinize the critical success factors influencing technology commercialization via licensing, with a particular focus on SMEs. In pursuit of this aim, we conducted an in-depth analysis of one licensor—Company L, specializing in the engineering of solar mounting systems—and four distinct licensees (Companies I, T, G, and M), each of which expressed interest in the production and marketing of this technology. A salient, overarching observation emerged from our analysis: three out of the four licensees successfully or at least adequately leveraged key factors—namely, relational issues, culture, people, and resources—that were instrumental in the successful commercialization of their respective technologies. Conversely, the failure of the fourth licensee to effectively capitalize on these same critical factors served as the primary catalyst for the unsuccessful outcome of its commercialization endeavor.

Our findings underscore the pivotal role of relational issues in shaping the outcomes of technology commercialization endeavors. Company L, for instance, strategically leveraged pre-existing partnerships to create synergies, notably with Company T—a prior collaborator in engineering, sales, and marketing—and Company G, a long-standing manufacturing

partner. This approach not only augmented the likelihood of successful project outcomes but also optimized resource allocation, particularly during the initial phases of collaboration. Such synergies conferred additional advantages, including enhanced quality control over licensee-produced products (as evidenced by Company G) and expedited technology familiarization (observed in both Companies T and G). Our data suggest that SMEs stand to benefit significantly from alliances with either suppliers or previous customers, particularly other SMEs. Collaborating with an already market-established entity, such as Company I, may offer advantages but often entails a more protracted time investment. It is imperative to acknowledge the inherent dynamism and variability of most technology sectors, which can be further exacerbated by country-specific external factors. For instance, in the solar photovoltaic sector, unforeseen governmental interventions—such as abrupt reductions in feed-in tariffs—can precipitate a cascade of challenges, including diminished revenue streams, cash flow disruptions, project delays, and ultimately, failed commercialization efforts. Given these considerations, the expeditious establishment of a licensing business is likely to yield more favorable outcomes for licensors. This is particularly true in the context of SME alliances, where streamlined decision-making processes and shared strategic objectives can accelerate project timelines.

The organizational culture of a licensee emerges as another critical determinant of successful technology commercialization. A licensee with a track record of successful licensing endeavors and substantial revenue generation is more likely to be receptive to external innovations and amenable to knowledge sharing. For SME licensors, it is therefore advisable to forge alliances with companies that exhibit an open culture toward licensing. Such openness can manifest either through prior experience in the field, as exemplified by Company I, or through pre-existing collaborations with the licensor, as seen in Companies T and G. It is worth noting that licensing often necessitates financial commitments that can be challenging to budget for, particularly for licensees lacking either relevant operational experience or familiarity with the technology in question. This financial miscalculation was a key factor contributing to the failure of Company M's project. The company harbored unrealistic expectations of immediate revenue generation, only to find that licensing is both a resource-intensive and time-consuming venture.

Another key determinant of success in licensing ventures is the full-time engagement of specialized staff. Ideally, organizations should establish a dedicated licensing department, staffed with a multidisciplinary team of highly skilled professionals who are intrinsically motivated to identify business opportunities and enhance the company's market position. The presence of employees with prior licensing experience, as evidenced in the case of Company I, offers a distinct competitive advantage.

The availability and effective utilization of resources—ranging from time and specialized equipment to financial investment—also emerged as significant factors in the study. Both licensors and licensees must allocate these resources judiciously to sustain a viable licensing business model. Managers overseeing licensing ventures should be prepared to commit adequate resources and temper expectations for immediate financial returns, particularly during the initial six to twelve months of operation. Existing infrastructure, whether in manufacturing as demonstrated by Company G, or in sales as illustrated by Companies I and T, serves as a valuable asset in this context. An attitude of impatience, coupled with unrealistic expectations for immediate revenue generation prior to substantial investment, is fundamentally misaligned with the long-term nature of licensing ventures. This was exemplified by the failure of Company M's project.

The findings of this study offer several critical insights for managers navigating the complex landscape of technology commercialization through licensing, especially within the SME sector. First and foremost, the importance of leveraging existing relationships cannot be overstated. Managers should prioritize partnerships with entities that have complementary skills or prior successful collaborations, as these alliances often lead to more efficient resource allocation and higher chances of project success. Secondly, organizational culture is a pivotal determinant; hence, managers should seek partners with a proven

openness to innovation and a history of successful licensing. This reduces the learning curve and fosters a more collaborative environment. Thirdly, this study underscores the necessity of dedicated, full-time staff for licensing activities. Managers should consider establishing specialized licensing departments to solely focus on identifying and capitalizing on commercialization opportunities. Finally, patience and realistic financial planning are crucial. Managers must be prepared for substantial initial investments and should not expect immediate returns. This long-term perspective is essential for mitigating risks and ensuring the sustainability of licensing ventures.

While this study contributes valuable insights, it also encounters certain limitations. Primarily, its reliance on case studies from a specific industry constrains its broader applicability. While the dynamics between licensor and licensee in sectors like automotive, electronics, and IT are crucial, they may hold different significance in other fields, suggesting that our conclusions may not universally apply. The small sample size of four SMEs further limits the study's scope, potentially missing the diverse and complex aspects of technology commercialization in varied industries and geographies. Additionally, the qualitative case study methodology, while providing depth, lacks the wider generalizability and objective validation of quantitative analyses. This could lead to subjective interpretations, tied closely to the specific context of the cases studied. Furthermore, the rapid advancement in technology and the dynamic nature of international business environments may necessitate a timely reassessment of the findings, in light of emerging technological innovations, market shifts, and evolving regulatory frameworks. These factors should be carefully considered when interpreting and applying the study's findings, acknowledging that they represent a perspective distinctly tailored to a specific sector within a defined temporal context.

The findings of this study open multiple avenues for future research that could further enrich our understanding of technology commercialization through licensing, particularly within the context of SMEs. One intriguing area of inquiry would be to explore the attitudes and perceptions of employees who are not directly involved in the Licensing Department. For instance, how do professionals in the R&D or Sales departments perceive the impact of licensing on their work and the overall business strategy? Such an investigation could employ Organizational Behavior Theory to examine how licensing activities influence inter-departmental dynamics and organizational culture. Another promising direction would be to examine the licensing process from the vantage point of the end customer. How do licensing agreements affect product quality, customer satisfaction, and brand perception? The Service-Dominant Logic theory could offer a useful framework for this line of research, focusing on value co-creation between the licensee and the end customer. The role of intellectual property rights in shaping the relationships between licensors and licensees, and their subsequent impact on technology commercialization projects, warrants in-depth study. Theories from Law and Economics could be applied to analyze how different intellectual property rights regimes influence the risk and reward profiles for both parties. Given the international scope of many licensing agreements, an examination of how geopolitical factors and trade regulations impact technology commercialization would be beneficial. International Business Theory could serve as a guiding framework for such an investigation. Lastly, the study of incentive policies, including royalty structures and other motivational tools, is crucial. Behavioral Economics could provide insights into how various incentives influence decision-making processes and outcomes. By addressing these areas, future research can offer a more comprehensive and nuanced understanding of the complexities involved in technology commercialization through licensing. This would not only contribute to the academic discourse but also provide actionable insights for practitioners in the field.

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Appendix A

Questionnaire utilized for the semi-structured interview with the licensor (Company L):

- Could you provide a brief history of your company?
- What is the current size of your company (e.g., number of employees, annual revenue)?
- Can you describe your main products or services?
- Can you describe the primary objectives of your technology commercialization projects through licensing alliances with Companies I, T, G, and M?
- How do these licensing alliances fit into your overall strategy for market penetration in targeted geographic locations?
- Could you detail the range of solar mounting systems configurations you offer through these alliances?
- What are the specific engineering and technical responsibilities that your company retains in these licensing alliances?
- How does your company approach the manufacturing phase in these international markets?
- Can you elaborate on the economic considerations that led you to leverage local manufacturing facilities instead of using Spanish suppliers?
- What criteria do you use to select potential licensees for your technology?
- Can you discuss the importance of a licensee's willingness and capability to produce and market your technology in their local markets?
- Could you describe the nature of your relationship with these licensees, particularly in terms of their satisfaction and collaboration history?
- How do pre-existing networks influence your decision to target specific licensees?
- What complexities and challenges have you encountered in commercializing technology via licensing?
- How does your company mitigate the risks associated with these complexities and failures?
- What do you consider as your company's core competencies in the design and development of solar mounting systems?
- How does your technical expertise and experience play a role in these licensing partnerships?
- How do you assess the outcomes of your licensing alliances with Companies I, T, G, and M?

Appendix B

Questionnaire utilized for the semi-structured interviews with the licensees (Companies I, T, G, and M):

- Could you provide a brief history of your company?
- What is the current size of your company (e.g., number of employees, annual revenue)?
- Can you describe your main products or services?
- Why did your company choose licensing as a strategy for technology commercialization?

- How did you go about selecting your licensing partner?
- Can you describe the nature of your licensing alliance?
- Can you describe your company's approach to the technology commercialization process in collaboration with Company L?
- How do you adapt the commercialization process to align with different technologies and market conditions?
- How do relational dynamics with Company L influence the success of your licensing alliance?
- Have you engaged any external facilitators or trainers to assist in the technology commercialization process? If so, how have they contributed?
- Can you discuss the role and composition of the team involved in the technology commercialization project?
- How does leadership within your company contribute to the success of the licensing alliance?
- What aspects of your company's culture have been pivotal in navigating the technology commercialization process?
- What resources (financial, human, etc.) have been crucial in your technology commercialization efforts?
- How is governance structured in your company for overseeing the licensing process?
- How does technology commercialization via licensing integrate into your overall corporate strategy?
- How do you assess the outcomes of your licensing alliance with Company L?

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