

Evaluating the Impact of Technology Transfer from the Perspective of Entrepreneurial Capacity

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Abstract

This paper examines the benefits of and barriers to technology transfer from academia to industry perceived by entrepreneurs, and those particularly associated with the dimensions of Entrepreneurial Capacity. The presented study is one of the first in which the analysis of the topic goes beyond the high-tech sectors. It is based on a survey of representatives of Small and Medium Enterprises (SMEs) dedicated to the production of Leather and Footwear in Peru. The main findings were that the Absorption Capability

dimension had a positive relationship coefficient with the understanding of the benefits of and barriers to technology transfer, while the Networking Diversity dimension presented a negative relationship coefficient. Likewise, this study shows that the main barriers to technology transfer were the fear of information leaks and the lack of training. The results of this research can add value for decisionmakers in industry, academia, and government agencies interested in science and technology policies.

Keywords: entrepreneurial capacity; strategies; technology transfer; SMEs; absorption capability; networking diversity; STI policy.

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Technology transfer comprises the exchange of skills, technology, or knowledge between academic institutions and industry (Henry et al., 2009). In recent years, this topic has begun to take on greater relevance due to its contribution to business competitiveness, especially in the Small and Medium Enterprises (SME) sector. Technology transfer involves a process that requires collaboration between companies, universities, research institutes, Technology Transfer Offices (OTT), and financing agents, among others, where the necessary conditions for favorable interactions can also be established (Rücker et al., 2018). All this can lead to creating sustainable innovative ecosystems with a vision for the future (Komlósi et al., 2019).

At the macro level, as the Triple Helix Model points out, the interaction between Business, Academia, and the Public Sector can occur through OTTs, Technology Parks, and Innovation Centers (Etzkowitz, Leydesdorff, 2000). These entities can help SMEs overcome the limitations they face such as the lack of unified networks that streamline the linking process (Shmeleva et al., 2021), access to infrastructure and human resources (Arredondo et al., 2016), as well as the lack of experience and strategic vision (Rogers, 2003; Jung, 1980). Unquestionably, universities play a key role in this process, since they offer a variety of technological services and products that favor productive development (Guerrero, Molero, 2019; Maresova et al., 2019; Baglieri et al., 2018), including the generation of new tools according to each context (Apa et al., 2020). Several Latin American countries such as Colombia, Mexico, Chile, and Peru have found a key element in this field to improve the competitiveness of their industries, allowing them to adopt new tools, transform their processes, and create value to meet the demand of the national and international market (Shmeleva et al., 2021; Garrigós, Nuchera, 2008).

Particularly, in the public sector of Peru, programs are offered to support adoption and technology transfer by providing access to financial resources, as well as strategic training. However, only 14.7% of companies, especially SMEs, include technology transfer activities in their innovation processes (CONCYTEC, 2016). To discover the factors that influence entrepreneurs to undertake technology transfer activities or eschew them, this paper examines the benefits of and barriers to this activity using the Entrepreneurial Capacity approach. Considering that SMEs were those with the greatest limitations in terms of technology transfer activities, it was for this reason that they were chosen to be studied, specifically SMEs in the Leather and Footwear sector in Peru. For the purposes of this study, technology transfer is related to Entrepreneurial Capacity through two of its dimensions. First, Absorption Capability, which represents the ability to obtain and process data from the environment to improve company decisions, and secondly, Networking Diversity, focused on the network of contacts that the company has to improve its strategic orientation.

Technology Transfer and Entrepreneurial Capacity

Technology transfer comprises the exchange of skills, technology, or knowledge between different entities, primarily academia and businesses (Henry et al., 2009). In the last two decades, various models have been proposed for the link between both entities (Maresova et al., 2019), involving the public sector as a facilitator agent that can promote the success of transfer programs (Shmeleva et al., 2021; Tunca, Kanat, 2019; Baglieri et al., 2018). Technology transfer involves a process that not only entails important benefits but also barriers to face, elements that have been addressed mainly using descriptive and qualitative approaches (Hafeez et al., 2018; Collier et al., 2011; Shen, 2017). These studies highlight the need to have intermediate communication mechanisms and channels that make scientific and technological exchange feasible (Gilsing et al., 2011; Balconi, Laboranti, 2006), which requires legal support (Kenney, Patton, 2009) as well as financial resources (Mojaveri et al., 2011; Martyniuk et al., 2003). To facilitate the interactions between companies and universities, the latter use Technology Transfer Offices (TTOs) and the public sector employs its equivalent, which would be Linkage Centers, to overcome barriers and highlight the benefits of the technology transfer process (Goel et al., 2017).

Several benefits that produce technology transfer activities have been identified as drivers of innovation, new product development, improvement of products and services, access to financial resources, infrastructure improvement, and shared risk among participants. Through technology transfer, companies have also developed new management competencies and improved the professionalization of their people (O'Reilly, Cunningham, 2017; Hofer, 2009), increasing their competitiveness. On the other hand, for a successful technology transfer, various barriers must be overcome, for example, the lack of financial resources, support from senior management, qualified human resources, training, proper guidelines for the implementation of new technologies, and trust between partners. Furthermore, skepticism poses a barrier, as does limited planning and forecasting, scarce R&D activities, inadequate or insufficient information, deficient communication, cultural barriers, resistance to change, as well as organizational and country risks. (O'Reilly, Cunningham, 2017; Khan et al., 2017; Hofer, 2009).

Although various barriers and benefits have been detected in technology transfer activity, it would add a lot of value for SMEs to also examine their relationship with Entrepreneurial Capacity to identify opportunities for development and strategic linkages. According to Rodríguez-López and Souto (2020) and Zeithaml and Rice (1987), Entrepreneurial Capacity is an ability acquired by entrepreneurs to develop a project or business while minimizing risks, making decisions in uncertain environments, adapting to rapid growth in volatile contexts, and maintaining

an efficient work network with other companies in the sector. In this way, Entrepreneurial Capacity integrates the strategic vision and understanding of the context where the project or business is developed (Bacigalupo et al., 2016; Shane, Venkataraman, 2000; Frese, Gielnik, 2014), for which the information analysis with a long-term vision is essential. In addition, Entrepreneurial Capacity is often associated with the company's maturity level (Dunham, 2010; Kodithuwakku, Rosa, 2002) and productive efficiency (Rodríguez-López, Souto, 2020).

In particular, Radoslaw (2014) proposes that Entrepreneurial Capacity comprises two critical dimensions, which were considered for this study. The first, Networking Diversity, establishes a number of inter-organizational links between the company and external partners at local, regional, and national levels while taking into consideration information and knowledge connections. The second dimension is Absorption Capability, which represents the efficiency of companies in understanding, processing, as well as using information internally and correctly, transforming it into knowledge that generates value, thus facilitating the identification of opportunities.

Current State of the Leather and Footwear Industry in Peru

According to the Banco Central de Reserva del Perú [2021], total national Non-Primary Manufacturing in Peru accounts for 8.4% of Gross Domestic Product (GDP). The Leather and Footwear sector is included in this category, and it represents 1.1% of the total national Non-Primary Manufacturing previously mentioned, which means it accounts for 0.13% of GDP (BCRP, 2021), generating employment for more than 45,557 people in the country, 42.3% of which corresponds to the La Libertad region encompassing the cities of Trujillo, El Porvenir, Florencia de Mora, and La Esperanza. In these cities there are a total of 3,148 formal businesses, from micro-enterprises to small and medium-sized enterprises (Cosavalente, 2019). However, a large part of these entrepreneurs lack access to information and financing, limiting their entrepreneurial capacity for technology transfer (Roca, 2015). The Centers for Productive Innovation and Technology Transfer (CITE) financed by the government are key agents for reducing this gap, since they can facilitate the adoption of knowledge and technological resources that lead to better performance. Although there are studies related to technology transfer in Latin America, their focus has been mainly associated with highly technical industries, such as the study by Arenas (2018) specifically focused on Start-ups. Therefore, it is important to delve into other fields, such as the SME sector, which are more traditional.

Peruvian entities, such as the National Council for Science, Technology, and Technological Innovation (CONYTEC) and the Center for Productive Innovation and Technology Transfer for Leather and Footwear (CITEccal), promote the identification of potential technologies to be transferred in the leather and footwear industry to support the tanning and dressing of leather, the manufacturing of footwear and leather articles such as trunks, suitcases, handbags, briefcases, wallets, document holders, covers, cases, saddlery, garments, and clothing accessories, among others. In addition, CONCYTEC and CITEccal promote research projects on the development of new products and services in the leather, footwear, and related industries, including the reuse of waste as a way of innovating, as well as the use of clean technologies, and new techniques to reduce the negative impact on the environment. Particularly, CITEccal is developing various technological research projects such as the use of tanned fish skin in leather goods, preserving their color and patterns, and the recovery of chrome shavings for their reintroduction into the tanning process, and determining the optimal hydrolysis process for the recovery of hydrolyzed collagen and chromium salts. Likewise, CITEccal is continuously identifying technological advances such as leather dyeing through natural colorants, the functionalization of leather surfaces through the application of nanomaterials, and the technologies associated with the design and manufacture of comfortable and ergonomic footwear. For instance, the personalized footwear trend represents an opportunity to use technologies such as 3D printing for footwear and customized insoles, the 3D image of the foot using smartphones, biomechanical footwear for people with obesity, and personalized insoles to prevent pressure from ulcers in diabetic patients.¹

So far in Peru there is no research that analyzes technology transfer and its relationship with the Entrepreneurial Capacity at SMEs. Given the importance of both elements for the development of companies, this paper seeks to examine the benefits of and barriers to technology transfer, and relate them to the dimensions of Entrepreneurial Capacity, for which four hypotheses were formulated, through which a descriptive model was proposed:

- 1) There is a positive correlation between Networking Diversity and perceived barriers to technology transfer.
- 2) There is a positive correlation between Networking Diversity and the perceived benefits of technology transfer.
- 3) There is a positive correlation between Absorption Capability and the perceived barriers to technology transfer.
- 4) There is a positive correlation between Absorption Capability and the perceived benefits of technology transfer.

¹ <https://citeccal.itp.gob.pe/boletin-vigilancia-tecnologica-en-cuero-y-calzado/>, accessed 25.01.2023.

Research Methodology

This study was developed through a non-experimental correlational-descriptive analysis in two phases. The first phase was the development of a questionnaire, which was divided into two sections. In the first section, Radoslaw's proposal was used to measure Entrepreneurial Capacity in two dimensions: Network Diversity and Absorption Capability (Radoslaw, 2014). For this, a total of 13 questions were established based on the indicated proposal, five of which correspond to the first dimension that considers local, regional, and national networking. The other eight questions focused on the ability of entrepreneurs to acquire, process, and transform information from the environment. The second section of the questionnaire was based on the Hofer (2009) scheme to assess the opinion on barriers to and benefits of technology transfer perceived by businessmen, for which 17 questions were established based on the aforementioned scheme. Nine of them focus on benefits, while eight focus on barriers. To record the responses, a 7-point Likert scale was used, with values ranging from 1 (totally disagree) to 7 (totally agree).

To determine whether the questions used in this research presented an adequate level of reliability, a Cronbach's Alpha coefficient was used for statistical verification. This coefficient was applied to a pilot test of 15 entrepreneurs representing the Center for Productive Innovation and Technology Transfer of Leather, Footwear and Related Industries (CITEccal) Trujillo from the La Libertad region in Peru, obtaining values greater than 70%, which confirm the reliability of the questions considered in the questionnaire. This demonstrates high internal consistency and the validity of the questions (Easterby-Smith et al., 2015), whose detailed parameters are shown in Table 1.

The second phase of the study involved sending a questionnaire to entrepreneurs enrolled at CITEccal, who had participated in training, services, and technology transfer processes between 2018 and 2021, who had at least five years of experience in the sector. For this, we worked with a database of 115 businessmen registered at CITEccal Trujillo, who met these criteria. A total of 81 businessmen answered the questionnaire over a period of two months, from May 20 to July 10, 2021.

For the processing of the obtained results, SPSS (version 22) software was used, through which the Spearman Rank Correlation Coefficient was analyzed as an inferential statistical method, thus verifying the relationship between the variables (Anderson et al., 2008).

Figure 1 shows the main barriers and benefits that influence technology transfer activities that are particularly present in SMEs in the Leather and Footwear sector in Peru. These elements were assessed via a questionnaire on a Likert scale to understand how they were perceived.

Results and Discussion

The results of the descriptive statistical analysis carried out are presented in Tables 2 and 3. The first table shows that the majority of businessmen who participated in technology transfer activities in the last three years and responded to the survey are: women (59.26%), owners of a company in a managerial position (48.1%), people with five to 15 years of experience in the Leather and Footwear industry (56.8%), and with ages ranging between 19 and 35 years (39%). On the other hand, the results in Table 3 show the perceived barriers to and benefits of technology transfer that entrepreneurs constantly face. As mentioned, the questions were prepared on a Likert scale with values ranging from 1 (totally disagree) to 7 (totally agree). The average value obtained in relation to the perceived barriers ranges between 4.963 and 5.383. These values are considered high as they are between 1 and 7 points and above the average. In the case of perceived benefits, the results range between 4.469 and 5.383, also considered high values. Among the three most notable barriers for entrepreneurs are the fear of information leaks, the lack of management of indicators, and the lack of information on how to use a technology (Table 3). Regarding the perception of benefits, businessmen consider that technology transfer allows them, above all, to promote three key elements: access to new clients and markets, links to universities and suppliers, as well as access to financing from public and private institutions. Furthermore, other benefits also motivate them to carry out technology transfer activities.

In order to evaluate the four hypotheses indicated in the previous section, inferential statistics were applied to determine correlation coefficients, showing the findings in Tables 4 and 5. Table 4 shows the first correlation between the Networking Diversity dimension and the perceived barriers to technology transfer of the 81 participating entrepreneurs, obtaining a p-value greater than 0.05, that is, a negative relationship ($p = 0.414$), for which reason Hypothesis 1 is rejected. Likewise, the second test presented corresponds to the

Table 1. Cronbach's Alpha Values for the Studied Variables

Variable	Cronbach's Alpha
<i>Dependent variables (Barriers, Attributes and Benefits of Technology Transfer)</i>	
Barriers Perceived	0.909
Benefits Perceived	0.834
<i>Independent variables (Entrepreneurial Capacity Dimensions)</i>	
Networking Diversity	0.840
Absorption Capability	0.836

Source: authors.

Table 2. Demographic Characteristics of the Respondents

Item	Number of respondents	Share (%)
Gender		
Male	33	40.74
Female	48	59.26
Work Position		
Administrative Manager	12	14.8
Operations manager	5	6.2
General Manager	25	30.9
Owner	39	48.1
Work Experience in the Leather and Footwear Industry		
5–15 years	46	56.8
15–25 years	20	24.7
25–35 years	10	12.4
Over 35 years	5	6.2

Source: authors.

relationship between the Networking Diversity dimension and the perceived benefits of technology transfer where a p-value of 0.997 was obtained, which is higher than 0.05 and leads to a negative relationship; therefore Hypothesis 2 is also rejected.

Table 5 shows the relationship between the Absorption Capability dimension and the perceived barriers to technology transfer, obtaining a p-value of less than 0.05 and a Rho coefficient = 0.352, which is considered a weak positive or valid relationship by virtue of the coefficient found, confirming Hypothesis 3. Finally, the Absorption Capability dimension was evaluated with the perceived benefits, obtaining a p-value less than 0.05 and a Rho coefficient = 0.558, which represents a moderate positive relationship, confirming Hypothesis 4.

Based on these results, a descriptive model is proposed of relationships between the Networking Diversity and Absorption Capability dimensions corresponding to Entrepreneurial Capacity with the barriers to and benefits of technology transfer, as shown in Figure 2. This model is the result of the analysis focused on SME entrepreneurs of the Center for Productive Innovation and Technology Transfer (CITE) of Leather and Footwear in the La Libertad region of Peru. It can be seen that the Networking Diversity dimension has a negative relationship both with the barriers to and the perceived benefits of technology transfer by entrepreneurs. While the Absorption Capability dimension presents positive relationships with the barriers to and perceived benefits. In this sense, the study carried out shows that relationships with business partners and suppliers (Networking Diversity) do not necessarily favor the development of technology transfer activities.

Figure 1. Technology Transfer's Barriers and Benefits



Table 3. Descriptive Statistics of Exogenous Variables (Perceived Barriers to and Benefits of Technology Transfer)

Evaluated parameters	Mean value	Standard deviation
Barriers Perceived		
Fear of information leak	5.321	1.2925
Lack of management of indicators	5.284	1.1207
Lack of information on how to use a technology	5.272	1.0608
Skepticism	5.210	1.1260
Limited human resources	5.160	1.2496
Negative impact	5.160	1.2496
Uncertainty of results	5.111	1.2748
High costs	5.099	1.4196
Difficulty of adaptation	4.963	1.3365
Benefits Perceived		
Access to new markets	5.383	1.3093
Links with universities and providers	5.284	1.1644
Obtain external financing	5.259	1.2528
Reduce shortfalls in operations	5.000	1.2649
Ability to hire HR	4.975	1.3321
Product and process improvement	4.889	1.2942
New products and processes developed	4.630	1.0179
Processes to get collaborators	4.469	1.6054

Source: authors.

Table 4. Rho Spearman Coefficient of Diversity Networking and Barriers, Benefits, and Attributes ($p < 0.01$)

Independent Variable - Diversity Networking	Statistical indexes			
	Dependent Variable	N	Rho Spearman coefficient	P-Value
Variable 1	Barriers	81	0.092	0.414
Variable 2	Benefits	81	0.000	0.997

Source: authors.

Table 5. Rho Spearman Coefficient of Absorption Capability and Barriers, Benefits, and Attributes ($p < 0.01$)

Independent Variable - Absorption Capability	Statistical indexes			
	Dependent Variable	N	Rho Spearman coefficient	P-Value
Variable 1	Barriers	81	0.352	0.001
Variable 2	Benefits	81	0.558	0.001

Source: authors.

On the other hand, the Entrepreneurial Capacity in this group of entrepreneurs is mainly based on their ability to process information from the environment (Absorption Capability), which allows them to better understand the characteristics and benefits of technology transfer.

Conclusion

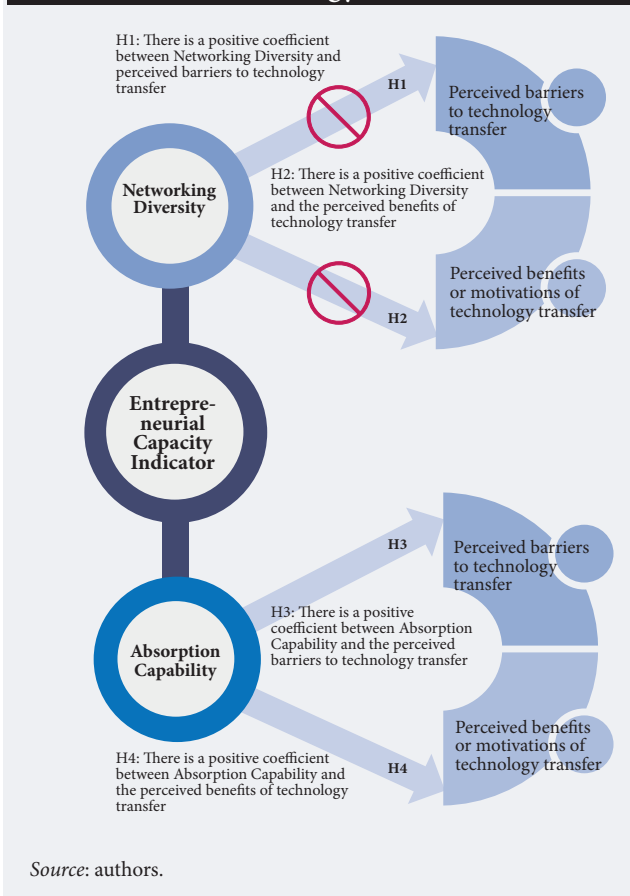
The objective of this research was to examine the benefits of and barriers to technology transfer relat-

ing it to the dimensions of Entrepreneurial Capacity for a total of 81 entrepreneurs registered at the Center for Productive Innovation and Technology Transfer (CITEcall Trujillo) for Leather and Footwear in the Libertad region of Peru. Research on technology transfer in this country is incipient. The most recent studies have focused on analyzing the effect of technology transfer on the development of ventures such as startups or spin-offs, but there are no references focused on traditional SMEs as in the case of Leather and Footwear.

The results of the descriptive analysis showed that the participants who carried out technology transfer processes in the last three years are mainly between 19 and 35 years old and have between five and 15 years of experience in this industry. Entrepreneurs in this sector have a high level of barriers, essentially due to fear and lack of personnel as well as poor readiness to take on new challenges. The benefits that most attract these entrepreneurs to carry out technology transfer activities are being able to reach new markets and form connections with specialized research centers at universities. The inferential analysis that was carried out shows that the Networking Diversity dimension of Entrepreneurial Capacity has a negative relationship with the perception of barriers and benefits by entrepreneurs, while the Absorption Capability dimension of Entrepreneurial Capacity presents a positive relationship with the aforementioned barriers and benefits. This shows that the ability of SME entrepreneurs to analyze information from the environment allows them to better understand the characteristics of technology transfer, while relationships with business partners and suppliers do not favor this process.

This result allows us to identify a clear opportunity to improve planning processes and the strategic management of technology transfer at SMEs in key sectors in Peru, such as Leather and Footwear, which represents 0.13% of GDP. This information can be useful for government agencies and decisionmakers in academia and industry, who could improve communication channels and linking activities to consolidate a diverse system of relationships for the benefit of technology transfers. Likewise, entrepreneurs could be trained to

Figure 2. Descriptive Model of Entrepreneurial Capacity and Perceived Benefits of and Barriers to Technology Transfer



eliminate the barriers that affect confidence in technology transfer in the country, especially by reinforcing positive relations in the sector.

A limitation of this study is that this research did not consider all 115 businessmen registered in the Leather and Footwear CITE of the La Libertad region who have carried out technology transfer activities. However, 81 of them were interviewed, meaning 70.43%, to investigate Entrepreneurial Capacity and the perception of barriers to and benefits of technology transfer. Future research could compare the results with a higher percentage of interviewees within the same sector, as well

as explore the similarities and differences of the results with other sectors in which the Peruvian government also invests, such as the textile and agricultural industries, to promote technology transfer. It is also recommended that one carry out a further analysis of business groups at the international level.

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