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Scientific articles

Validación de Instrumento de medición para Transferencia de Tecnología Intra-Empresa

Validation of a Measurement Instrument for Intra-firm Technology Transfer

***Validação de Instrumento de Medição para Transferência de Tecnologia
Intraempresarial***

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Resumen

Este estudio valida un instrumento de medición diseñado para analizar las relaciones entre los componentes de la capacidad de absorción y su impacto en la transferencia de tecnología intra-empresa, un proceso clave para potenciar la competitividad e innovación en organizaciones industriales. El instrumento, basado en un modelo teórico que integra constructos como gestión del conocimiento, liderazgo, agilidad organizacional y talento humano calificado, entre otros, fue sometido a un riguroso proceso de validación mediante el juicio de expertos: dos académicos y dos profesionales del sector manufacturero.

Los resultados demostraron que el instrumento mide con precisión las dimensiones propuestas, permitiendo identificar cómo cada componente de la capacidad de absorción influye significativamente en la efectividad de la transferencia tecnológica interna. En particular, este estudio destaca que la integración de capacidades organizacionales robustas potencia la implementación de tecnologías avanzadas en contextos industriales altamente competitivos. Estas conclusiones subrayan la relevancia del instrumento para investigaciones futuras y su utilidad como herramienta estratégica para optimizar la transferencia de tecnología en sectores industriales clave, especialmente en regiones como Ciudad Juárez, donde las dinámicas tecnológicas son críticas para el desarrollo competitivo.

Palabras Clave: Transferencia de Tecnología, Validación de Contenido, Juicio de Expertos, Capacidad de Absorción.

Abstract

This study validates a measurement instrument designed to analyze the relationships between the components of Absorptive Capacity and their impact on intra-firm technology transfer, a critical process for maximizing competitiveness and fostering innovation in industrial organizations. The instrument, based on a theoretical model integrating constructs such as knowledge management, leadership, organizational agility, and qualified human talent and others, underwent a rigorous validation process through expert judgment: two academics and two professionals from the manufacturing sector.

The results demonstrated that the instrument accurately measures the proposed dimensions, allowing the identification of how each component of Absorptive Capacity significantly influences the efficiency and effectiveness of internal technology transfer. The study notably highlights how robust organizational capabilities enhance the implementation of advanced technologies in dynamic industrial contexts. These conclusions underscore the relevance of the instrument for future research and its utility as a strategic tool to optimize technology transfer in key industrial sectors, particularly in regions like Ciudad Juárez, where technological dynamics are critical for competitive development.

Keywords: Technology Transfer, Content Validation, Expert Judgment, Absorptive Capacity.

Resumo

Este estudo valida um instrumento de medição projetado para analisar as relações entre os componentes da capacidade de absorção e seu impacto na transferência de tecnologia intrafirma, um processo fundamental para aumentar a competitividade e a inovação em organizações industriais. O instrumento, baseado em um modelo teórico que integra construtos como gestão do conhecimento, liderança, agilidade organizacional e talento humano qualificado, entre outros, foi submetido a um rigoroso processo de validação por meio do julgamento de especialistas: dois acadêmicos e dois profissionais do setor manufatureiro.

Os resultados mostraram que o instrumento mede com precisão as dimensões propostas, permitindo identificar como cada componente da capacidade de absorção influencia significativamente a eficácia da transferência interna de tecnologia. Em particular, este estudo destaca que a integração de capacidades organizacionais robustas melhora a implementação de tecnologias avançadas em contextos industriais altamente competitivos. Essas descobertas ressaltam a relevância do instrumento para pesquisas futuras e sua utilidade como uma ferramenta estratégica para otimizar a transferência de tecnologia em setores industriais importantes, especialmente em regiões como Ciudad Juárez, onde a dinâmica tecnológica é crítica para o desenvolvimento competitivo.

Palavras-chave: Transferência de Tecnologia, Validação de Conteúdo, Julgamento Pericial, Capacidade de Absorção.

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Introduction

In the context of intra-firm technology transfer in Ciudad Juárez, the concept of absorptive capacity plays a crucial role in determining how effectively an organization can acquire, assimilate, and apply new and existing technology to maintain a competitive advantage and foster internal innovation. This process is essential for firms seeking to continuously improve their processes and products by acquiring knowledge and advanced technologies in the business cluster (Singh et al., 2023; Tippakoon et al., 2023).

Absorptive capacity is divided into two main components: potential, related to the firm's ability to identify, understand, and evaluate the value of external knowledge; and realized, focused on the effective application of such knowledge for business purposes. These

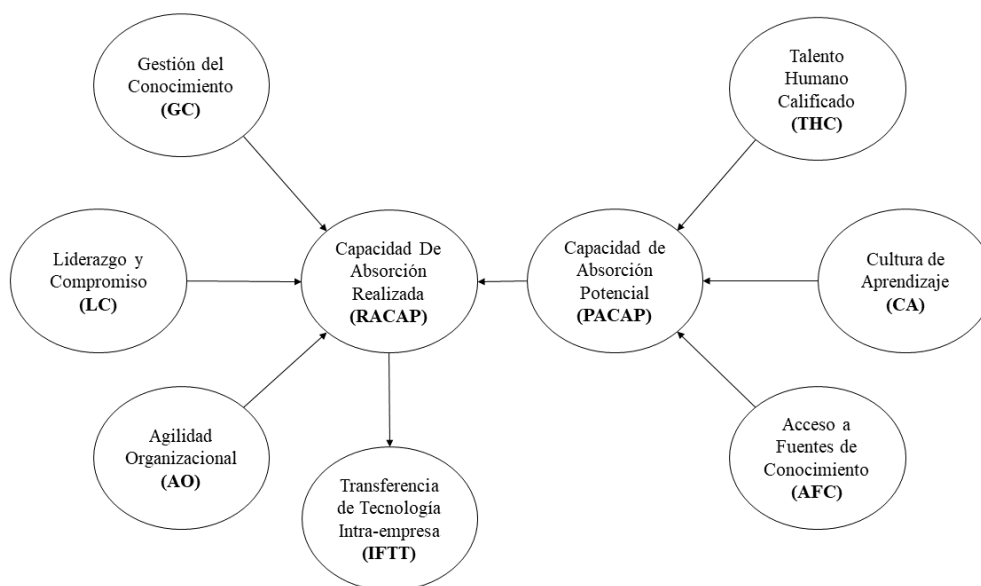
dimensions allow organizations not only to acquire new technologies, but also to adapt and apply them in their operations. This conceptual framework has been key in previous research on the impact of absorptive capacity on organizational performance (Truong & Nguyen, 2024).

The relationship between intra-firm technology transfer and absorptive capacity is manifested in the effective management of knowledge to drive innovation and optimize organizational processes. Organizations with high absorptive capacities are better able to integrate new technologies in ways that complement and enhance their existing resources. This link is consistent with research highlighting how absorptive capacity facilitates effective technology transfer ecosystems (Conlé et al., 2023).

The development of an effective intra-firm technology transfer strategy, supported by robust absorptive capabilities, enables firms to maximize the value of technological innovations and ensure that these advances contribute to their competitive success. Furthermore, it fosters an environment of continuous innovation, where knowledge and technology are strategically used to maintain competitiveness in a dynamic global market (Yang et al., 2023).

Through a systematic literature review using the PRISMA methodology, multiple factors related to intra-firm technology transfer have been identified (Quijano, 2023). In the specific context of Ciudad Juárez, a major industrial and technological center, research on intra-firm technology transfer and its interaction with absorptive capacity takes on particular relevance. Given the concentration of manufacturing and technological industries in the region, exploring these dynamics from a statistical approach not only clarifies the underlying relationships and processes, but also facilitates the formulation of effective strategies for technological implementation. This statistical approach will allow not only to understand current dynamics, but also to foresee and plan for future technological and organizational developments, ensuring that companies in Ciudad Juárez stay at the forefront of innovation and maintain their competitive advantage.

Figure 1: Conceptual model



Source: Own elaboration

The conceptual model, as shown in Figure 1, illustrates how intra-firm technology transfer is intrinsically linked to potential and realized absorptive capabilities. Different dimensions of absorptive capacity, such as knowledge management, leadership and commitment, organizational agility, qualified human talent, learning culture, and access to knowledge sources, play a vital role in the effective implementation and utilization of new technologies within the firm.

Methodology

The methodology of this research focuses on the meticulous operationalization of the essential constructs to understand the dynamics of intra-firm technology transfer. Such operationalization is crucial to assess absorptive capacity and facilitate the implementation of technologies within organizations. The key constructs addressed are Knowledge Management (KM), Leadership and Commitment (LC), Organizational Agility (OA), Realized Absorptive Capacity (RACAP), Potential Absorptive Capacity (PACAP), Qualified Human Talent (THC), Learning Culture (LC), Intra-Firm Technology Transfer (IFTT) and Access to Knowledge Sources (AFC).

The instrument is designed for application in manufacturing industries, especially those oriented towards high-tech production, such as the electronics, automotive and aerospace industries. These industries, characterized by their dynamism, require efficient technology transfer processes to preserve their competitive advantage.

Each construct is defined through both conceptual and operational dimensions that allow for rigorous understanding and application. Operationalization includes the creation of detailed measurement items, facilitating quantitative assessments that reveal the direct impact of each factor on technology transfer. This approach provides clarity on how these constructs manifest in business practice and establishes a solid foundation for the effective application of technology transfer strategies and for future research in this vital field.

The validation of the measurement instrument is carried out through the judgment of four experts: two academics and two professionals from the electronic device manufacturing sector in Ciudad Juárez. This validation seeks to ensure that the instrument is suitable for accurately and effectively measuring the study variables and that the results obtained can be used to make informed decisions to improve processes in the intra-company context.

The following sections of the paper will delve deeper into each of the aforementioned constructs, providing a thorough exploration of the measurement items and the validation structure employed. This breakdown ensures a comprehensive understanding of the adopted methodological framework, providing a clear understanding of the interrelationship between theoretical and practical elements in intra-firm technology transfer research.

Knowledge management

Knowledge Management (KM) is an essential process in the modern organizational structure that spans from the initial generation and capture of knowledge, both implicit and explicit, to its assimilation and strategic application to drive innovation and optimize organizational products and processes. It refers to the process of understanding and leveraging knowledge within an organization in order to gain a competitive advantage. This involves sharing, acquiring, disseminating, exchanging and preserving information, using technologies such as knowledge management systems (KMS). Furthermore, it is closely related to the effective implementation of document management systems and participation in online information discussions (Mubuyaeta and Ponera, 2023). The systematic implementation of KM strategies plays a crucial role in maintaining and advancing innovation (Alegre et al., 2013), allowing for a significant improvement in innovation capability. This not only strengthens the company's competitive position in the short term, but also lays the foundation for sustainable growth and adaptability in the long term.

The importance of KM is evidenced by the direct correlation between effective knowledge management and an increase in the innovative capacity of organizations, as pointed out by Siregar et al. (2019). This link translates into a greater capacity to take advantage of emerging opportunities and continuous improvement of operational performance. Andrea and Wanyoike (2024) highlight the critical importance of KM for organizational performance. They point out that practices vary significantly between organizations and national contexts, depending on knowledge-oriented economies. The authors underline the need to adopt deliberate and effective strategies, directly linking their implementation to improved organizational performance.

The strategic use of KM has a profound impact on the development of organizations, facilitating the creation and maintenance of lasting competitive advantages. Through the effective integration and application of knowledge, organizations continue to adapt to changes in the market and environment, ensuring their long-term success and viability. KM is not only an essential process for organizational optimization, but also a critical resource for achieving sustainable competitive advantages in the context of varied economies. Table 1 shows the conceptual description, operational description and proposed items for the KM construct.

Table 1: Operationalization of the Knowledge Management (KM) Construct

Construct	Conceptual Description	Operational Description	Items for measurement
Knowledge Management (GC)	Process by which organizations generate value from their intellectual capital and existing knowledge.	It is materialized through defined procedures for the acquisition, integration and dissemination of knowledge. These processes are supported by organizational policies that promote the active transfer and strategic application of knowledge.	GC1.- The organization systematizes the collection of information relevant to daily operations.
			GC2.- Changes are made to the organization's processes to integrate new knowledge.
			GC3.- In the organization, there is an active flow of relevant information between team members.
			GC4.- There are standards that facilitate the exchange of knowledge within the organization.
			GC5.- Newly acquired knowledge is strategically implemented to drive improvements in organizational practices.

Source: Own elaboration

Leadership and Commitment

In the field of organizations, leadership is understood as the ability to effectively influence and manage employees, relying on moral principles such as trust and honesty. Effective and ethical leadership is crucial to retaining employees and fostering strong organizational commitment. It is observed that a leadership style that promotes fair and ethical treatment contributes significantly to the integration of the employee with the objectives and values of the organization, thus enhancing their intrinsic motivation and commitment to work (Santiago-Torner, 2023).

On the other hand, commitment in the organizational environment is influenced by several factors, among which leadership behavior and approach play a fundamental role. Effective leadership can reduce the natural tendency of workers to seek new employment opportunities, increasing their intrinsic motivation and commitment to work activity. Rejas et al. (2021) propose that transformational leadership plays a key role in aligning the strategic objectives of organizations.

This leadership style motivates and inspires employees to align themselves with the organization's goals and interests, fostering a culture of innovation. Transformational leaders empower subordinates, promote creativity, and generate a work environment conducive to learning and innovation, which directly impacts the quality and performance of the institution. Table 2 shows the conceptual description, operational description, and proposed items for the Leadership and Commitment (LC) construct.

Table 2: Operationalization of the Leadership and Commitment (LC) Construct

Construct	Conceptual Description	Operational Description	Items for measurement
Leadership and Commitment (LC)	Leaders' ability to inspire, influence and guide employees toward organizational goals.	They manifest themselves through effective communication of the organizational vision and mission, the exercise of leadership that mobilizes change, positive evaluation of leaders by staff, and congruence between individual employee goals and company objectives.	LC1.- Senior management clearly communicates the organization's vision and mission to all staff, ensuring their understanding and alignment with strategic objectives.
			LC2.- Leaders inspire others with a clear vision of the future, motivating them to achieve ambitious goals.
			LC3.- Leaders demonstrate effective skills to motivate the team, guiding it with clarity.
			LC4.- Leaders show empathy towards the needs of employees, promoting a collaborative work environment.
			LC5.- Leaders ensure that employees' personal objectives support organizational goals.

Source: Own elaboration

Organizational Agility

Both organizational flexibility and agility have become fundamental terms in the business operations and management literature. Gómez-Duque et al. (2023) propose that flexibility is an organization's ability to adapt to changes and challenges with some foresight, this adaptive capacity is crucial to maintaining a competitive advantage in a dynamic market. Akpan and Adim (2023) propose that strategic flexibility empowers small and medium-sized enterprises to adapt to changing market conditions, customer needs, and technological advances. Koçyiğit and Akkaya (2020) highlight how a flexible organizational structure can facilitate greater agility, enabling rapid adaptations to market and technological changes.

On the other hand, agility, as highlighted by Nogalski et al. (2020), implies a rapid and effective response to unforeseen opportunities and risks, highlighting the importance of anticipating and leading change rather than simply adapting to it. Abourobah et al. (2023) reinforce the idea that agility and resilience in the supply chain, enhanced by robust digital capabilities, are essential for innovative performance, especially in contexts of intense digitalization.

This combination of corporate entrepreneurial behaviors and a culture of innovation and risk-taking enables the exploration of new business opportunities and the development of unique resources and capabilities, contributing significantly to the sustained long-term success of organizations. These collective perspectives suggest that while flexibility and agility share a common purpose of adaptation, they diverge in their approach and application.

Flexibility is more associated with a passive capacity for adjustment, while agility implies a proactive and dynamic capacity that facilitates not only adaptation but also anticipation and leadership in change. In this sense, organizational agility is presented as a strategic imperative for the maturity of the business model, ensuring the competitiveness and sustainability of the company in the future. Table 3 shows the conceptual description, the operational description and the items proposed for the Organizational Agility (AO) construct.

Table 3: Operationalization of the Organizational Agility (AO) Construct

Construct	Conceptual Description	Operational Description	Items for measurement
Organizational Agility (AO)	The ability of an organization to make decisions quickly based on changes in the environment.	The speed with which an organization responds to changes in the environment, measured by the speed with which these changes are identified and decisions are made accordingly. It is quantified through the response time to new opportunities or threats and the speed with which actions are implemented. strategic.	AO1.- The organization responds within predetermined response times to significant external changes.
			AO2.- Changes in the environment that could affect the organization are identified in advance.
			AO3.- Organizational strategies adapt dynamically based on analyses of changing scenarios.
			AO4.- The organization continuously evaluates internal processes to accelerate strategic decision-making time.
			AO5.- The organization evaluates the effectiveness of strategic actions based on their impact on the speed of organizational response.

Source: Own elaboration

Qualified Human Talent

Qualified human talent (THC) encompasses the acquisition and development of knowledge and skills by individuals, crucial aspects for the success or failure of any organization. According to Salazar Vázquez et al. (2023), this talent stands as a source of

competitive advantage, by driving innovation, creativity and the implementation of new methodologies within organizations. The ability to properly share, transfer and apply this knowledge within the organizational environment is essential to maintain agility and adaptability to changes, key elements to stand out in the competitive market.

Krylov (2023) argues that THC is essential for achieving a sustainable competitive advantage, as it enables the generation of unique value for customers, which is difficult for competitors to imitate. This value generation is not only achieved through the optimization of internal resources, but also by taking advantage of the existing human talent in the organization, establishing an intrinsic relationship between human talent and competitive advantage as mutually reinforcing variables.

Training and coaching emerge as vital elements in this context, acting as catalysts for achieving satisfactory results in various organizational dimensions. Rajagopal et al. (2021) emphasize the importance of aligning training programs with the company's needs and strategic objectives, ensuring that staff are prepared to face present and future challenges. This preparation not only improves the individual competence of employees but also contributes significantly to the overall performance of the organization.

Along similar lines, Yasa and Irwansyah (2023) argue that THC is a determining factor for the development and maintenance of competitive advantages in any sector. The capacity, skills, and knowledge of employees have a significant impact on the innovation, efficiency, and quality of the service or product offered, thus differentiating an organization from its competitors. A well-trained and educated team is crucial to quickly adapt to market changes and meet growing customer demands, reinforcing the company's competitive position in the market. Table 4 shows the conceptual description, operational description, and proposed items for the THC construct.

Table 4: Operationalization of the Qualified Human Talent (THC) Construct

Construct	Conceptual Description	Operational Description	Items for measurement
Qualified Human Talent (THC)	employees to perform tasks that require specific skills, experience and advanced knowledge.	Assesses employees' competence and ability to perform tasks that are critical to organizational success. Measurement is based on the effectiveness and efficiency of tasks completed, as well as the innovation and creativity demonstrated.	THC1.- Employees demonstrate advanced skills in their respective fields of work.
			THC2.- Continuous training programs are carried out to maintain and improve employee skills.
			THC3.- Employees actively participate in conferences and workshops to improve their skills.
			THC4.- The organization regularly assesses the technical competence of employees to ensure their suitability for their assigned roles.
			THC5.- Innovation and creativity in the performance of work tasks are encouraged and recognized.

Source: Own elaboration

Learning Culture

Learning culture (LC) in the organizational context refers to a set of practices, beliefs, values, and norms that promote and sustain continuous learning within an organization. This culture fosters an environment in which the acquisition, sharing, and application of knowledge are valued and facilitated, which in turn enables the organization to adapt and evolve in response to changes and challenges in the environment. LC is characterized by support for experimentation, reflection, and knowledge sharing, as well as a willingness to learn from mistakes and the encouragement of curiosity and innovation among employees (Garzón, 2018).

Halmaghi and Todăriță (2023) propose that learning in an organization has a significant impact on its ability to adapt and develop and that a robust learning culture enables the organization to be more flexible and adaptable, which is crucial to survive and thrive in a competitive and constantly changing environment. This culture fosters innovation, effective problem solving, and employee retention, leading to increased efficiency, productivity, and profitability in the organization. It also promotes critical thinking, open communication, and collaboration, ensuring a collective effort in learning and knowledge sharing. Table 5 shows the conceptual description, operational description, and proposed items for the CA construct.

Table 5: Operationalization of the Learning Culture (CA) Construct

Construct	Conceptual Description	Operational Description	Items for measurement
Learning Culture (CA)	Organizational approach to continuous learning and knowledge development.	It focuses on creating an environment that promotes continuous learning and knowledge sharing, as well as implementing policies that support continuing education and professional development.	CA1.- The organization has resources dedicated to learning and professional development.
			CA2.- There are policies that promote and support participation in continuing education programs.
			CA3.- Knowledge exchange between employees is encouraged through collaborative platforms.
			CA4.- The organization's leaders act as mentors to foster the professional development of employees.
			CA5.- Learning needs are regularly assessed to adjust professional development policies and resources.

Source: Own elaboration

Access to Knowledge Sources

In modern organizations, access to knowledge sources (AKS) is the ability to acquire and use information and skills from a wide range of sources, both interpersonal and digital, which is vital to driving productivity, innovation and optimal employee performance. This comprehensive approach ensures that essential operational knowledge is not only retained but also efficiently transmitted to both current and future employees, encompassing different forms of knowledge, including tacit and explicit (Zhao et al., 2021).

This knowledge can come from a variety of sources, such as employee training activities, collaborations with customers and suppliers. The latter are especially valuable as they extend skills and competencies beyond the organization's internal capabilities, emphasizing the need for KM that integrates both internal and external resources to foster organizational success (Chae et al., 2020).

Basit (2021), for his part, highlights how leveraging external sources of knowledge, particularly interactions with the private sector and industry associations, is crucial for organizational innovation. These interactions not only promote the adoption of new work and decision-making methodologies, but also facilitate significant improvements in organizational efficiency and effectiveness. Together, these elements underline the critical importance of a strategy that enables easy access to new knowledge, capitalizing on both

internal and external knowledge to ensure the long-term success of the organization. Table 6 shows the conceptual description, operational description, and proposed items for the AFC construct.

Table 6: Operationalization of the Access to Knowledge Sources (AFC) Construct

Construct	Conceptual Description	Operational Description	Items for measurement
Access to Knowledge Sources (AFC)	The ability of an organization to identify, access and use diverse sources of external and internal knowledge.	It is measured by the effectiveness of organizational processes in incorporating knowledge of external sources and the ease of access to these sources for employees.	AFC1.- Employees have access to updated databases and bibliographic resources.
			AFC2.- Alliances with academic institutions and other organizations are promoted for the exchange of knowledge.
			AFC3.- There are established channels for the acquisition of relevant external knowledge.
			AFC4.- The organization effectively uses knowledge acquired from external sources to improve its processes.
			AFC5.- Information systems are integrated to facilitate access to diversified sources of knowledge.

Source: Own elaboration

Potential Absorption Capacity

Potential absorptive capacity (PACAP) is a critical dimension within the KM framework that facilitates the integration of new ideas and technologies from the outside into an organization's internal environment . According to González (2023), this capacity not only involves the ability to identify and acquire relevant external knowledge, but also to assimilate it so that it can be effectively applied in innovative processes and products. This process is considerably reinforced by the presence of well-trained human resources, an organizational culture strongly inclined towards continuous learning, and strategic access to diverse sources of knowledge.

The work of Algarni et al. (2023) expands on this conceptualization, highlighting the critical importance of organizational adaptability and willingness to change as catalysts that facilitate effective knowledge assimilation. These factors are vital because they allow the organization not only to recognize and value external knowledge, but also to integrate it in

such a way that it becomes a valuable resource for continuous innovation and sustainable growth.

Additionally, PACAP implies a commitment to continuous improvement and optimization of internal processes to align them with new trends and acquired knowledge. This commitment is manifested in the organization's ability to transform existing practices and adopt new methodologies that promote greater operational efficiency and effectiveness. Table 7 presents in detail the conceptual description, the operational description, and the items proposed to measure the PACAP construct.

Table 7: Operationalization of the Potential Absorptive Capacity Construct (PACAP)

Construct	Conceptual Description	Operational Description	Items for measurement
Potential Absorption Capacity (PACAP)	It includes the organization's readiness to identify, acquire and be prepared to apply external knowledge. It focuses on the infrastructure and culture that foster learning and adaptability, facilitating innovation for the development of future competitive advantages.	It consists of structures that foster the conditions for learning and knowledge absorption. This includes allocating resources for exploring new ideas and creating channels for acquiring external knowledge, as well as developing key competencies within the workforce.	PACAP1: The organization invests resources in systematically monitoring technological advances in its sector.
			PACAP2: The organization regularly implements programs for the development of key skills.
			PACAP3: The organization encourages the inclusion of diverse perspectives from external collaborators.
			PACAP4: The organization encourages participation in conferences, seminars and professional networks.
			PACAP5: There are policies that facilitate the reconfiguration of roles and responsibilities in the face of new ideas.

Source: Own elaboration

Realized Absorption Capacity

Realized absorptive capacity (RACAP), as defined in Gonzalez's studies (2023), encompasses the last phase of the KM process, where previously acquired and assimilated knowledge is transformed and exploited to create real value within the organization. This level of absorption focuses intensely on the effective integration of knowledge into corporate strategies, the improvement of products and services, and the optimization of operational

processes. The effectiveness of RACAP depends largely on strategic knowledge management, committed leadership, and organizational agility that facilitates rapid adaptation to new ideas and technologies.

Algarni et al. (2023) argue that for RACAP to function optimally, a deep and effective integration of new perspectives and knowledge across all areas of the organization is indispensable. This requires not only visionary leadership but also an organizational culture that encourages and values innovation and experimentation. Such cultural and leadership elements are essential for the organization to not only adopt new ideas but to apply them in ways that generate a significant impact on its performance and growth.

Furthermore, the study by Limaj and Bernroider (2019) suggests that there is a direct and positive relationship between PCAP and RACAP, indicating that a robust PACAP can significantly amplify the effects of RACAP. This relationship underlines the importance of good knowledge assimilation as an indispensable preliminary step for its successful application. The interaction between PACAP and RACAP illustrates a dynamic sequence where the quality of knowledge assimilation acts as a critical precursor for its effective transformation into sustainable competitive advantages and organizational development. These findings highlight the need to strengthen both capabilities to maximize the innovative and competitive potential of the organization. Table 8 shows the conceptual description, operational description, and proposed items for the RACAP construct.

Table 8: Operationalization of the Realized Absorptive Capacity (RACAP) Construct

Construct	Conceptual Description	Operational Description	Items for measurement
Realized Absorption Capacity (RACAP)	The ability of the organization to transform and leverage acquired knowledge by effectively integrating it into daily operations and strategic decision-making.	It is evident in the integration of acquired knowledge into strategic processes and decisions, reflected in the organization's ability to adapt its operations continuously and agilely, resulting in improvements in efficiency and competitive advantages.	RACAP1: The organization has incorporated external knowledge into its daily operations.
			RACAP2: Recent strategic decisions are based on newly acquired knowledge.
			RACAP3: Changes in processes reflect an adaptation to emerging knowledge.
			RACAP4: The organization has improved its efficiency by applying new knowledge.
			RACAP5: The organization has obtained competitive advantages by exploiting knowledge.

Source: Own elaboration

Intra-company Technology Transfer

Intra-firm technology transfer (IFTT) is the process by which technical knowledge, information and personnel are shared between technical areas, such as engineering, R&D and manufacturing, and non-technical areas, such as sales and marketing. The objective of this process is to develop innovative services and products that meet the strategic needs of the company and its customers (Behane and Grobbelaar, 2018). This practice is considered essential for organizations to access and acquire advanced technologies, allowing them to compete in the global market and contribute to the economic development of less developed countries (Elshahoupy, 2020). More than a simple transfer of equipment, TT involves a dynamic exchange of knowledge, experiences and intellectual property rights between the supplier and the recipient.

Selecting the right method for technology transfer requires a thorough analysis of the technology, a long-term collaboration strategy, adequate investments and the technical capacity to integrate new technologies. This close cooperation not only improves the efficiency and quality of manufacturing processes, but also ensures the constant updating and adaptation of technologies to organizational needs, highlighting that true organizational transformation originates from the transfer of knowledge and skills, not just equipment.

Finally, an organization's ability to perform technology transfers in the intra-firm context, effectively facilitating the movement of technology and knowledge within the organization, is crucial. Absorptive capacity acts as a bridge between knowledge management, leadership, human resources, learning culture, knowledge sources, and their positive impact on innovation and long-term organizational performance. This integrated approach underlines the importance of TT not only as a one-time activity, but as a fundamental element for the sustained success of the organization in a competitive and constantly changing business environment. Table 9 shows the conceptual description, operational description, and proposed items for the IFTT construct.

Table 9: Operationalization of the Intra-Firm Technology Transfer (IFTT) Construct

Construct	Conceptual Description	Operational Description	Items for measurement
Transfer of Technology Intra-Company (IFTT)	The exchange of technical knowledge and personnel between areas within an organization to develop innovative products and services, essential for global competitiveness and economic development.	It focuses on establishing strategies and policies that facilitate the flow of information, knowledge and technical skills between different areas of the organization, evaluating their impact on innovation and organizational performance.	IFTT1: There are clear procedures for the transfer of technical information between departments.
			IFTT2: Strategies have been established to share technical skills across the organization.
			IFTT3: The impact of the transfer of technical knowledge on the company's innovation is regularly assessed.
			IFTT4: There is a defined policy for the flow of personnel with specialized knowledge between key areas.
			IFTT5: The organization measures the effect of internal technology transfer on its overall performance.

Source: Own elaboration

Measuring instrument

This section addresses the design and validation of the measurement instrument, highlighting the statistical methodology used to ensure its validity and reliability. Given the nature of the study, with a small sample of expert judges, specific measurement techniques adapted to the conditions of the study were adopted.

Instrument Design

The construction of the measurement instrument was carried out through a meticulous operationalization of variables, based on an extensive systematic review of previous literature and a careful adaptation to the specific needs inherent to intra-company technology transfer. This operationalization phase proved to be fundamental, as it allowed a precise definition of the items that would compose the final instrument.

During this process, each item underwent numerous iterations to refine its wording and conceptual precision. For the assessment of the instrument, a 5-point Likert scale was used, where the experts evaluated each item in terms of relevance, clarity and neutrality. The scale used included the following levels: (1) Very low, (2) Low, (3) Moderate, (4) High, (5)

Very high. The experts provided additional qualitative feedback to improve the formulation of the items.

This effort made it possible to effectively capture the crucial dimensions related to absorptive capacity and other theoretical constructs relevant to the study. Thus, this stage not only guaranteed the theoretical coherence of the instrument, but also ensured its applicability and relevance to specifically address the phenomena of interest within the particular context of organizations focused on technological innovation and adaptation.

Validation of the Instrument

The validation of the instrument involved several critical stages:

- Expert Rating: Four experts were selected, two academics with experience in technology transfer and two professionals from the manufacturing sector with at least five years of experience in advanced technologies. The experts evaluated the items using a 5-point Likert scale to measure relevance, clarity and neutrality, and provided qualitative feedback to improve the items where necessary. This process allowed refining the instrument and ensuring its alignment with the underlying theoretical constructs.
- Hernández-Nieto Index: Given the limited number of expert evaluations, the Hernández-Nieto index was selected for its adaptability to this context (Pedrosa et al., 2013). This index calculates the proportion of agreement between the judges for each item using the formula:

$$CVC_i = \frac{M_i}{V_{max}}$$

Where M_i is the average of the scores given by the judges for each item and V_{max} is the maximum possible score. In addition, it is adjusted for the possible error assigned to each item (P_e), calculated as:

$$P_{e_i} = \left(\frac{1}{j}\right)$$

Where j is the number of judges. The final index is obtained by applying:

$$CVC = CVC_i - P_e$$

This formula provides a robust measure of content validity, adjusting for maximum possible agreement and random error.

- Exclusion of Cronbach's alpha: It was decided not to use Cronbach's alpha in this study due to its unsuitability for small sample sizes and low variability in responses. This decision was based on the specialized literature suggesting that Cronbach's alpha might not provide a reliable estimate of internal consistency in such contexts.

These techniques not only ensured that the instrument was valid and reliable, but also allowed the measurement process to be adapted to the peculiarities of the research context in Ciudad Juárez, a major center of industrial and technological activity. The careful selection and adaptation of validation techniques underscore the study's commitment to methodological precision and the practical relevance of its findings.

Results

This section details the results obtained from the measurement instrument used to assess the key dimensions of intra-firm technology transfer. Quantitative data are presented to illustrate the effectiveness and precision of the instrument, and variability and consistency in the evaluators' responses are analyzed.

Statistical results

This section presents an analysis of the descriptive statistics related to each criterion evaluated: relevance, clarity and neutrality. The 45 items of the instrument were evaluated from these three perspectives by the four expert judges. The evaluation was carried out using a 5-point Likert scale, allowing for a detailed view of how the judges valued each aspect of the items.

Statistics for Relevance

The results presented in Table 10 show the descriptive statistics for the relevance ratings given by the judges. Unlike the neutrality ratings, the variability in the relevance ratings is more notable, especially for Judge 1, who showed a wider range of responses.

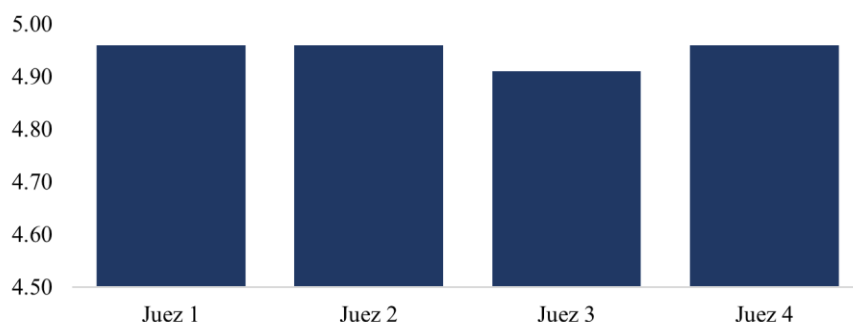
Table 10: Descriptive statistics for relevance ratings by judges

Judge	N	Range	Average	Standard Deviation
1	45	4	4.96	0.640
2	45	1	4.96	0.288
3	45	1	4.91	0.367
4	45	1	4.96	0.458

Source: Own elaboration

Figure 2 shows the mean relevance ratings for each judge. Although the means are close to 5, the variability suggests that the judges interpreted the items slightly differently. This finding is vital for assessing the internal consistency and reliability of the instrument in future studies.

Figure 2: Descriptive statistics of relevance ratings by judges



Source: Own elaboration

In conclusion, the presence of variability in relevance scores among judges indicates a need to revise the wording of the items to ensure a more uniform interpretation and improve the quality of the instrument.

Statistics for Clarity

The results shown in Table 11 reflect descriptive statistics for the clarity ratings given by the judges. The ratings showed moderate variation among the judges, reflecting greater diversity compared to the neutrality ratings.

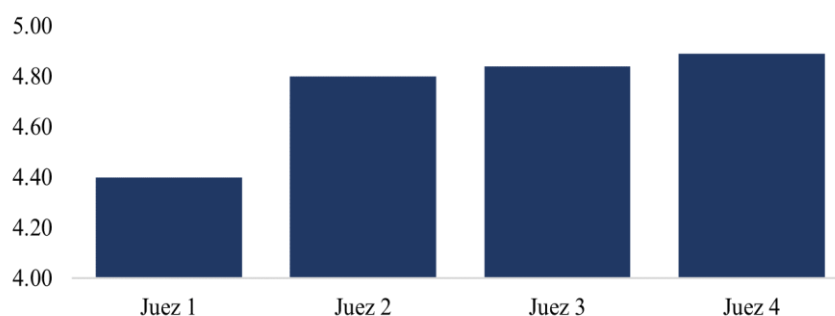
Table 11: Descriptive statistics for clarity ratings by judges

Judge	N	Range	Average	Standard Deviation
1	45	4	4.40	0.837
2	45	2	4.80	0.457
3	45	2	4.84	0.424
4	45	1	4.89	0.318

Source: Own elaboration

Figure 3 visually illustrates the mean clarity ratings by each judge. Although the means are close to 5, the variability suggests that the judges interpreted the items slightly differently, which is vital to assess the internal consistency and reliability of the instrument in future studies.

Figure 3: Descriptive statistics of clarity ratings by judges



Source: Own elaboration

In conclusion, although the clarity means are high, the variability between the ratings suggests that there is room for improvement in the wording of the items to ensure a consistent interpretation between the judges. This is crucial for the validity and reliability of the results of the measurement instrument.

Statistics for Neutrality

The results presented in Table 12 show descriptive statistics for the neutrality ratings given by the judges. Each judge evaluated the items using a 5-point scale, with 5 representing maximum neutrality. Judge 1 assigned the maximum score to all items, resulting in a standard deviation of 0.000, indicating a complete lack of variability. Judges 2, 3, and 4 showed slight variations in their ratings, with means close to 5 and standard deviations of 0.208 and 0.288, respectively.

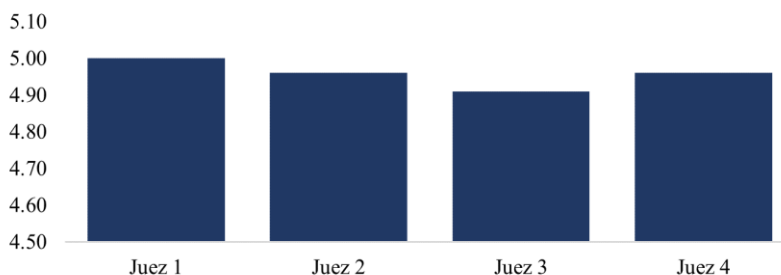
Table 12: Descriptive statistics for neutrality ratings by judges

Judge	N	Range	Average	Standard Deviation
1	45	0	5.00	0.000
2	45	1	4.96	0.208
3	45	1	4.91	0.288
4	45	1	4.96	0.208

Source: Own elaboration

Figure 4 illustrates the mean neutrality scores for each judge. As can be seen, all the means are close to 5, suggesting a high degree of agreement on the neutrality of the items evaluated. However, the reduced variability in the responses significantly limits the validity of the data. This homogeneity prevents an effective assessment of the internal consistency and reliability of the instrument .

Figure 4: Descriptive statistics of neutrality ratings by judges



Source: Own elaboration

In conclusion, the uniformity in high scores and low variability suggest that the instrument's items may not be adequately discriminating between different levels of neutrality. This could indicate a need to revise the wording of the items or consider adjustments to the measurement scale to capture a broader range of opinions and thus improve the instrument's usefulness in future studies.

Content Validation Results for Relevance, Clarity and Neutrality

In this section, the results of the content validation of the 45 items of the measurement instrument, evaluated by four experts, are presented. The validation was carried out using the Hernández-Nieto index, which allows determining the relevance, clarity and neutrality of each item within the context of the study. This index is particularly useful for evaluating the correspondence between the items and the theoretical constructs they aim to measure. Table 13 is shown below, which summarizes the results obtained for each of the items of the

Knowledge Management, Leadership and Commitment and Organizational Agility constructs.

Table 13: Content Validation Coefficient for GC, LC and AO

Code	Item	Relevance	Clarity	Neutrality
GC1	01	1.00	1.00	1.00
GC2	02	1.00	0.91	1.00
GC3	03	1.00	1.00	1.00
GC4	04	1.00	0.73	1.00
GC5	05	0.91	0.81	1.00
LC1	06	1.00	0.91	0.91
LC2	07	0.85	0.91	0.91
LC3	08	1.00	0.85	1.00
LC4	09	0.91	0.85	1.00
LC5	10	0.85	1.00	1.00
AO1	11	1.00	0.91	1.00
AO2	12	1.00	0.91	1.00
AO3	13	0.90	1.00	1.00
AO4	14	0.91	1.00	1.00
AO5	15	1.00	0.81	1.00

Source: Own elaboration

Table 14 shows the results obtained for the items corresponding to the constructs of Knowledge Management, Leadership and Commitment, and Organizational Agility.

Table 14: Content Validation Coefficient for THC, CA and AFC

Code	Item	Relevance	Clarity	Neutrality
THC1	16	1.00	1.00	1.00
THC2	17	1.00	0.91	1.00
THC3	18	0.85	0.80	1.00
THC4	19	0.91	0.91	0.85
THC5	20	0.91	0.91	1.00
CA1	21	1.00	0.55	1.00
CA2	22	0.59	1.00	1.00
CA3	23	0.91	0.61	1.00
CA4	24	0.71	0.91	0.91
CA5	25	1.00	1.00	0.91
AFC1	26	1.00	0.91	0.91
AFC2	27	0.91	1.00	1.00
AFC3	28	1.00	0.91	1.00
AFC4	29	0.91	0.81	1.00
AFC5	30	0.91	0.91	1.00

Source: Own elaboration

Table 15 presents the results obtained for each of the items of the Knowledge Management, Leadership and Commitment and Organizational Agility constructs.

Table 15: Content Validation Coefficient for PACAP, RACAP and IFTT

Code	Item	Relevance	Clarity	Neutrality
PACAP1	31	0.91	1.00	1.00
PACAP2	32	1.00	0.91	1.00
PACAP3	33	1.00	1.00	1.00
PACAP4	34	0.91	1.00	1.00
PACAP5	35	1.00	0.91	1.00
RACAP1	36	1.00	0.91	1.00
RACAP2	37	0.81	1.00	1.00
RACAP3	38	1.00	0.91	1.00
RACAP4	39	0.91	0.91	1.00
RACAP5	40	0.91	1.00	1.00
IFTT1	41	1.00	1.00	0.91
IFTT2	42	1.00	1.00	1.00
IFTT3	43	1.00	1.00	1.00
IFTT4	44	1.00	1.00	1.00
IFTT5	45	1.00	1.00	1.00

Source: Own elaboration

The results obtained from the Content Validation Coefficient show that some items of the Learning Culture constructs presented low CVC values, specifically below the threshold of 0.78, which could indicate a need for revision (Pedrosa et al., 2013). It is recommended to evaluate the wording of these items to clarify their content and ensure that they align more precisely with the constructs they are intended to measure. In addition, it is convenient to consider whether these items overlap with others or whether the questions can be interpreted in multiple ways, which could affect the consistency of the answers. For these purposes, experts in the field have been consulted, who have provided valuable feedback that will be used to make the pertinent modifications and improve the quality and effectiveness of the instrument.

Discussion

The construction of this instrument was based on a solid theoretical framework, supported by a broad consensus among the judges, which guarantees the correct definition of the variables and the relevance of the items. However, the limited variability in the judges' evaluations suggests that traditional indices, such as Kendall's W coefficient and Fleiss' Kappa, may not be the most appropriate for this study. For this reason, the Hernández-Nieto index was used, which adapts effectively to the limited number of expert evaluations and provides a robust measure of the agreement between them .

This study also highlights that, similar to previous research such as Vlačić et al. (2019), Absorptive Capacity (ACAP) plays a crucial role in organizational success, both in knowledge acquisition and assimilation. Similar to Kale et al. (2019), who highlighted that the use of acquired knowledge has a direct impact on organizational performance, our findings reinforce the importance of all ACAP dimensions, particularly in the context of intra-firm technology transfer, where the ability to acquire and exploit knowledge is key to improving internal processes.

Although some items scored lower on clarity and relevance, these do not compromise the overall validity of the instrument or its ability to meet the objectives of the initial validation. This document addresses the initial validation; however, a pilot test is planned in a future phase to confirm its effectiveness and make final adjustments if necessary.

Finally, the use of the Hernández-Nieto index made it possible to overcome the limitations presented by the low variability in the judges' responses, ensuring that the results obtained faithfully reflect the consensus among experts, as required by the rigor of the

validation process. This reinforces not only the validity of the instrument's content, but also its applicability in different business contexts, aligned with the challenges presented by dynamic environments.

Conclusions

This study has succeeded in validating the measurement instrument designed to assess the critical success factors in the intra-company technology transfer process. Throughout the process, challenges have been overcome, such as the limited variability in the judges' responses, by implementing appropriate methodologies, ensuring an accurate and reliable evaluation of the items.

The results obtained highlight that the ability of firms to acquire, assimilate and exploit internal and external knowledge is critical to success in technology transfer. The validated instrument has proven to be effective in measuring these factors, providing a comprehensive understanding of how firms can optimize their internal processes and facilitate effective technology transfer.

Despite the observed limitations, this study has established a solid foundation for future application of the instrument in different organizational contexts. The consistency in the experts' assessments confirms the content validity and suggests that the instrument can be reliably applied in future research and diverse business settings.

Contributions to Future Lines of Research

Future research could focus on applying the validated instrument to different industrial sectors and companies of different sizes. This approach will allow for a comparative assessment of the effectiveness of intra-firm technology transfer, providing valuable data for adjusting and improving technology transfer strategies in diverse contexts.

Furthermore, the continued application of this instrument could contribute to economic and social development, encouraging the adoption of innovative technologies that boost business productivity and sustainability. Optimizing technology transfer will benefit both organizations and the growth of strategic sectors, generating a positive impact on communities and boosting their development.

This approach will improve business competitiveness, promote greater efficiency in the use of technological resources and, ultimately, create a more favourable environment for innovation and economic progress.

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Software	Jorge Quijano Gallardo
Validation	Jorge Quijano Gallardo (Support), Jesus Hernandez Gomez (Principal), Salvador Noriega Morales (Support)
Formal Analysis	Jorge Quijano Gallardo (Principal), Jesus Hernandez Gomez (Same), Salvador Noriega Morales (Support)
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