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AN EMPIRICAL INVESTIGATION OF ABSORPTIVE CAPACITY ON TECHNOLOGY TRANSFER EFFECTIVENESS THROUGH ORGANIZATIONAL INNOVATION

Aamer Hafeez[A], Alina Binti Shamsuddin[B], Bilal Saeed[C]

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ABSTRACT

Purpose: Achieving technology transfer effectiveness (TTE) remains challenging in developing and underdeveloped economies to improve social infrastructures and develop economic systems. Bringing effectiveness in technology transfer is a complicated process for organizations that require improvement in their absorptive capacity (ACAP) and organizational innovation (OI). In the Information and communication technology (ICT) sector of Pakistan, technology transfer is ineffective due to a lack of ACAP and OI. This study aims to investigate the impact of ACAP and OI on TTE in the ICT sector of Pakistan.

Theoretical framework: This study empirically investigated the relationship of ACAP and OI with TTE with underpinning organizational learning theory.

Design/methodology/approach: A cross-sectional survey design was adapted for collecting data from 393 management representatives from 33 organizations of two main sub-sectors (Telecommunications and Information Technology) of the ICT sector of Pakistan. PLS-SEM was used for the reliability and validity measurement of research constructs. It also tested the hypothesized relationships between ACAP, OI, and TTE.

Findings: This study confirmed the significant relationship of ACAP and OI with TTE. Further, the results also confirmed the mediation of OI between ACAP and TTE in the ICT sector of Pakistan.

Research, Practical & Social implications: The implication of this research is to help government institutions and public and private sectors to develop mechanisms, economic policies, strategies, and business support for effective technology transfer in the ICT sector. This research model is also helpful for researchers and practitioners in its applicability in other industries, countries, and cross-cultural environments.

Originality/value: Due to the lack of research in the ICT sector of Pakistan, this study empirically investigated the hypothesized significant relationships of ACAP and OI with TTE. This study also filled the research gap by evaluating the significant mediation of OI between ACAP and TTE and contributed to the body of knowledge.

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[A] *MS Telecommunication Engineering. Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Johar, Malaysia. E-mail: aamer.hafeez100@gmail.com*
Orcid: https://orcid.org/0000-0002-5557-7355
[B] *Doctor of Philosophy in Technology Management. Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Johar, Malaysia. E-mail: alina@uthm.edu.my*
Orcid: https://orcid.org/0000-0003-2700-7950
[C] *MS Telecommunication Engineering. Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Johar, Malaysia. E-mail: e.bilalsaeed@gmail.com Orcid: https://orcid.org/0000-0001-6182-8926*

UMA INVESTIGAÇÃO EMPÍRICA DA CAPACIDADE DE ABSORÇÃO SOBRE A EFICÁCIA DA TRANSMISSÃO

RESUMO

Objetivo: Alcançar a eficiência na transferência de tecnologia (TTE) continua sendo um desafio no desenvolvimento e subdesenvolvimento das economias para melhorar a infra-estrutura social e desenvolver sistemas econômicos. Trazer eficiência para a transferência de tecnologia é um processo complicado para organizações que precisam melhorar sua capacidade de absorção (ACAP) e inovação organizacional (OI). No setor de tecnologia da informação e comunicação (TIC) do Paquistão, a transferência de tecnologia é ineficaz devido à falta de ACAP e OI. Este estudo visa investigar o impacto da ACAP e da OI na TTE no setor de TIC do Paquistão.

Estrutura teórica: Este estudo investigou empiricamente a relação da ACAP e da OI com a TTE com o apoio da teoria da aprendizagem organizacional.

Design/metodologia/abordagem: Um projeto de pesquisa transversal foi adaptado para coletar dados de 393 representantes de gestão de 33 organizações em dois sub-setores principais (telecomunicações e tecnologia da informação) do setor de TIC do Paquistão. O PLS-SEM foi usado para medir a confiabilidade e validade das construções de pesquisa. As relações hipotéticas entre ACAP, OI e TTE também foram testadas.

Resultados: Este estudo confirmou a relação significativa da ACAP e da OI com a TTE. Além disso, os resultados também confirmaram a mediação da OI entre ACAP e TTE no setor de TIC do Paquistão.

Pesquisa, implicações práticas e sociais: A implicação desta pesquisa é ajudar as instituições governamentais e os setores público e privado a desenvolver mecanismos, políticas econômicas, estratégias e apoio empresarial para a transferência efetiva de tecnologia no setor das TIC. Este modelo de pesquisa também é útil para pesquisadores e profissionais devido a sua aplicabilidade em outras indústrias, países e ambientes interculturais.

Originalidade/valor: Devido à falta de pesquisa no setor de TIC do Paquistão, este estudo investigou empiricamente as hipóteses de relações significativas da ACAP e OI com a TTE. Este estudo também preencheu a lacuna da pesquisa ao avaliar a mediação significativa da OI entre ACAP e TTE e contribuiu para o corpo de conhecimento.

Palavras-chave: Eficácia de Transferência de Tecnologia, Capacidade Absortiva, Inovação Organizacional, Tecnologia da Informação e Comunicação.

UNA INVESTIGACIÓN EMPÍRICA DE LA CAPACIDAD DE ABSORCIÓN SOBRE LA EFICACIA DE LA TRANSFERENCIA DE TECNOLOGÍA A TRAVÉS DE LA INNOVACIÓN ORGANIZATIVA

RESUMEN

Propósito: Lograr la eficacia en la transferencia de tecnología (TTE) sigue siendo un reto en las economías en desarrollo y subdesarrolladas para mejorar las infraestructuras sociales y desarrollar los sistemas económicos. Aportar eficacia a la transferencia de tecnología es un proceso complicado para las organizaciones que requieren mejorar su capacidad de absorción (ACAP) y su innovación organizativa (IO). En el sector de las tecnologías de la información y la comunicación (TIC) de Pakistán, la transferencia de tecnología es ineficaz debido a la falta de ACAP y OI. Este estudio pretende investigar el impacto de la ACAP y la OI en la TTE en el sector de las TIC de Pakistán.

Marco teórico: Este estudio investigó empíricamente la relación del ACAP y la OI con la TTE con el apoyo de la teoría del aprendizaje organizativo.

Diseño/metodología/enfoque: Se adaptó un diseño de encuesta transversal para recopilar datos de 393 representantes de la dirección de 33 organizaciones de dos subsectores principales (telecomunicaciones y tecnología de la información) del sector de las TIC de Pakistán. Se utilizó PLS-SEM para medir la fiabilidad y validez de los constructos de la investigación. También se comprobaron las relaciones hipotéticas entre ACAP, OI y TTE.

Resultados: Este estudio confirmó la relación significativa de ACAP y OI con TTE. Además, los resultados también confirmaron la mediación de OI entre ACAP y TTE en el sector de las TIC de Pakistán.

Investigación, implicaciones prácticas y sociales: La implicación de esta investigación es ayudar a las instituciones gubernamentales y a los sectores público y privado a desarrollar mecanismos, políticas económicas, estrategias y apoyo empresarial para una transferencia de tecnología eficaz en el sector de las TIC. Este modelo de investigación también es útil para investigadores y profesionales por su aplicabilidad en otras industrias, países y entornos transculturales.

Originalidad/valor: Debido a la falta de investigación en el sector de las TIC de Pakistán, este estudio investigó empíricamente las relaciones significativas hipotetizadas de ACAP y OI con TTE. Este estudio también llenó el vacío de investigación mediante la evaluación de la mediación significativa de OI entre ACAP y TTE y contribuyó al cuerpo de conocimientos.

Palabras clave: Eficacia de la Transferencia Tecnológica, Capacidad de Absorción, Innovación Organizativa, Tecnología de la Información y la Comunicación.

INTRODUCTION

Technologies are not static but dynamic. Due to changing customer requirements and a competitive business environment, rapid and disruptive changes are brought in technologies employed in industries over time (Hafeez, Shamsuddin, Saeed, Mehmood, & Andleeb, 2020). Such technological innovations influence market competition, the learning environment, and the economic growth of a country (C. H. Liu, Hou, & Chen, 2018). Hence organizations must explore and manage new and impending technologies for their survival and growth (Herterich, Uebernickel, & Brenner, 2015). But not all organizations and countries especially developing and underdeveloped countries, can develop new technologies due to a lack of skills and resources and have to transfer state-of-the-art technologies from other organizations and countries. Technology Transfer (TT) is a broad and complex process between independent units where both transferor and transferee of new technology co-exist. The technology transfer process is successful and effective only if the transferee can utilize, reproduce, improvise, re-sell and add value to its capabilities and skills by bringing the innovation (Fazal, Wahab, Zarin, Yaacob, & Zawawi, 2016). Technology attainment involves people, financial resources and investments, efforts, and commitment, which is anticipated from an efficient technology transfer process to attain favourable results (da Silva, Kovaleski, & Pagani, 2019). Through effective technology transfer, growing companies can aggressively develop their technologies, human resources, and businesses (Setiawan, Susanti, & Syah, 2019). Therefore, effectiveness in technology transfer surrounds the three important dimensions of Product and Process performance (PPP), Human Recourse capability (HRC), and Business Performance (BP) (Hafeez et al., 2020; Soliman, 2020; Whangthomkum, Igel, & Speece, 2006).

Audretsch and Caiazza (2016) confirmed that effective technology transfer positively affects organizational growth and the country's economic growth. United Nations has also declared that in the knowledge and information-based economies, powerful tools for economic growth and sustainable development of organizations and their countries are creating, enhancing, and introducing new products, services, and knowledge through technology and its technology transfer (Bengoa, Maseda, Iturralde, & Aparicio, 2020). Governments and organizations collaborate to achieve the latest technologies through technology transfer and absorption. TT is not just the material transfer but also the diffusion of technology and the transfer of know-how and skills (Bozeman, 2000; Pankova, 2002). The technology transfer effectiveness depends on the traits of the technology sender and receptor (Jafari, Akhavan, & Rafiei, 2014). Hence, technology transfer is not simple work but involves different sensitive and complicated processes.

Due to the lack of infrastructure and limited resources, developing countries are unable to move towards a knowledge-based economy. They cannot develop new technology and knowledge and prefer to transfer the latest technologies from developed countries to compete in the dynamic market and attain economic growth (Salem, 2016). The transfer of advanced and modern technology remains ineffective due to the poor absorptive capacity of the recipient firms and organizations (van der Heiden, Pohl, Mansor, & van Genderen, 2016). Moreover, all the processes involved should be conducted vigilantly for effective technology transfer. Otherwise, it may lead to heavy damages and losses in time and cost (Farhadikhah & Husseini, 2015). This issue also remains a research problem for researchers in different studies on the various aspects of technology transfer, especially in its effectiveness (Cunningham & O'Reilly, 2018).

Technology transfer between organizations and countries relies on various technology sender and recipient agents and factors. These factors influence the effectiveness of technology transfer and are grouped as human-oriented and technology-oriented (Distanont, Khongmalai, & Kritpipat, 2018). In literature, different authors have related the effectiveness of technology transfer with varying factors like human resources, financial resources & investments, struggling efforts, leadership empowerment, transformational, transactional, charismatic, visionary, culture-based leaderships, absorptive capacity, nature of technology, and international experience, etc. (da Silva et al., 2019; Farouk Soliman, 2016; B. W. Lin & Berg, 2001; Soliman, 2020; Whangthomkum et al., 2006).

Among various recipient characteristics influencing the effectiveness of technology transfer, absorptive capacity (ACAP) is the major factor impacting TTE (Abidin, Abdullah, & Hasnan, 2015; del Carmen Haro-Domínguez, Arias-Aranda, Javier Lloréns-Montes, & Ruíz Moreno, 2007; Distanont et al., 2018; Fredriksson, Malm, & Skov Madsen, 2019b; Gandenberger, Bodenheimer, Schleich, Orzanna, & Macht, 2016; Juhaini Jabar & Soosay, 2010; Juhaini Jabar, Soosay, & Santa, 2011; C. Lin, Chang, & Chang, 2004; C. Lin, Tan, & Chang, 2002; J. L. Lin, Fang, Fang, & Tsai, 2009; Sazali, Raduan, Jegak, & Haslinda, 2009; Seçkin, 2015; Whangthomkum et al., 2006; Winkelbach & Walter, 2015). ACAP is the ability of an organization to recognize, integrate and apply new information to improve organizational learning (W. M. Cohen & Levinthal, 1990b). In literature, it is mostly recognized by four dimensions that are acquisition, assimilation, transformation and exploitation (Albort-Morant, Henseler, Cepeda-Carrión, & Leal-Rodríguez, 2018; Ali & Park, 2016; Ali, Seny Kan, & Sarstedt, 2016; Božič & Dimovski, 2019; Cenamor, Parida, Oghazi, Pesämaa, & Wincent, 2019; De Paula Guedes, Ziviani, De Paiva, Ferreira, & De Mendonça Herzog, 2017; Lau & Lo, 2015; Min, Ling, & Piew, 2016; Santoro & Gopalakrishnan, 2015; Winkelbach & Walter, 2015; Zahra & George, 2002). Achieving effective technology transfer in developing countries where generally weak organizations have less absorptive capacity is a difficult task. If the absorptive capacity of the receiver is improved, the technology transferred can be more effective and successful (Gandenberger et al., 2016). Various authors investigated how absorptive capacity relates to organizational innovation (OI) (Roberts & Dinger, 2016). OI is the employment of new organizational techniques in an organization’s business practices, workplace environment, or external dealings, and also includes the use of new managerial conceptions and processes (Cusumano, Kahl, & Suarez, 2008; Min et al., 2016).

The Government of Pakistan aims to build a knowledge-based information society focusing on effective technology transfer from developed countries, research, and innovation in the industrial sector, especially in the ICT sector, to ensure local production with local resources (Universal Service Fund, 2015). Due to a lack of study in evaluating the technology transfer effectiveness, this study proposes the following research questions

Q1. Is there a direct impact of ACAP on TTE in the ICT sector of Pakistan?

Q2. Is there a direct impact of ACAP on OI in the ICT sector of Pakistan?

Q3. What is the relationship between OI and TTE in the ICT sector of Pakistan?

Q4. Does OI mediate the relationship between ACAP and TTE in the ICT sector of Pakistan?

This study includes hypotheses development based on the literature survey and research questions. Further, the research methodology consists of data collection and descriptive analysis of demographic information and measures. Afterward, the results, limitations of this research, and conclusions are also presented in this study.

THEORETICAL BACKGROUND

Argyris & Schön (1997) defined organizational learning theory with the support of three learning loops (Single, Double, and Deutero Loops). Single-Loop Learning is for error detection, correction, and effectiveness to achieve organizational goals based on existing policies. In continuation to single-loop, double-loop learning adds more factors to the organizational environment (internally and externally) and Research and development for the external competition by modification of policies. Deutero-learning covers both single-loop and double-loop learning and additionally brings creativity, innovation, and change management for better organizational learning (Ch Argyris & Schön, 1997; Hafeez et al., 2020). Previous studies empirically investigated technology transfer effectiveness with different antecedent variables (strategic technology alliances, absorptive capacity, nature & type of strategic technology alliances, learning environment) and underpinning organizational learning (Juhaini Jabar, 2012; Juhaini Jabar et al., 2011; Liao, Chen, Hu, Chung, & Yang, 2017).

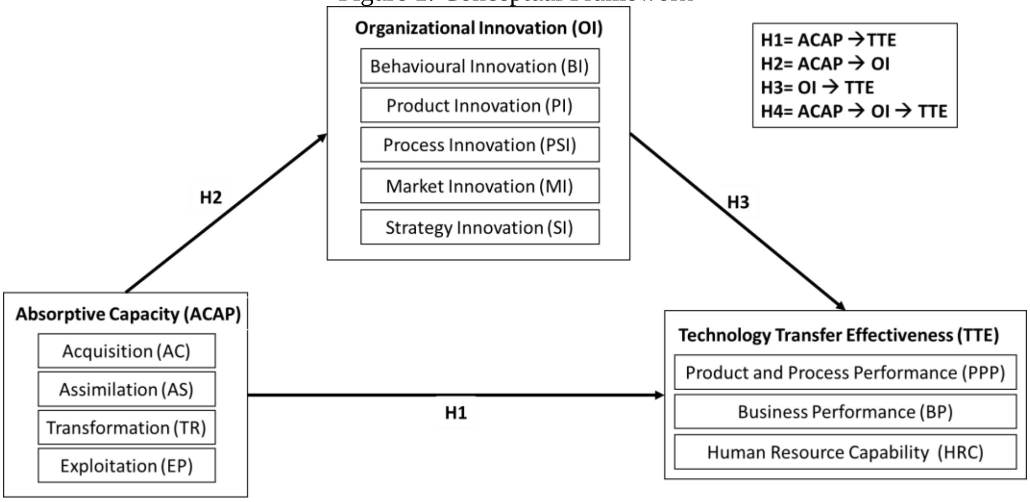
The conceptual framework of this study in Figure 1 contains technology transfer effectiveness as a dependent variable which lies in all domains of single, double, and deutro-loops learning that measure the effectiveness of learning from Knowledge sources. Argyris & Schön (1997) defined organizational learning capacity as necessary for organizations to learn from different sources and avoid failures. The quest for this organizational learning is to enhance absorptive capacity through deutro-learning. Organizational learning theory explains that absorptive capacity is key to an ability of an organization to learn from external sources of knowledge (Farrell & Coburn, 2016). Each element of ACAP determines the organizational capacity to effectively absorb, assimilate and utilize outside information (Vasylieva, 2013). In light of organizational learning theory, philosophers explained that organizational learning is how to attain and further innovate new expertise, technology, and capabilities. This way, organizational activities can be further improved (Lien, Hung, Yang, & Li, 2006). There is a linkage between organizational learning and absorptive capacity and ACAP is a precondition for organizational learning (Jukevicene, 2015). In previous studies, absorptive capacity is empirically investigated as an antecedent of different dependent variables (organizational innovativeness, product innovation, technological innovation, innovative culture, organizational learning, innovation performance, and innovation) with underpinning organizational learning theory (Ali & Park, 2016; García-Morales, Ruiz-Moreno, & Llorens-Montes, 2007; Lau & Lo, 2015; Leverin & Liljander, 2004; Min et al., 2016; Song, 2015).

Argyris & Schön (1997) revealed that organizational innovation is a central idea in organizations that belong to duetro-loop learning. In previous research, organizational innovation is mediating between different dependent and independent variables underpinning the theory of Organizational learning (Aminbeidokhti, Jamshidi, & Mohammadi Hoseini, 2016; Lyles, 1994; Wujiabudula & Zehir, 2016). Based on theoretical and empirical evidence, all three constructs (TTE, ACAP, and OI) of the proposed research framework fall in the domain of organizational learning theory.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

This study constitutes three latent variables; technology transfer effectiveness, absorptive capacity, and organizational innovation. With the support of previous literature, definitions of all three variables are included in this section. Further, based on organizational learning theory and previous empirical studies, four hypotheses have been proposed in this research. Finally, based on these four hypotheses, a conceptual framework indicates direct and indirect relationships between variables as shown in Figure.1.

Figure 1: Conceptual Framework



Technology Transfer Effectiveness

Technology transfer has been widely addressed in the literature, but there is no consensus on one definition as it is a complex and continuously evolving process (Bengoa et al., 2020). Lavoie (2019) stated that the definition of technology transfer is based on different research disciplines and the study's purpose, etc. Technology transfer is a multidisciplinary effort and is not quite expansively understood. Several definitions are witnessed across the literature, each with slightly different viewpoints and distinctions. The definitions depend on how the user represents technology and context (Bozeman, 2000). However, Fazal et al. (2016) defined technology transfer as an extensive and complicated procedure between two independent units in which both the transferor and transferee agree on the transfer of new technology. This transference will be considered effective and efficient only if the receiver becomes competent in skills and gains capabilities of utilizing, reproducing, improving, and reselling technology. The effectiveness of a technology transfer is achieving the objectives of that TT project (Wong, Shaw, & Sher, 1999). Taleghani (2016) in his work concluded that technology transfer is a critical process that provides effective rights to use and acquisition of technology for the economic growth of developing and less developed countries.

Whangthomkum et al. (2006) considered financial and non-financial metrics to gauge the effectiveness of technology transfer: innovation scale, quality grade, proper arrangements, and knowledge enhancement. These measures of TTE were gathered as product and process performance, business performance, and human resources capability. Soliman (2020), in his research on TTE, also used the dimensions of TTE given by Whangthomkum et al. (2006), considering their suitability in a dynamic environment.

Absorptive Capacity

Companies should enhance their absorptive capacity to stand out and remain relevant in the competitive global economy (Singh, Del Giudice, Nicotra, & Fiano, 2020; Todorova & Durisin, 2007; Zahra & George, 2002). Absorptive capacity connects the firm's external environmental advancement and accomplishments with internal innovative activities (Human, 2020; Kostopoulos, Papalexandris, Papachroni, & Ioannou, 2011; Y. Liu, Wang, Yuan, & Li, 2012; Muse, Njeru, & Waiganjo, 2016) and creates value additions in the company's performance (C. S. Lee & Wong, 2015; Sindakis, Depeige, & Anoyrkati, 2015).

Over the past three decades, the studies on ACAP have tremendously grown (Du & Wang, 2022). Absorptive capacity is the organizational ability to use outside knowledge internally, and as a construct, it has been extensively used since its initiation in the late 1980s /early 1990s (Harris & Yan, 2019). After Cohen and Levinthal's pivotal work on absorptive capacity, it has become accepted as a vital driver of an organization's competitive edge. It is defined as the ability of a firm to identify the worth of new, external knowledge, adapt it, and apply it to commercial ends (W. M. Cohen & Levinthal, 1990b; Roberts, Galluch, Dinger, & Grover, 2012; Zahra & George, 2002). According to Cohen and Levinthal (1990a), organizations must be dynamic and innovative, and therefore, they should adopt new trends and state-of-the-art techniques. Organizations should continuously align people's behaviours with the enterprise's principles to achieve operational excellence (Saeed, Tasmin, Mahmood, & Hafeez, 2021). Therefore, they need to embed absorptive capabilities to use and transform external knowledge into new products, processes, and organization modernization. Van Der Heiden and Pohl (2016) presented five ACAP learning steps: knowledge acquiring, dissemination, interpretation, incorporation, and organizational memory, and they stated that it had gained substantial attention from researchers working on technology transfer.

Organizational Innovation

Organizational innovation is the mechanism through which organizations acquire and use outside knowledge and go for modernization (Cusumano et al., 2008). It uses new managerial concepts, processes, and practices (Min et al., 2016). OI is simple and straightforward, but research on it is very complex as it is multilevel and multi-dimensional and depends on the perspective for which it is used (Damanpour, 2017). Soto-Acosta et al. (2016) concluded that organizational innovation is the characteristic of any organization that focuses on Research & Development and other organizational procedures and processes for new products, practices, and methods. In literature, not a single definition of Organizational innovation exists, and there is a lack of consensus on the definition of OI (Meroño-Cerdán & López-Nicolás, 2017). Different authors defined organizational innovation differently as some relate OI with changes in organizational structure, and some associate it with product/service and process (Jia, Chen, Mei, & Wu, 2018; Kahn, 2018; Wu, 2017; Zheng, Wu, & Xie, 2017). Some authors connect OI with organizational innovation capabilities involving innovative products to the market or new marketing potential using new strategies and creative ideas (C. Chen, 2017).

Relationship Between Technology Transfer Effectiveness and Absorptive Capacity

Absorptive capacity has received considerable attention from researchers regarding technology transfer since it is one of the most significant factors determining organizational learning (van der Heiden et al., 2016; Yu, Zhang, Zhang, & Fan, 2022). It is a collection of organizational routines and processes with which organizations obtain, integrate, change and exploit knowledge to yield a dynamic organizational ability (W. M. Cohen & Levinthal, 1990b). Danquah (2018) proved that effective technology transfer and absorptive capacity are the most critical factors influencing national efficiency and productivity growth. The cross-border technological knowledge transfer depends on the recipient's absorptive capacity (Mehreen, Rammal, Pereira, & Del Giudice, 2022). But effective technology transfer is the responsibility of both the transferor and transferee and depends on the balance between the transferor's disseminative capability and the transferee's absorptive capability (Fredriksson, Malm, & Skov Madsen, 2019a). Therefore, it is mandatory to reduce the capability gap between the transferor and transferee at the individual and organizational levels for effective technology transfer (Fredriksson et al., 2019b). If it has not been taken care of, the cost estimated and time taken by technology transfer will be augmented, and therefore learning growth will not be according to anticipations.

Multiple studies in previous literature reveal a positive and significant relationship between absorptive capacity and technology transfer effectiveness (Abidin et al., 2015; Distanont et al., 2018; Juhaini Jabar et al., 2011; C. Lin et al., 2002; J. L. Lin et al., 2009). J. Jabar & Soosay (2010), in their assessment of technology transfer in Malaysian manufacturing organizations, empirically proved that absorptive capacity positively affects technology transfer. Whangthomkum et al. (2006), in their empirical study of the Thailand packaging industry, used the three dimensions (Product and Process Performance, Business Performance, and Human Resources Capability) of technology transfer and four dimensions of ACAP (ability to recognize, ability to acquire, ability to assimilate, and ability to apply). They proved that the industry could enhance the effectiveness of its technology transfers by managing four specific ACAP dimensions. On the other hand, Distanont et al. (2018), in their study of the Thailand Petrochemical Industry, used absorptive capacity dimensionless. They proved that ACAP capacity effectively encourages technology transfer performance. C. Lin et al. (2004), in their research of Taiwanese electronic and chemical manufacturing firms, concluded that absorptive capacity influences the effectiveness of technology transfer performance. J. Jabar & Soosay (2010) researched Malaysian manufacturing organizations and stated that absorptive capacity positively affects technology transfer.

However, Fazal, Al Mamun, Wahab, & Mohiuddin (2017) unveiled that, except for other factors, absorptive capacities significantly influence the transfer of innovative knowledge and technology, which are mandatory for the sustainability of the corporate sector. The transfer of tacit knowledge and technology depends on the absorptive capacity of the recipient (Gandenberger et al., 2016). On the other hand, absorptive capacity is a precondition for organizational learning and is necessary to identify barriers to building absorptive capacity (Van Der Heiden & Pohl, 2016). Absorptive capacity is an appropriate mechanism to increase innovation's speed, frequency, and magnitude (Lane, Koka, & Pathak, 2002). This study proposes hypothesized significant relationship between ACAP and TTE to investigate in the ICT sector of Pakistan:

H1: There is a significant relationship between ACAP and TTE in the ICT sector of Pakistan

Relationship Between Absorptive Capacity and Organizational Innovation

Absorptive capacity is essential to organizations' innovation performance (Duan, Wang, & Zhou, 2020). Firms and companies bearing higher organizational innovation will have to have a higher absorptive capacity, and therefore external information can easily be absorbed more than others having a low absorptive capacity (Duchek, 2015).

Multiple studies in previous literature empirically investigated the significant and positive relationship between ACAP and OI (Ali & Park, 2016; Ali et al., 2016; Demartini, 2015; García-Morales et al., 2007; García-Sánchez, García-Morales, & Martín-Rojas, 2018; Kittikunchotiwut, 2015; E.-S. Lee & Song, 2015; Leverin & Liljander, 2004; Min et al., 2016). Kittikunchotiwut (2015), in their study of Leather Products Exporting Firms, used ACAP and OI unidimensional and proved that absorptive capacity has a significant positive impact on organizational innovation. In literature, it is also evident that different OI dimensions influence the different absorptive capacity dimensions differently. Ali et al.(2016) used four dimensions of ACAP (Acquisition, Assimilation, Exploitation, and Transformation) and three dimensions of OI (Product Innovation, Process Innovation, and Management innovation). They proved that all other dimensions positively and significantly influence OI and increase organizational performance except transformation. In another study of the Korean multiple industrial sectors, Ali & Park (2016) used two dimensions of absorptive capacity Potential absorptive capacity (PACAP) and Realized absorptive capacity (RACAP). PACAP makes a firm capable of acquiring new external knowledge and assimilating that knowledge obtained, whereas RACAP helps exploit the latest knowledge and finally assists in creating value. They concluded that PACAP significantly affects product, process, and management.

Moreover, RACAP significantly affects products and processes, but the impact on management is not substantial. Using the exact dimensions of ACAP, García-Sánchez (2018) studied European technology companies and empirically proved that potential absorptive capacity influences realized absorptive capacity influencing organizational innovation. Therefore, the present study posits the below following hypothesis:

H2: There is a significant relationship between ACAP and OI in the ICT sector of Pakistan

Relationship Between Organizational Innovation and Technology Transfer Effectiveness

In previous studies, different factors like Leadership Empowerment, Inter-Organizational relationships, Resource Availability, Organizational learning, R&D Resources, and Organizational culture play a significant role in bringing effectiveness in technology transfer in organizations (Distanont et al., 2018; J. Jabar & Soosay, 2010; J. L. Lin et al., 2009; Soliman, 2020). The effectiveness of technology transfer required innovation in products and processes, business, and human resources (Whangthomkum et al., 2006). Briones-Penalver, Bernal-Conesa & Nieves Nieto (2020) indicated that innovation contributed positively to technology transfer in the defence industries. The empirical investigations in previous literature are limited to checking the direct relationship between OI and TTE. The current study has developed a conceptual model that proposed a hypothesized relationship between OI and TTE based on the previous technology transfer model.

H3: There is a significant relationship between OI and TTE in the ICT sector of Pakistan

Absorptive Capacity, Organizational Innovation, and Technology Transfer Effectiveness

OI is an influencing mediating variable between ACAP and other dependent variables like Product Innovation, Technological Innovation, and Organizational performance (Ali et al., 2016b; García-Morales et al., 2007; Min, Ling & Tan, 2016a). Various other researchers have also used organizational innovation as a mediator in their studies. In their work, Y. S. Chen, Lin, & Chang (2009) investigated the positive impact of relationship learning and absorptive capacity on the competitive advantages of organizations mediated by innovation performances. Min, Ling, & Piew (2016) explored the influence of organizational innovation, technological innovation, and absorptive capacity on product innovation. Moreover, in their article, Garcia-Morales (2007) formulated a global model to analyze the effect of technology absorptive capacity and technology proactivity on organizational performance through organizational learning and organizational innovation.

Previous studies revealed that different authors have gone through quantitative and qualitative work on the relationship between ACAP & TTE and ACAP & OI. But limited quantitative research is available to measure the effect of OI on TTE. Hence it is required to investigate the influence of the absorptive capacity of organizations on the effectiveness of technology transfer through organizational innovation, which seems to be a research gap as very few researchers in the previous research. This study is committed to filling this gap.

H4: Organizational Innovation mediates a significant relationship between Absorptive Capacity and Technology Transfer Effectiveness.

Research Model

This study proposes a theoretical framework based on a literature survey for the technology transfer effectiveness in the Information and Communication Technology sector of

Pakistan. Conceptual framework is shown in Figure 1. The conceptual framework considers technology transfer effectiveness (TTE) as the dependent variable, absorptive capacity (ACAP) of the transferee as an independent variable, and organizational innovation (OI) of the transferee as the mediation variable.

METHOD

Data Collection Procedure and Sample Profile

In this study, a quantitative cross-sectional survey was employed to investigate the TT process in the ICT industry of Pakistan. This study considered two main sub-sectors of the ICT industry of Pakistan, i.e., Telecom and Information Technology (IT). The population of employees involved in the TT process is 8857, with 36 organizations in these two sub-sectors. The Telecom subsector includes 29 organizations with a population of 6724, and the IT subsector comprises seven organizations with 2133 professionals (Ministry of Information Technology and Telecommunication, 2019).

The sampling technique used for collecting data from the professionals of the ICT sector of Pakistan is stratified random sampling. In stratified random sampling strategies, *n* batches are selected randomly out of the *N* number of total batches so that every one of the possible discrete samples has an equal chance of being drawn (Bouzembrak & van der Fels-Klerx, 2018). A stratified random sample seems to best fit at all levels due to non-homogeneity observed between strata and homogeneity inside each stratum among all the categories of employees within the organization. According to Krejcie and Morgan (1970), a sample is a population subset with some participants chosen. Instead of taking all population elements in research, it is better to consider a reasonable sample representing the whole population. Selecting a sample for research studies discloses that researchers should arrange the population of interest in the comprehensive method. The sample size for the total population (N=8857) is approximately 368 using the Krejcie and Morgan (1970) formula

Demographic Information

Data was gathered through personal contact, email, and electronic means. 393 valid responses were received from the management employees of the ICT industry of Pakistan who are involved in technology transfer projects. The demographic information of this study is in Table 1. After dealing with missing data and outliers through Mahalanobis distance, we had 370 respondents above the recommended criterion (Krejcie & Morgan, 1970). The descriptive statistics revealed that 352 males (89.6%) and 41females (10.4%) respondents participated in this survey. 44.5 % of the employees had an experience of greater than ten years, and 55.5% had less than ten years of experience. In addition, 47.6% of the employees were with Bachelor's degrees, 41.2 % were Master's, and 11.2 % had MS/Ph.D. and other degrees.

Measures

For the assessment of TTE, ACAP, and OI, this study adapted the scales from existing studies. The instrument for measuring TTE was adapted from the work of Whangthomkum et al. (2006), ACAP from the scale of Jansen, Van Den Bosch, & Volberda (2005), and OI from Wang & Ahmed (2004). The survey consisted of 16 questions for technology transfer effectiveness (TTE), 20 questions for organizational innovation (OI), and 21 questions for absorptive capacity (ACAP). The 57-item questionnaire comprised twelve subscales of TTE, ACAP, and OI. Product and Process Performance (PPP), Business Performance (BP), and Human Resource Capability (HRC) were related to TTE. Acquisition (AC), Assimilation (AS), Transformation (TR), and Exploitation (EP) belonged to ACAP. Behavioural Innovation (BI), Product Innovation (PI), Process Innovation (PSI), Market Innovation (MI), and Strategic Innovation (SI) were related to OI. Participants responded to the questionnaire of 57 items by indicating their support for each statement on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Data Analysis

The software tool Smart PLS 3.2.8 is employed to analyze the research model of this study. For modeling complex multivariable relationships among observed and latent variables, PLS-SEM a statistical approach is used. Therefore, researchers working in accounting, management, and marketing use this approach (Esposito Vinzi, Chin, Henseler, & Wang, 2010). In conducting PLS-SEM, there are two steps: assessment of measurement and structural model (J. F. Hair Jr, Hult, Ringle, & Sarstedt, 2016). The Repeated Indicator approach evaluates the first-order measurement model, and the two-stage approach assesses the second-order and structural models (J. Hair Jr, Hult, Ringle, & Sarstedt, 2016).

Table 1 – Demographic Information of respondents for CFA

Description	**Category**	**Count**	**Percentage**
Gender	Female	41	10.4
	Male	352	89.6

Description	**Category**	**Count**	**Percentage**
Age	21 - 25 years	55	14.0
	26 - 30 years	99	25.2
	31- 35 years	98	24.9
	Above 35 years	141	35.9
	Bachelors	187	47.6
Education	Masters	162	41.2
	MS and PhD	36	9.2
	Others	8	2.0
	Assistant Manager	107	27.2
	Manager	110	28.0
	Senior Manager	37	9.4
	General Manager	13	3.3
	EVP	3	.8
	CXO	2	.5
Current Designation	Other Management Positions	121	30.8
Years of Experience	0 to 3	78	19.8
	4 to 7	89	22.6
	8 to 10	51	13.0
	10 above	175	44.5

RESULTS

Following Joseph F Hair, Hult, Ringle, & Sarstedt (2014), the result's interpretation consists of two steps: the measurement model assessment and the structural model evaluation. Three variables of the present study are evaluated in the first and second order in the measurement model. Firstly, the reliability and validity of research measurements with the help of Confirmatory Factor Analysis (CFA) have been evaluated. Later, the hypotheses testing for direct and mediating relationships are untaken. The measurement model is assessed in two stages/orders: lower-order or first-order and higher-order or second-order (Becker, Klein, & Wetzels, 2012; Sarstedt, Hair Jr, Cheah, Becker, & Ringle, 2019). First-order constructs are considered lower-order constructs with a relationship between indicators and dimensions. Second-order constructs are higher-order constructs with a patch relationship between dimensions and variables. The much-admired practice of assessing a hierarchical latent variable model considers the first-order and second-order constructs to find the constructs' validity (Joe F. Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014). In Hierarchical Component Models, indicators and constructs can be reflective or formative (Jarvis, MacKenzie, & Podsakoff, 2003). Absorptive capacity (ACAP) with four dimensions is used as reflective in the first order and formative in the second. However, the other two constructs, organizational innovation (OI) and technology transfer effectiveness (TTE), are reflective in the first and second order.

Measurement Model Evaluation (First Order)

Measurement model evaluation for reflective constructs includes three steps. Figure 2 shows the measurement model assessment using Smart PLS.

In the first step, Cronbach's alpha (α), Composite Reliability (CR), and Reliability coefficient (ρA) are evaluated to measure the internal consistency of the scale items. The scale is internally consistent if Cronbach's alpha value is above 0.7 (J. Hair Jr et al., 2016). The Cronbach's alpha values of all dimensions of this study are above 0.7, indicating that the scale is internally consistent. The composite reliability ranges from 0.7 and 0.9 are satisfactory, and values more than 0.950 are not acceptable depicting that the items as redundant (J. Hair Jr et al., 2016). In this research, the value of CR is above 0.883 and below 0.931, conforming to the sufficient internal consistency of lower-order constructs. The reliability coefficient (ρA) is an accurate measure of composite reliability between Cronbach's alpha and composite reliability. The values of ρA more than 0.855 and less than 0.913, conform to the satisfactory requirement criterion (Dijkstra & Henseler, 2015; Joseph F Hair, Risher, Sarstedt, & Ringle, 2019). Table 2 depicts the internal consistency of the scale items of this work.

The second step is to evaluate convergent validity, which indicates how the measures correlate positively with the same construct's alternative measures (J.F. Hair, Hult, Ringle, & Sarstedt, 2017). Convergent Validity testing includes the Indicator's reliability (outer loadings of the indicators) and Average Variance Extracted (AVE) assessments (J.F. Hair et al., 2017). Individual item reliability was investigated by examining their factor loadings. Table 2 shows that each item's loadings of first-order reflective models of PPP, BP, HRC, BI, PI, PSI, MI, SI, AC, AS, TR, and EP are above 0.7, supporting the indicator's reliability criterion (J. Hair Jr et al., 2016). 55 out of 57 indicators have loading above 0.7. However, two indicators (AC6 and SI1) have loadings between 0.6 to 0.7. In this study, these two items are retained considering their contribution towards content validity and better value of AVE, as suggested by (J. F. Hair Jr et al., 2016). The AVE is a statistical assessment that measures the average percentage of the variance extracted commonly from the observed variables (J.F. Hair et al., 2017; Joseph F Hair et al., 2019). Table 2 shows that all values of AVE surpass the threshold of 0.5 and conform to the convergent validity of the construct measures.

Figure 2: First Order measurement model

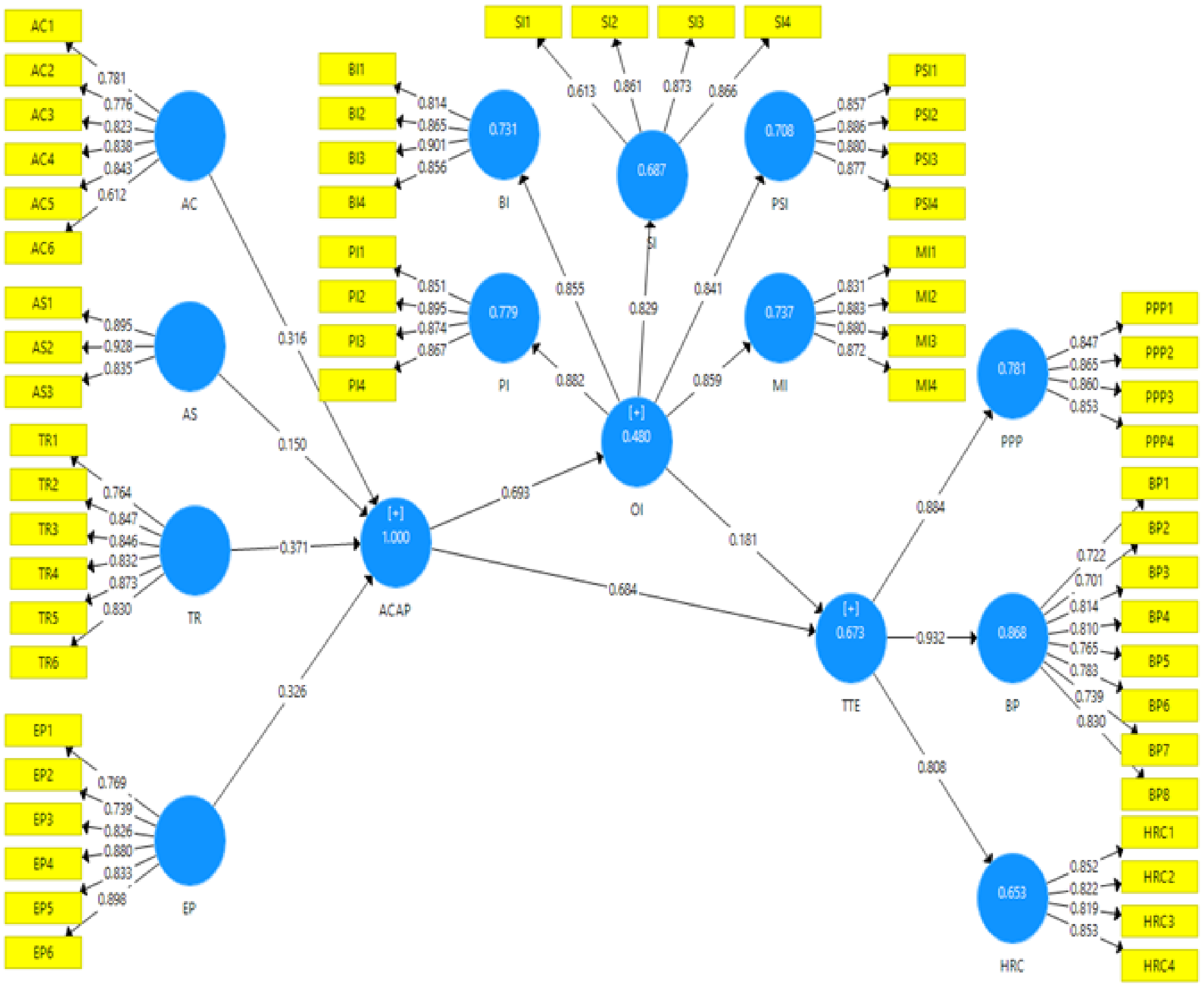


Table 2 – Results of first order measurement model

Constructs	Items	Loadings	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Absorptive Capacity (First Order Reflective)						
Acquisition	AC1	0.781	0.871	0.879	0.904	0.613
	AC2	0.776				
	AC3	0.823				
	AC4	0.838				
	AC5	0.843				
	AC6	0.612				
Assimilation	AS1	0.895	0.863	0.866	0.917	0.787
	AS2	0.928				
	AS3	0.835				
Transformation	TR1	0.764	0.911	0.913	0.931	0.693
	TR2	0.847				
	TR3	0.846				
	TR4	0.832				
	TR5	0.873				
	TR6	0.830				

Constructs	Items	Loadings	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Exploitation	EP1	0.769	0.905	0.907	0.928	0.682
	EP2	0.739				
	EP3	0.826				
	EP4	0.880				
	EP5	0.833				
	EP6	0.898				
Organizational Innovation (First Order Reflective)						
Behavioural innovation	BI1	0.814	0.882	0.885	0.919	0.739
	BI2	0.865				
	BI3	0.901				
	BI4	0.856				
Product Innovation	PI1	0.851	0.895	0.896	0.927	0.76
	PI2	0.895				
	PI3	0.874				
	PI4	0.867				
Process Innovation	PSI1	0.857	0.898	0.899	0.929	0.766
	PSI2	0.886				
	PSI3	0.880				
	PSI4	0.877				
Market Innovation	MI1	0.831	0.889	0.889	0.924	0.751
	MI2	0.883				
	MI3	0.880				
	MI4	0.872				
Strategy Innovation	SI1	0.613	0.821	0.855	0.883	0.657
	SI2	0.861				
	SI3	0.873				
	SI4	0.866				
Technology Transfer Effectiveness (First Order Reflective)						
Product and Process Performance	PPP1	0.847	0.879	0.879	0.916	0.733
	PPP2	0.865				
	PPP3	0.860				
	PPP4	0.853				
Business Performance	BP1	0.722	0.902	0.905	0.922	0.596
	BP2	0.701				
	BP3	0.814				
	BP4	0.810				
	BP5	0.765				
	BP6	0.783				
	BP7	0.739				
	BP8	0.830				
	HRC1	0.852	0.857	0.86	0.903	0.7
	HRC2	0.822				

Constructs	Items	Loadings	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Human Resource Capability	HRC3	0.819				
	HRC4	0.853				

The third step is to evaluate discriminant validity, the extent to which measures of constructs are theoretically distinct from each other (Joe F. Hair et al., 2014). Three criteria measure the discriminant validity: Cross-loadings, Fornell and Larcker criterion, and Heterotrait-Monotrait (HTMT) (J. Hair Jr et al., 2016) . For the first criterion, it is evident from Table 3 that the cross-loadings of each construct (ACAP, OI, and TTE) are adequately higher than the cross-loadings of other indicators of each construct with a higher value on the respective construct and lower values on other constructs. Hence, discriminant validity which is the first criterion of is fulfilled. Fornell-Larcker is the second criterion, in which the square root of the AVE values with the latent variable correlations is compared. The recommendation is that the square root of each construct's AVE should be greater than its highest correlation with any other construct. It is based on the fact that a construct shares more variance with its related indicators than any other construct (Fornell & Larcker, 1981). It is quite obvious from the Table 3 that the square root values of AVE along the diagonal are greater than the correlation values of the other constructs, fulfilling the second discriminant validity criterion.

Table 3 – Discriminant validity: Fornell & Larcker

	AC	AS	BI	BP	EP	HRC	MI	PI	PPP	PSI	SI	TR
AC	0.783											
AS	0.525	0.887										
BI	0.516	0.391	0.86									
BP	0.687	0.425	0.457	0.772								
EP	0.667	0.699	0.453	0.608	0.826							
HRC	0.568	0.403	0.449	0.616	0.5	0.837						
MI	0.522	0.372	0.645	0.476	0.426	0.463	0.867					
PI	0.458	0.346	0.718	0.427	0.437	0.492	0.683	0.872				
PPP	0.685	0.465	0.471	0.732	0.609	0.633	0.485	0.506	0.856			
PSI	0.644	0.384	0.627	0.614	0.541	0.57	0.679	0.666	0.661	0.875		
SI	0.492	0.442	0.663	0.438	0.464	0.451	0.651	0.689	0.462	0.585	0.811	
TR	0.743	0.434	0.52	0.709	0.645	0.626	0.56	0.521	0.713	0.734	0.541	0.833

HTMT is the third discriminant validity criterion, which measures the similarity between latent variables. HTMT values above 0.90 recommend a lack of discriminant validity (Henseler, Ringle, & Sarstedt, 2015). When constructs in the path model are conceptually discrete, conservative threshold values of 0.85 are acceptable. This research has all the values below 0.85 and is tabulated in Table 4, depicting the acceptability of the third discriminant validity criterion.

In the first-order measurement model, the composite reliability, internal consistency, convergent validity, and discriminant validity were assessed using a repeated indicator approach (Becker et al., 2012). All the tests conclude the reliability and validity of the first-order constructs. The reliability and validity of the second-order measurement model are evaluated in the next section.

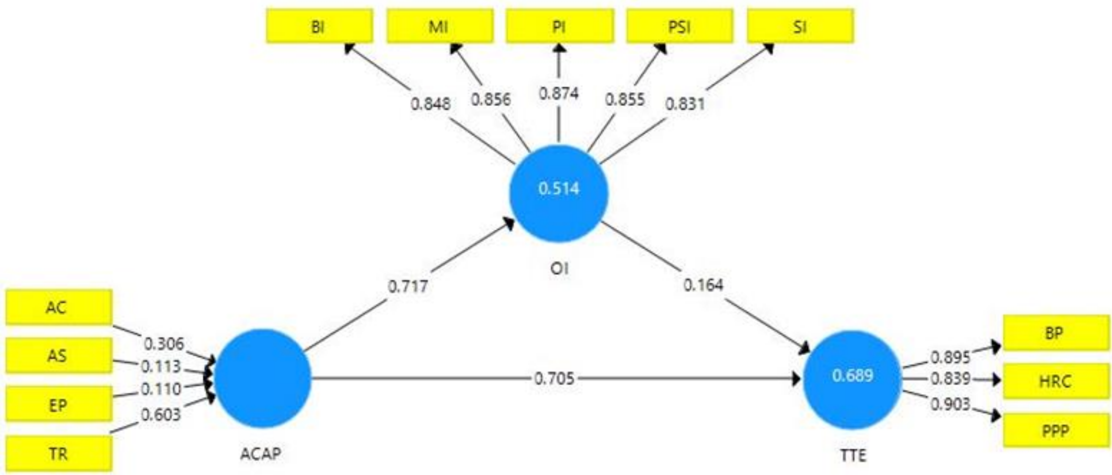
Table 4 – Discriminant validity: HTMT criterion

	AC	**AS**	**BI**	**BP**	**EP**	**HRC**	**MI**	**PI**	**PPP**	**PSI**	**SI**	**TR**
AC												
AS	0.61											
BI	0.594	0.451										
BP	0.773	0.48	0.511									
EP	0.749	0.79	0.508	0.672								
HRC	0.66	0.47	0.515	0.698	0.567							
MI	0.6	0.426	0.726	0.529	0.475	0.53						
PI	0.523	0.395	0.807	0.473	0.486	0.56	0.763					
PPP	0.781	0.534	0.533	0.819	0.683	0.726	0.549	0.571				
PSI	0.728	0.437	0.703	0.681	0.601	0.649	0.759	0.741	0.745			
SI	0.591	0.536	0.773	0.509	0.542	0.536	0.747	0.786	0.54	0.665		
TR	0.832	0.487	0.582	0.781	0.708	0.709	0.625	0.577	0.796	0.811	0.62	

Evaluation of Measurement Model (Second order)

A two-stage approach evaluates the second-order / Higher order measurement model (Becker et al., 2012; Henseler, Ringle, & Sinkovics, 2009; Sarstedt et al., 2019). During the evaluation, the latent scores of first-order constructs are obtained using a repeated indicator approach (Becker et al., 2012; Wetzels, Odekerken-Schröder, & Van Oppen, 2009). In this work, OI at the second-order measurement model has five reflective indicators, TTE has three reflective indicators, and ACAP has four formative indicators. For measurement model evaluation of reflective constructs (TTE and OI), reliability and validity are measured in the second order. In addition, the multicollinearity issue test (including variance inflation factor), significance and relevance of outer weights are measured for formative construct (ACAP).

Figure 3: Second-Order Measurement Model



The data from the repeated indicator approach is collected, imported, and reloaded as separate data sets (including the collective results of the first-order measurement model) to measure Cronbach's alpha, composite reliability, and AVE at second-order results. The second-order reflective model's two-stage results are in Figure 3 and Table 5 for the OI and TTE variables of this study. Cronbach's alpha values are above 0.7, Composite reliability (CR) values are between 0.7 to 0.9, rho_A values are between 0.70 to 0.95, and meet the criteria of Hair Jr et al. (2016) for the reflective measurement model. Moreover, all the outer loadings of reflective constructs and AVE values are more than 0.7 and 0.5, respectively, as shown in Table 5. Hence, all the requirements for the reflective measurement for these two variables (OI and TTE) are fulfilled, as Hair Jr et al. (2016) recommended.

Table 5 – Results of measurement Model (Second order reflective)

Construct	**Loadings**	**Cronbach's Alpha**	**rho_A**	**Composite Reliability**	**Average Variance Extracted (AVE)**
Organizational Innovation (2nd order Reflective)					
BI	0.848	0.907	0.917	0.93	0.727
PSI	0.855				
SI	0.831				
MI	0.856				
PI	0.874				
Technology Transfer Effectiveness (2nd order Reflective)					
BP	0.895	0.854	0.859	0.911	0.774
HRC	0.839				
PPP	0.903				

Hair et al. (2017) defined three criteria (the cross-loadings, Fornell Larcker criterion, and heterotrait-monotrait ratio of correlations) for the calculation of discriminant validity of second-order construct using the two-stage approach for the reflective measurement model. The indicator's outer loadings on the associated construct are greater than any of its cross-loadings (i.e., its correlation) on other constructs, as shown in Table 6. Therefore, the first criterion to assess the indicators' discriminant validity, i.e., cross-loadings, is fulfilled. The second criterion for assessing discriminant validity is the Fornell Larcker criterion. Table 7 shows that all diagonal values (Square root of AVE) for this study are greater than the construct's corresponding correlations relative to all other constructs as per the requirements of Fornell & Larcker (1981). The third criterion for evaluating discriminant validity is the heterotrait-monotrait (HTMT) ratio of correlations (Henseler et al., 2015). For this study, the HTMT criterion for discriminant validity assessment at second order measured is 0.749. The threshold for the HTMT criterion should be below 0.85 (Clark, Watson, & Reynolds, 1995; Kline, 2011), and according to Henseler et al. (2015), the threshold defined is less than 0.9. Considering both threshold values, the measured results of this study meet the criterion. Therefore, all outcomes of Cross Loading, Fornell Larcker's, and HTMT meet the second-order measurement model criteria.

Table 6 – Cross Loadings (Second Order)

	ACAP	**OI**	**TTE**
AC	**0.887**	0.625	0.738
AS	**0.612**	0.454	0.491
EP	**0.782**	0.549	0.653
TR	**0.95**	0.686	0.778
BI	0.566	**0.848**	0.522
PSI	0.743	**0.855**	0.701
SI	0.578	**0.831**	0.511
MI	0.587	**0.856**	0.54
PI	0.541	**0.874**	0.539
BP	0.753	0.575	**0.895**
HRC	0.652	0.574	**0.839**
PPP	0.759	0.616	**0.903**

Table 7 – Fornell Larcker criterion (Second Order)

	ACAP	**OI**	**TTE**
ACAP	Formative		
OI	0.717	**0.853**	
TTE	0.822	0.669	**0.88**

While evaluating the second-order measurement model for formative indicators, i.e., ACAP in this study must be tested for multicollinearity issues, significance and relevance of outer weights. Variation inflation factor (VIF) evaluates multicollinearity. In PLS-SEM, the VIF value above 5 is a sign of collinearity issues (Joe F. Hair, Ringle, & Sarstedt, 2011). In Table 8, the VIF values of formative indicators AC, AS, EP, and TR associated with ACAP are below 5; hence there is no collinearity for ACAP formative indicators. Secondly, the significance of relevance of outer weights is gauged. It is measured by the values of outer weights that are required to be smaller than the outer loadings. According to Hair et al. (2017), for significance testing with a two-tailed test (significance level of 1%), the criterion of t value is greater than 2.57. From Table 8, The t-values of AC and TR are above the threshold value of 2.57 at 1% significance level (p less than 0.01) indicating that the outer weights of formative indicators are significant. However, the t-values of AS and EP are below 2.57. The p-value shown in Table 9 for the formative indicator is below 0.01 for AC and TR and above 0.01 for AS and EP. However, these formative indicators can be retained when the outer loadings are above 0.5. In case the weights are non-significant, but outer loadings are above 0.5, formative indicators can also be retained based on conceptual significance (J.F. Hair et al., 2017). In this research, AS and EP are non-significant, but as loadings are above 0.5, they are retained based on conceptual significance.

Table 8 – Assessment of measurement Model (Second order Formative)

Construct	Loadings	Weight	VIF	t-value	p-value
AC	0.887	0.306	2.642	5.604	0.000
AS	0.612	0.113	2.002	2.147	0.032
EP	0.782	0.110	2.852	1.786	0.074
TR	0.950	0.603	2.483	11.558	0.000

The second-order measurement model in this study qualifies all criteria.

Evaluation of structural model

A well-constructed and developed structural model is required to be evaluated to find out whether the data support the developed hypothesis proposed by the structural model or not (Urbach & Ahlemann, 2010). The six assessments in this evaluation are Collinearity assessment among the exogenous constructs (lateral collinearity), Hypotheses Testing (Path Coefficient), Coefficient of Determination (R^2 Value) assessment, Effect Size f^2 assessment, Predictive Relevance of the Model (Q^2), and Effect Size (q^2) assessment (J. Hair Jr et al., 2016). The structural model of this research is composed of reflective and formative indicators after measuring the latent score of indicators in the first-order measurement model.

Collinearity assessment is among the exogenous constructs (lateral collinearity measures the relationship between two or more independent variables). Collinearity occurs when the two variables are hypothesized to be casually related and measure the same construct. The criterion for this assessment is that VIF less than 5 is acceptable (Joe F. Hair et al., 2011). Table 9 shows that this study's collinearity values are less than 5 which is the threshold value.

Table 9 – Collinearity Assessment

Relationship	**VIF<5**
ACAP>TTE	2.057
ACAP>OI	1
OI>>TTE	2.057

Hypotheses Testing (Path Coefficients β) evaluates the structural model in which hypothesized relationships between exogenous and endogenous constructs are tested. These relationships are based on the path coefficient values. Path coefficients lie between +1 and -1 (J.F. Hair et al., 2017). Values near +1 indicate strong positive relationships and are usually significant statistically. On the other hand, values closer to zero indicate the weak relationships between the exogenous and endogenous constructs, and such values are not significantly different. Critical values which are mostly employed in two-tailed tests are 1.65 (significance level =10%), 1.96 (significance level = 5%), and 2.57 (significance level = 1%). The significance of relevance for the structural model relationships has been assessed. To evaluate whether the relationship between ACAP & OI and ACAP & TTE is significant, complete bootstrapping with 5000 samples, Bias-Corrected and Accelerated (BCa) Bootstrap with 2-tailed testing at the significance level of 0.01 were conducted. The significance parameters (empirical t- and p- values) are calculated for all structural path coefficients with the help of a bootstrap standard error. If an empirical t-value is greater than the critical value, the coefficient is concluded as statistically significant at that specific error probability and is declared significance level. In this context, the significance of ACAP & OI and ACAP & TTE have been calculated and listed in Table 8. The coefficient is declared significant because the empirical t-value is greater than the critical value of 2.57 (significance level = 1%). The p-value measures the probability that an observed difference could have happened randomly. The p-value is inversely proportional to the statistical significance of the observed difference. The strict criterion of testing the relationships has been considered in this study, i.e., while assuming a 1% significance level, the corresponding p-value should be smaller than 0.01. Accordingly, the relationships between ACAP & OI, ACAP & TTE, and OI &TTE have been significant. A confidence interval is a method to assess how well the sample characterizes the entire population under study, so it is better to include confidence interval in the assessment (Henseler et al., 2009). As per the confidence interval criterion, all hypotheses with path coefficient zero are not selected. Table 10 shows a significant positive relationship between ACAP & OI, ACAP & TTE, and OI &TTE.

Table 10 – Significance of relevance

Hypothesis	**Relationship**	**Path coefficient (Beta)**	**t-value**	**p-value**	**Confidence Interval Lower**	**Confidence Interval Upper**	**Significance (P<0.01)**	**Decision**
H1	ACAP -> OI	0.717	26.165	0.000	0.646	0.786	0	Supported
H2	ACAP-> TTE	0.705	13.337	0.000	0.555	0.833	0	Supported
H3	OI -> TTE	0.164	3.004	0.002	0.026	0.306	0.003	Supported

The coefficient of determination (R^2 value) assesses the model's predictive power is a statistical measure. It expresses the goodness of fit, which means how well the data fits the model (J. Hair Jr et al., 2016). The R-squared value is between 0.0 (no better predicting) and 1.0 (excellent value). If R^2 values for endogenous latent variables are 0.75, 0.50, or 0.25, they will be respectively substantial, moderate, or weak (Chin, 1998; Henseler et al., 2009). In this research, as shown in Table 11, the R^2 value assessed for OI and TTE is 0.514 and 0.689, respectively; hence, they are at moderate and substantial levels of predictive accuracy.

Table 11 – Coefficient of determination (R^2 value)

Measure	**R^2 Ranges**	**R^2 value**	**Decision**
OI	0.75 substantial 0.50 moderate 0.25 weak	0.514	Moderate
TTE		0.689	Substantial

Effect size (f^2) is a statistical concept for assessing the strength of the relationship between two variables on a numeric scale with the help of the R^2 value. The R-square as an index for measuring overall model performance can be evaluated further regarding the contribution of individual exogenous constructs that formed the model. The effect size f^2 is the estimation of R^2 in a case when a given independent variable is removed from the research model. It assesses the effect size of the removed independent construct on the dependent construct (J. Hair Jr et al., 2016). The effect size is measured according to 0.02, 0.15, and 0.35 respectively for a weak, medium, or significant effect at the structural level (J. Cohen, 1998;

Henseler et al., 2009). Two techniques have been used to find the Effect size (f^2): The effect size of the exogenous constructs through R^2 values and the direct calculation of the Effect size (f^2) of the exogenous through Smart PLS. The first technique was used for this research, and the effect size of 1.057 depicts the large effect size of ACAP on OI, 0.771 shows the significant effect of ACAP on TTE, and 0.0353 describes the weak effect of OI on TTE. The same is shown in Table 12.

Table 12 – Effect size (f^2) of the exogenous constructs through R^2 values

Construct	R^2 include	R^2 exclude	f^2	Results
ACAP -> OI	0.514	0	1.057	Large Effect
ACAP -> TTE	0.689	0.449	0.771	Large Effect
OI -> TTE	0.689	0.678	0.0353	Small Effect

In the second technique, Smart PLS is directly used to determine f^2 values to measure the effect size of exogenous variables on the endogenous variables. In this research, the effect size of 1.057 depicts the large effect size of ACAP on OI, 0.777 shows the significant effect of ACAP on TTE, and 0.0353 describes the weak effect of OI on TTE. Table 13 presents the PLS manual results, which show f^2 values of the respective path relationships in the structural model.

Table 13 – Effect size (f^2) Using PLS

Hypothesis	Relationship	Ranges	f^2	Inference
H1	ACAP -> OI	0.02 weak 0.15 medium 0.35 large	1.057	Large Effect
H2	ACAP -> TTE		0.771	Large Effect
H3	OI -> TTE		0.035	Small Effect

Except for the assessment of the R^2 value, based on the blindfolding procedure, Stone-Geisser's predictive relevance Q^2 criterion assesses the predictive validity of a model using PLS (Geisser, 1974; Stone, 1974). Critical values have also been defined for Q^2, and if values are greater than zero, then that particular endogenous construct of the model has predictive relevance. On the other hand, if Q^2 values are zero or below, this will depict a lack of predictive relevance. For this study, the measured Q^2 values for OI and TTE are 0.356 and 0.525, respectively. Therefore, they are greater than zero; accordingly, they suggest the predictive relevance of OI and TTE, as shown in Table 14.

Table 14 – Predictive Relevance Q^2

Measure	Q^2 Range	Q^2 value	Results
OI	$Q^2>0$	0.356	$Q^2>0$ Explanatory variable provides predictive relevance
TTE		0.525	$Q^2>0$ Explanatory variable provides predictive relevance

Effect size (q^2) or Cohen's Indicator is assessed to measure the degree of relationship between the latent variables. The effect size q^2 values of 0.02, 0.15, and 0.35 are measured as small, medium, and large, and the values less than 0.02 depict no effect (J. Hair Jr et al., 2016). Table 15 shows that the Effect size (q^2) with respect to Q^2 include and Q^2 exclude for OI and TTE as an endogenous construct has a large effect with respect to ACAP an exogenous construct. However, the q^2 for TTE with respect to OI has no effect.

Table 15 – Effect size q^2

Hypothesis	Relationship	Ranges	Q^2 include	Q^2 exclude	q^2 exclude	Results
H1	ACAP -> OI	0.02 weak 0.15 medium 0.35 large	0.356	0	0.553	Large Effect
H2	ACAP -> TTE		0.525	0.342	0.385	Large Effect
H3	OI -> TTE		0.525	0.517	0.017	No Effect

Mediation Analysis

According to Baron and Kenny (1986), the mediation variable caters to all or part of the relationship between a predictor and outcome. In this work, ACAP and OI are the predictors of TTE, whereas OI mediates between ACAP and TTE. Bootstrapping test is a nonparametric resampling technique and has been considered a rigorous and powerful technique for mediating effect testing. The same has been supported by Joseph F Hair et al.(2013). The bootstrapping approach does not assume regarding the shape of the variables or the sampling distribution of the statistics and can be applied to small sample sizes. Hence, this technique is well suited for PLS-SEM (Joseph F Hair et al., 2013; Preacher & Hayes, 2008). In this study, the bootstrapping method has been applied to examine the significance of mediating relationships. The mediation variable is significant if the t-value exceeds 2.57 and the p-value <0.01 (J.F. Hair et al., 2017). Based on this study's t and p values, it is concluded that there is an indirect influence of ACAP on TTE through OI, as shown in Table 16. The bootstrapping analysis indicates that the indirect effects with $\beta = 0.117$ are significant having a t-value of 2.973 and p-value=.003. The indirect effects 99.5% Boot CI Bias Corrected: [LL = 0.018, UL = 0.259] did not straddle a zero in between indicated that there was mediation (Preacher & Hayes, 2008). Hence hypothesis H4 is supported and indicates that there is a partial mediation.

Table 16 – Mediation Analysis (Indirect Effects (Mediation Effects)

Hypothesis	**Relationship**	**Path Coefficient (β)**	**Standard Error (STDEV)**	**T value**	**P value**	**CI_LL 0.5%**	**CI_UL 99.5%**	**Decision**
H4	ACAP -> OI -> TTE	0.117	0.039	3.016	0.003	0.019	0.226	Supported

After the evaluation of data in the measurement model, hypotheses were tested in the structural model to evaluate the relationships between the independent and dependent variables. The results of this study determined the significant relationships between the independent variable ACAP and the dependent variable TTE. Similarly, this study also explored the significant relationship between independent variables ACAP with mediating variable OI. Further, the mediating of OI is also significant in the relationships between ACAP and TTE.

LIMITATIONS AND FURTHER RESEARCH

This research has certain limitations that need to be highlighted for future research. Firstly, the role of absorptive capacity and organizational innovation on technology transfer effectiveness is examined through quantitative methodology by collecting data only from the ICT sector of Pakistan. To expand the research contributions and verify the research generalizability, future research is required to gather data from different sample groups and/or comparative populations or other business sectors, increasing the level of reliable results. Secondly, the results of this research may differ from studies conducted in developed countries because of variations in the economic situation in developing and developed countries (Aycan et al., 2000). Therefore, the adoption of this study is highly recommended in other developed countries. Thirdly this research is conducted under a quantitative, deductive, and cross-sectional time horizon that was appropriate for probing the existing ICT sector of Pakistan. On the contrary, future studies can adopt other research designs like longitudinal studies that can contribute to understanding the technology transfer effectiveness in different periods. For instance, absorptive capacity and organizational innovation can be investigated two other times to test the impact of these variables during the start of the guarantee and warranty period of the technology transfer process and after the expiry of this period. Moreover, this research development could also be elevated by implementing a qualitative or multilevel research design.

CONCLUSION

This paper extends the literature by narrowing the research gap by examining the causal relationship between a firm's absorptive capacity and technology transfer effectiveness in Information and Communication Technology companies in Pakistan. Although numerous studies on technology transfer have been carried out in the existing literature, little work is present regarding TTE. The technology transfer effectiveness is meeting objectives for a specific technology transfer project regarding three performance and capability-related areas: product and process performance, business performance, and human resource capability. These areas can contribute to technology transfer efficiently if organizations have better absorptive capacity. Absorptive capacity is the combined capabilities of any organization to identify the worth of outside knowledge, acquire, assimilate and apply it to attain continued competitiveness (W. M. Cohen & Levinthal, 1990b). Mostly used dimensions in literature are acquisition, assimilation, transformation, and exploitation. The empirical analysis concludes that different dimensions of absorptive capacity have different effects on the organizational innovation of high-tech firms. Organizational innovation uses new managerial concepts & practices and is the exact mechanism for achieving and using external knowledge. In this study, product, market, behavioural, process, and strategic innovation are the five dimensions of OI. This study empirically validates the conceptual findings of organizational learning theory. It has exposed the importance of two factors, absorptive capacity and organizational innovation, to increase technology transfer performance. It has investigated the empirical relationship between absorptive capacity (ACAP) and technology transfer effectiveness (TTE) through organizational innovation (OI) in the ICT Sector of Pakistan. This research has empirically investigated the positive relationship between ACAP & TTE, confirmed OI's mediation effect between ACAP & TTE, and found significant positive results. The results of this work help provide valuable insights to technology transfer policymakers and ICT-owned managers.

References

Abidin, R., Abdullah, C. S., & Hasnan, N. (2015). The mediating effect of absorptive capacity on the relationship between social capital and technology transfer performance. *Journal of Technology and Operations Management*, *10*(2), 10–23.

Albort-Morant, G., Henseler, J., Cepeda-Carrión, G., & Leal-Rodríguez, A. L. (2018). Potential and realized absorptive capacity as complementary drivers of green product and process innovation performance. *Sustainability (Switzerland)*, *10*(2). https://doi.org/10.3390/su10020381

Ali, M., & Park, K. (2016). The mediating role of an innovative culture in the relationship between absorptive capacity and technical and non-technical innovation. *Journal of Business Research*, *69*(5), 1669–1675. https://doi.org/10.1016/j.jbusres.2015.10.036

Ali, M., Seny Kan, K. A., & Sarstedt, M. (2016). Direct and configurational paths of absorptive capacity and organizational innovation to successful organizational performance. *Journal of Business Research*, *69*(11), 5317–5323. https://doi.org/10.1016/j.jbusres.2016.04.131

Aminbeidokhti, A., Jamshidi, L., & Mohammadi Hoseini, A. (2016). The effect of the total quality management on organizational innovation in higher education mediated by organizational learning. *Studies in Higher Education*, *41*(7), 1153–1166. https://doi.org/10.1080/03075079.2014.966667

Argyris, Ch, & Schön, D. A. (1997). Organizational learning: A theory of action perspective. *Reis*, (77/78), 345–348.

Argyris, Chris, & Schön, D. a. (1997). *Organizational Learning: A Theory of Action Perspective*. *Revista Española de investigaciones sociológicas* (Vol. 77). https://doi.org/10.1177/002188637901500410

Audretsch, D., & Caiazza, R. (2016). Technology transfer and entrepreneurship: cross-national analysis. *Journal of Technology Transfer*, *41*(6), 1247–1259. https://doi.org/10.1007/s10961-015-9441-8

Aycan, Z., Kanungo, R., Mendonca, M., Yu, K., Deller, J., Stahl, G., & Kurshid, A. (2000). Impact of culture on human resource management practices: A 10-country comparison. *Applied Psychology*, *49*(1), 192–221.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173.

Becker, J.-M., Klein, K., & Wetzels, M. (2012). Hierarchical latent variable models in PLS-SEM: guidelines for using reflective-formative type models. *Long Range Planning*, *45*(5–6), 359–394.

Bengoa, A., Maseda, A., Iturralde, T., & Aparicio, G. (2020). *A bibliometric review of the technology transfer literature*. *Journal of Technology Transfer*. Springer US. https://doi.org/10.1007/s10961-019-09774-5

Bouzembrak, Y., & van der Fels-Klerx, H. J. (2018). Effective sampling strategy to detect food and feed contamination: Herbs and spices case. *Food Control*, *83*, 28–37. https://doi.org/10.1016/j.foodcont.2017.04.038

Bozeman, B. (2000). Technology transfer and public policy: a review of research and theory. *In: Research Policy, Vol. 29, S*, 627–655. https://doi.org/10.1016/S0048-7333(99)00093-1

Božič, K., & Dimovski, V. (2019). Business intelligence and analytics for value creation: The role of absorptive capacity. *International Journal of Information Management*, *46*(November 2018), 93–103. https://doi.org/10.1016/j.ijinfomgt.2018.11.020

Briones-Peñalver, A. J., Bernal-Conesa, J. A., & de Nieves Nieto, C. (2020). Knowledge and innovation management model. Its influence on technology transfer and performance in

Spanish Defence industry. *International Entrepreneurship and Management Journal*, *16*(2), 595–615. https://doi.org/10.1007/s11365-019-00577-6

Cenamor, J., Parida, V., Oghazi, P., Pesämaa, O., & Wincent, J. (2019). Addressing dual embeddedness: The roles of absorptive capacity and appropriability mechanisms in subsidiary performance. *Industrial Marketing Management*, *78*(February 2016), 239–249. https://doi.org/10.1016/j.indmarman.2017.06.002

Chen, C. (2017). Assessing the influence of leadership style , organizational learning and organizational innovation. https://doi.org/10.1108/LODJ-11-2015-0261

Chen, Y. S., Lin, M. J. J., & Chang, C. H. (2009). The positive effects of relationship learning and absorptive capacity on innovation performance and competitive advantage in industrial markets. *Industrial Marketing Management*, *38*(2), 152–158. https://doi.org/10.1016/j.indmarman.2008.12.003

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. *Modern Methods for Business Research*, *295*(2), 295–336.

Clark, L. A., Watson, D., & Reynolds, S. (1995). Diagnosis and classification of psychopathology: Challenges to the current system and future directions. *Annual Review of Psychology*, *46*(1), 121–153.

Cohen, J. (1998). *Statistical Power Analysis for the Behavioral Sciences*. Routledge. https://doi.org/10.4324/9780203771587

Cohen, W. M., & Levinthal, D. a. (1990a). A new perspective on learning and innovation. *Administrative Science Quarterly*, *35*(1), 128–152. https://doi.org/10.2307/2393553

Cohen, W. M., & Levinthal, D. A. (1990b). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, *35*(1), 128. https://doi.org/10.2307/2393553

Cunningham, J. A., & O'Reilly, P. (2018). Macro, meso and micro perspectives of technology transfer. *Journal of Technology Transfer*, *43*(3), 545–557. https://doi.org/10.1007/s10961-018-9658-4

Cusumano, M. A., Kahl, S. j, & Suarez, F. F. (2008). Services, industry evolution, and the copetitive strategies of product firms. *Academy of Management Journal*, *51*(2), 315–334. https://doi.org/10.1002/smj

da Silva, V. L., Kovaleski, J. L., & Pagani, R. N. (2019). Technology transfer in the supply chain oriented to industry 4.0: a literature review. *Technology Analysis and Strategic Management*, *31*(5), 546–562. https://doi.org/10.1080/09537325.2018.1524135

Damanpour, F. (2017). Organizational innovation. In *Oxford Research Encyclopedia of Business and Management*.

Danquah, M. (2018). Technology transfer, adoption of technology and the efficiency of nations: Empirical evidence from sub Saharan Africa. *Technological Forecasting and Social Change*, *131*(October), 175–182. https://doi.org/10.1016/j.techfore.2017.12.007

De Paula Guedes, H., Ziviani, F., De Paiva, R. V. C., Ferreira, M. A. T., & De Mendonça Herzog, M. (2017). Assessment of absorptive capacity: A study in Brazilian manufactures of solar panels. *Gestao e Producao*, *24*(1), 50–63. https://doi.org/10.1590/0104-530X2666-16

del Carmen Haro-Domínguez, M., Arias-Aranda, D., Javier Lloréns-Montes, F., & Ruíz Moreno, A. (2007). The impact of absorptive capacity on technological acquisitions engineering consulting companies. *Technovation*, *27*(8), 417–425. https://doi.org/10.1016/j.technovation.2007.04.003

Demartini, C. (2015). A Process-Based Classification of Knowledge Maps and Application Examples. *Knowledge and Process Management*, *22*(2), 99–111. https://doi.org/10.1002/kpm

Dijkstra, T. K., & Henseler, J. (2015). Consistent partial least squares path modeling. *MIS Quarterly*, *39*(2).

Distanont, A., Khongmalai, O., & Kritpipat, P. (2018). Factors affecting Technology transfer performance in the Petrochemical Industry in Thailand : A Case study ป ั จจ ั ยท ี่ ส ่ งผลต ่ อประส ิ ทธ ิ ภาพของการถ ่ ายทอดเทคโนโลย ี ใน อ ุ ตสาหกรรมป ิ โตรเคม ี : กรณ ี ศ ึ กษา, *2*(2), 23–35.

Du, Y., & Wang, H. (2022). Green Innovation Sustainability: How Green Market Orientation and Absorptive Capacity Matter? *Sustainability*, *14*(13), 8192.

Duan, Y., Wang, W., & Zhou, W. (2020). The multiple mediation effect of absorptive capacity on the organizational slack and innovation performance of high-tech manufacturing firms: Evidence from Chinese firms. *International Journal of Production Economics*, *229*(December 2019). https://doi.org/10.1016/j.ijpe.2020.107754

Duchek, S. (2015). Enhancing Absorptive Capacity for Innovation and Change: The Role of Structural Determinants. *Journal of Change Management*, *15*(2), 142–160. https://doi.org/10.1080/14697017.2014.988637

Esposito Vinzi, V., Chin, W. W., Henseler, J., & Wang, H. (2010). *Handbook of partial least squares: Concepts, methods and applications*. Heidelberg, Dordrecht, London, New York: Springer.

Farhadikhah, Z., & Husseini, S. M. H. (2015). A Review of Methods and Models of Technology Transfer. *International Letters of Social and Humanistic Sciences*, *62*(Unido 1989), 173–181. https://doi.org/10.18052/www.scipress.com/ilshs.62.173

Farouk Soliman, A. (2016). Investigating the Leadership Style Effect on the Technology Transfer Effectiveness: A Proposed New Model (An Applied Study on the Dairy Manufacturing Sector in Egypt). *International Journal of Business and Management*, *11*(10), 141. https://doi.org/10.5539/ijbm.v11n10p141

Farrell, C. C., & Coburn, C. E. (2016). Absorptive capacity : A conceptual framework for understanding district central office learning. *Journal of Educational Change*. https://doi.org/10.1007/s10833-016-9291-7

Fazal, S. A., Al Mamun, A., Wahab, S. A., & Mohiuddin, M. (2017). Host-country characteristics, corporate sustainability, and the mediating effect of improved knowledge. *Multinational Business Review*, *25*(4), 328–349. https://doi.org/10.1108/mbr-07-2017-0042

Fazal, S. A., Wahab, S. A., Zarin, N., Yaacob, A. S. Bin, & Zawawi, N. F. M. (2016). The role of cultural factors on intra-firm technology transfer performance and corporate sustainability: A conceptual study. *Asian Social Science*, *12*(9), 15–25. https://doi.org/10.5539/ass.v12n9p15

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50.

Fredriksson, A., Malm, A., & Skov Madsen, E. (2019a). Technology transfer as a part of the business–inter-organizational transfer strategies based on experiences of aircraft production. *Journal of Global Operations and Strategic Sourcing*, *12*(1), 151–171.

Fredriksson, A., Malm, A., & Skov Madsen, E. (2019b). Technology transfer as a part of the business – inter-organizational transfer strategies based on experiences of aircraft production. *Journal of Global Operations and Strategic Sourcing*, *12*(1), 151–171. https://doi.org/10.1108/JGOSS-04-2018-0018

Gandenberger, C., Bodenheimer, M., Schleich, J., Orzanna, R., & Macht, L. (2016). Factors driving international technology transfer: empirical insights from a CDM project survey. *Climate Policy*, *16*(8), 1065–1084. https://doi.org/10.1080/14693062.2015.1069176

García-Morales, V. J., Ruiz-Moreno, A., & Llorens-Montes, F. J. (2007). Effects of technology absorptive capacity and technology proactivity on organizational learning, innovation and performance: An empirical examination. *Technology Analysis and Strategic Management*, *19*(4), 527–558. https://doi.org/10.1080/09537320701403540

García-Sánchez, E., García-Morales, V. J., & Martín-Rojas, R. (2018). Influence of technological assets on organizational performance through absorptive capacity, organizational innovation and internal labour flexibility. *Sustainability (Switzerland)*, *10*(3). https://doi.org/10.3390/su10030770

Geisser, S. (1974). A predictive approach to the random effect model. *Biometrika*, *61*(1), 101–107.

Hafeez, A., Shamsuddin, A. B., Saeed, B., Mehmood, A., & Andleeb, N. (2020). Exploring the impact of absorptive capacity on technology transfer effectiveness mediated by organizational innovation: A conceptual framework. *International Journal of Scientific and Technology Research*, *9*(3), 4779–4792.

Hair, J.F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Thousand Oaks, CA.: Sage.

Hair, Joe F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice*, *19*(2), 139–152. https://doi.org/10.2753/MTP1069-6679190202

Hair, Joe F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review*, *26*(2), 106–121. https://doi.org/10.1108/EBR-10-2013-0128

Hair, Joseph F, Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. *Handbook of Market Research*.

Hair, Joseph F, Ringle, C. M., & Sarstedt, M. (2013). Partial least squares structural equation modeling: Rigorous applications, better results and higher acceptance. *Long Range Planning*, *46*(1–2), 1–12.

Hair, Joseph F, Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*.

Hair Jr, J. F., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2016). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage publications.

Hair Jr, J., Hult, G. T., Ringle, C., & Sarstedt, M. (2016). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) - Joseph F. Hair, Jr., G. Tomas M. Hult, Christian Ringle, Marko Sarstedt*. *Sage*.

Harris, R., & Yan, J. (2019). the Measurement of Absorptive Capacity From an Economics Perspective: Definition, Measurement and Importance. *Journal of Economic Surveys*, *33*(3), 729–756. https://doi.org/10.1111/joes.12296

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135.

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. *Advances in International Marketing*, *20*(May 2014), 277–319. https://doi.org/10.1108/S1474-7979(2009)0000020014

Herterich, M. M., Uebernickel, F., & Brenner, W. (2015). The impact of cyber-physical systems on industrial services in manufacturing. *Procedia Cirp*, *30*, 323–328.

Human, G. (2020). Linking absorptive capacity, knowledge transfer and transactive memory. *Journal of Business & Industrial Marketing*.

Jabar, J., & Soosay, C. (2010). An assessment of technology transfer in Malaysian manufacturers and the impact on performance and innovativeness. *5th IEEE International Conference on Management of Innovation and Technology, ICMIT2010*, 983–989. https://doi.org/10.1109/ICMIT.2010.5492874

Jabar, Juhaini. (2012). Strategic Technology Alliances, Technology Transfer and the Performance of Malaysian Manufacturers. *Journal of Engineering and Technology (JET)*, *3*, 69–98.

Jabar, Juhaini, & Soosay, C. (2010). An assessment of technology transfer in Malaysian manufacturers and the impact on performance and innovativeness. In *2010 IEEE International Conference on Management of Innovation & Technology* (pp. 983–989). IEEE.

Jabar, Juhaini, Soosay, C., & Santa, R. (2011). Organisational learning as an antecedent of technology transfer and new product development: A study of manufacturing firms in Malaysia. *Journal of Manufacturing Technology Management*.

Jafari, M., Akhavan, P., & Rafiei, A. (2014). Technology Transfer Effectiveness in Knowledge-Based Centers Providing a Model Based on Knowledge Management. *International Journal of Scientific Knowledge, March 2014, Vol. 4, No. 7*, *4*(7).

Jansen, J. J. P., Van Den Bosch, F. A. J., & Volberda, H. W. (2005). Managing potential and realized absorptive capacity: How do organizational antecedents matter? *Academy of Management Journal*, *48*(6), 999–1015. https://doi.org/10.5465/AMJ.2005.19573106

Jarvis, C. B., MacKenzie, S. B., & Podsakoff, P. M. (2003). A critical review of construct indicators and measurement model misspecification in marketing and consumer research. *Journal of Consumer Research*, *30*(2), 199–218. https://doi.org/10.1086/376806

Jia, X., Chen, J., Mei, L., & Wu, Q. (2018). How leadership matters in organizational innovation: a perspective of openness. *Management Decision*.

Jukevicene, V. (2015). Development of Absorptive Capacity in a Regional Innovation System: Experience of Lithuanian Regions. *Journal of Education, Culture & Society*, *1*(September), 257. https://doi.org/10.15503/JECS20151.257.270

Kahn, K. B. (2018). Understanding innovation. *Business Horizons*, *61*(3), 453–460. https://doi.org/10.1016/j.bushor.2018.01.011

Kittikunchotiwut, P. (2015). The role of social capital on absorptive capacity and organizational innovation. *Journal of Business and Retail Management Research*, *10*(1), 27–39. https://doi.org/10.24052/JBRMR/200

Kline, R. B. (2011). *Convergence of structural equation modeling and multilevel modeling*. na.

Kostopoulos, K., Papalexandris, A., Papachroni, M., & Ioannou, G. (2011). Absorptive capacity, innovation, and financial performance. *Journal of Business Research*, *64*(12), 1335–1343.

Krejcie, R. V, & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, *30*(3), 607–610.

Lane, P. J., Koka, B., & Pathak, S. (2002). A THEMATIC ANALYSIS AND CRITICAL ASSESSMENT OF ABSORPTIVE CAPACITY RESEARCH. In *Academy of Management proceedings* (Vol. 2002, pp. M1–M6). Academy of Management Briarcliff Manor, NY 10510.

Lau, A. K. W., & Lo, W. (2015). Regional innovation system, absorptive capacity and innovation performance: An empirical study. *Technological Forecasting and Social Change*, *92*, 99–114. https://doi.org/10.1016/j.techfore.2014.11.005

Lavoie, J. R. (2019). Technology Transfer : A Literature Review. https://doi.org/10.1007/978-3-030-15409-7

Lee, C. S., & Wong, K. Y. (2015). Development and validation of knowledge management performance measurement constructs for small and medium enterprises. *Journal of Knowledge Management*.

Lee, E.-S., & Song, D.-W. (2015). The effect of shipping knowledge and absorptive capacity on organizational innovation and logistics value. *The International Journal of Logistics Management*, *26*(2), 218–237.

Leverin, A., & Liljander, V. (2004). Journal of Business & Industrial Marketing. *Journal of Business & Industrial Marketing Management Decision International Journal of Bank*

Marketing Iss Journal of Product &amp Brand Management, *19*(11), 5–14. Retrieved from http://dx.doi.org/10.1108/08858620410523981%5Cnhttp://dx.doi.org/10.1108/00251749610113613%5Cnhttp://dx.doi.org/10.1108/02652320610671333%5Cnhttp://dx.doi.org/10.1108/10610421111108067%5Cnwww.emeraldinsight.com/researchregister%5Cnwww.emeraldinsight.com/0

Liao, S. H., Chen, C. C., Hu, D. C., Chung, Y. chun, & Yang, M. J. (2017). Developing a sustainable competitive advantage: absorptive capacity, knowledge transfer and organizational learning. *Journal of Technology Transfer*, *42*(6), 1431–1450. https://doi.org/10.1007/s10961-016-9532-1

Lien, B. Y. H., Hung, R. Y. Y., Yang, B., & Li, M. (2006). Is the learning organization a valid concept in the Taiwanese context? *International Journal of Manpower*, *27*(2), 189–203. https://doi.org/10.1108/01437720610666209

Lin, B. W., & Berg, D. (2001). Effects of cultural difference on technology transfer projects: An empirical study of Taiwanese manufacturing companies. *International Journal of Project Management*, *19*(5), 287–293. https://doi.org/10.1016/S0263-7863(99)00081-2

Lin, C., Chang, S., & Chang, C.-S. (2004). The impact of technology absorptive capacity on technology transfer performance. *International Journal of Technology Transfer and Commercialisation*, *3*(4), 384. https://doi.org/10.1504/ijttc.2004.005610

Lin, C., Tan, B., & Chang, S. (2002). The critical factors for technology absorptive capacity. *Industrial Management and Data Systems*, *102*(5–6), 300–308. https://doi.org/10.1108/02635570210431993

Lin, J. L., Fang, S. C., Fang, S. R., & Tsai, F. S. (2009). Network embeddedness and technology transfer performance in R&D consortia in Taiwan. *Technovation*, *29*(11), 763–774. https://doi.org/10.1016/j.technovation.2009.05.001

Liu, C. H., Hou, M. C., & Chen, C. H. (2018). Applying Service Design Method to Technology Transfer Process: A Pilot Study. *2018 IEEE International Conference on Engineering, Technology and Innovation, ICE/ITMC 2018 - Proceedings*, 1–7. https://doi.org/10.1109/ICE.2018.8436390

Liu, Y., Wang, L., Yuan, C., & Li, Y. (2012). Information communication, organizational capability and new product development: an empirical study of Chinese firms. *The Journal of Technology Transfer*, *37*(4), 416–432.

Lyles, M. A. (1994). The impact of organizational learning on joint venture formations. *International Business Review*, *3*(4), 459–467. https://doi.org/10.1016/0969-5931(94)90034-5

Mehreen, H., Rammal, H. G., Pereira, V., & Del Giudice, M. (2022). Investigating the influence of absorptive capacity of recipients within cross-border transfer of knowledge: evidence from emerging markets. *International Marketing Review*, *39*(3), 734–754. https://doi.org/10.1108/IMR-11-2020-0264

Meroño-Cerdán, A. L., & López-Nicolás, C. (2017). Innovation objectives as determinants of organizational innovations. *Innovation: Management, Policy and Practice*, *19*(2), 208–226. https://doi.org/10.1080/14479338.2016.1276407

Min, W. Z., Ling, K. C., & Piew, T. H. (2016). The effects of technological innovation, organizational innovation and absorptive capacity on product innovation: A structural equation modeling approach. *Asian Social Science*, *12*(1), 199–222. https://doi.org/10.5539/ass.v12n1p199

Ministry of Information Technology and Telecommunication. (2019). Retrieved September 8, 2019, from https://moitt.gov.pk/

Muse, A., Njeru, A. W., & Waiganjo, E. (2016). Influence of Operational Excellence on the management of efficiency levels in the pharmaceutical industry in Kenya. *International Journal of Academic Research in Business and Social Sciences*, *6*(9), 266–296.

Pankova, L. (2002). Transfer of space technologies past and present: The Russian case. *Journal of Technology Transfer*, *27*(4), 349–360. https://doi.org/10.1023/A:1020263623811

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*(3), 879–891.

Roberts, N., & Dinger, M. (2016). The Impact of Virtual Customer Community Interactivity on Organizational Innovation: An Absorptive Capacity Perspective. *IEEE Transactions on Professional Communication*, *59*(2), 110–125.

Roberts, N., Galluch, P. S., Dinger, M., & Grover, V. (2012). Absorptive Capacity and Information Systems Research: Review, Synthesis, and Directions for Future Research Quarterly Absorptive Capacity and Information Systems Research: Review, Synthesis, and Directions for Future Research1. *Source: MIS Quarterly*, *36*(2), 625–648. Retrieved from http://www.misq.org

Saeed, B., Tasmin, R., Mahmood, A., & Hafeez, A. (2021). Development of a multi-item Operational Excellence scale: Exploratory and confirmatory factor analysis. *The TQM Journal*, *ahead-of-p*(ahead-of-print). https://doi.org/10.1108/TQM-10-2020-0227

Salem, A. (2016). Forging Direct Investment and Technology Transfer in Developing Countries : A Comparative Study of Libya and Egypt, *1*(1), 28–45.

Santoro, M. D., & Gopalakrishnan, S. (2015). Assimilating external knowledge: A look at university-industry alliances. *Portland International Conference on Management of Engineering and Technology*, *2015-Septe*, 227–237. https://doi.org/10.1109/PICMET.2015.7273040

Sarstedt, M., Hair Jr, J. F., Cheah, J.-H., Becker, J.-M., & Ringle, C. M. (2019). How to specify, estimate, and validate higher-order constructs in PLS-SEM. *Australasian Marketing Journal (AMJ)*, *27*(3), 197–211.

Sazali, A. W., Raduan, C. R., Jegak, U., & Haslinda, A. (2009). The Effects of Absorptive Capacity and Recipient Collaborativeness as Technology Recipient Characteristics on Degree of Inter-Firm Technology Transfe. *Journal of Social Sciences*, *5*(4), 423–430. https://doi.org/10.3844/jssp.2009.423.430

Seçkin, B. (2015). Firm Level Absorptive Capacity and the Success of International Technology Transfer : the Case of Aerospace Industry in Turkey.

Setiawan, R. C., Susanti, E., & Syah, T. Y. R. (2019). The Effect of Organizational Culture on Technology Transfers and Company Performance. *Journal of Multidisciplinary Academic*, *3*(3), 32–37.

Sindakis, S., Depeige, A., & Anoyrkati, E. (2015). Customer-centered knowledge management: challenges and implications for knowledge-based innovation in the public transport sector. *Journal of Knowledge Management*.

Singh, S. K., Del Giudice, M., Nicotra, M., & Fiano, F. (2020). How firm performs under stakeholder pressure: Unpacking the role of absorptive capacity and innovation capability. *IEEE Transactions on Engineering Management*.

Soliman, A. F. (2020). The effect of leadership empowerment on technology transfer effectiveness: A proposed model: An applied study on the telecommunication companies in one of the developing countries. *Journal of High Technology Management Research*, *31*(1). https://doi.org/10.1016/j.hitech.2020.100371

Song, Z. (2015). Organizational learning, absorptive capacity, imitation and innovation: Empirical analyses of 115 firms across China. *Chinese Management Studies*, *9*(1), 97–113.

Soto-Acosta, P., Popa, S., & Palacios-Marqués, D. (2016). E-business, organizational innovation and firm performance in manufacturing SMEs: an empirical study in Spain. *Technological and Economic Development of Economy*, *22*(6), 885–904. https://doi.org/10.3846/20294913.2015.1074126

Stone, M. (1974). Cross-validation and multinomial prediction. *Biometrika*, *61*(3), 509–515.

Taleghani, M. (2016). Determine the Factors Affecting the Technology Transfer in the Development of Iranian Oil Fields By Using Contingent Effectiveness Model of Technology, *5*(7), 76–90.

Todorova, G., & Durisin, B. (2007). Absorptive Capacity: Valuing a Reconceptualization. *The Academy of Management Review*, *32*(3), 774–786. https://doi.org/10.2307/20159334

Urbach, N., & Ahlemann, F. (2010). Structural equation modeling in information systems research using partial least squares. *Journal of Information Technology Theory and Application*, *11*(2), 5–40.

USF | Universal Service Fund. (2015). Retrieved November 12, 2019, from https://usf.org.pk/

Van Der Heiden, P., & Pohl, C. (2016). Organizational barriers to absorptive capacity building for international technology transfer to Malaysia. *International Geoscience and Remote Sensing Symposium (IGARSS)*, *2016-Novem*, 7627–7630. https://doi.org/10.1109/IGARSS.2016.7730989

van der Heiden, P., Pohl, C., Mansor, S., & van Genderen, J. (2016). Necessitated absorptive capacity and metaroutines in international technology transfer: A new model. *Journal of Engineering and Technology Management - JET-M*, *41*, 65–78. https://doi.org/10.1016/j.jengtecman.2016.07.001

Vasylieva, O. A. (2013). Absorptive capacity in organizational theories: Learning, innovation, managerial cognition. *Маркетинг і Менеджмент Інновацій*, (4), 190–198.

Wang, C. L., & Ahmed, P. (2004). The Development and Validation of the Organizational Innovativeness Construct Using Confirmatory Factor Analysis, (December). https://doi.org/10.1108/14601060410565056

Wetzels, M., Odekerken-Schröder, G., & Van Oppen, C. (2009). Using PLS path modeling for assessing hierarchical construct models: Guidelines and empirical illustration. *MIS Quarterly*, 177–195.

Whangthomkum, N., Igel, B., & Speece, M. (2006). An empirical study of the relationship between absorptive capacity and technology transfer effectiveness. *International Journal of Technology Transfer and Commercialisation*, *5*(1/2), 31. https://doi.org/10.1504/ijttc.2006.008652

Winkelbach, A., & Walter, A. (2015). Complex technological knowledge and value creation in science-to-industry technology transfer projects: The moderating effect of absorptive capacity. *Industrial Marketing Management*, *47*, 98–108. https://doi.org/10.1016/j.indmarman.2015.02.035

Wong, V., Shaw, V., & Sher, P. J. (1999). Intra-firm learning in technology transfer: A study of Taiwanese information technology firms. *International Journal of Innovation Management*, *3*(4), 427–458.

Wu, G. (2017). Effects of socially responsible supplier development and sustainability-oriented innovation on sustainable development: Empirical evidence from SMEs. *Corporate Social Responsibility and Environmental Management*, *24*(6), 661–675.

Wujiabudula, A., & Zehir, C. (2016). The effect of organizational learning on firm performance through product innovation. *Journal of Global Strategic Management*, *10*(1), 79–88.

Yu, H., Zhang, J., Zhang, M., & Fan, F. (2022). Cross-national knowledge transfer, absorptive capacity, and total factor productivity: the intermediary effect test of international technology spillover. *Technology Analysis and Strategic Management*, *34*(6), 625–640. https://doi.org/10.1080/09537325.2021.1915476

Zahra, S. A., & George, G. (2002). Absorptive Capacity : a Review , Reconceptualization , and Extension. *Academy of Management Review*, *17*(2), 185–203. https://doi.org/10.2307/4134351

Zheng, J., Wu, G., & Xie, H. (2017). Impacts of leadership on project-based organizational innovation performance: The mediator of knowledge sharing and moderator of social capital. *Sustainability*, *9*(10), 1893.