Critical success factors in the stages of technological transfer from university to industry: study in the Andean countries

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Abstract: Technology transfer (TT) is a tool for the development of societies and its success is affected by several factors; hence, it is important to identify them and note how they influence the different stages of the technology transfer process. The present work identifies new factors (adaptation to change, government policies, selection criterion of the project portfolio, work environment, product satisfaction, entropy, stress, and ethics), the same ones that have been supported in the theories of human and organisational behaviour, these affect all stages of the technology transfer process from university to industry. The study was made based on confirmatory factor analysis (CFA) and the model of structural equations and was carried out on 85 universities in four countries of the Andean region. The obtained results confirm that, at 95% confidence, the proposed factors influence all stages of the technology transfer process.

Keywords: factors of technology transfer; technology transfer; stages of technology transfer; model of structural equations.

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1 Introduction

Technology transfer (TT) refers to the process by which science and technology generated by universities, government agencies or research centres are transmitted to a beneficiary and by which an economic reward can be obtained for the investment made in the research (Huyghe et al., 2014). The entity that makes the TT is called technology transfer offices (OTT) (Amador, 2013), which identify and manage the results of the research to be commercialised. Accessing to technology, regardless of where it has been developed, is a fundamental element for the economic growth of countries, as noted by Omar (2010), Wang and Cao (2010), Audretsch, (2014) and Huuck (2015), because it promotes changes in society. The transfer of technology from university to business is an essential element of the innovation strategies of most countries that is why universities are becoming institutions that are immersed in scientific and commercial aspects.

According to data from the National Research and Development Census of Peru for the year 2017, it indicates that 0.08% of the gross domestic product (GDP) destines Peru in research and development, Colombia – 0.25%, Chile – 0.38%, Mexico – 0.54% %, and Ecuador – 1.17% according to the Central Bank of Ecuador; while in the whole world only six countries have managed to overcome investing 3% of GDP in development and research such as South Korea with 4.3%, Israel – 4.1%, Japan – 3.6%, Denmark, Finland and Sweden – 3.1%. Similarly, according to the data provided by Global Innovation Index 2017 (Dutta et al., 2017), he points out that the average research collaboration between the industry and the university in 127 countries surveyed worldwide is 3.66 on a scale of 1 to 7; and the average between Ecuador, Peru, Colombia and Chile is 3.28 which shows that the percentage of collaboration between universities and companies is less than 50%; these figures alert us to the fact that the third mission of the university is not growing adequately in Latin American countries; the university must actively relate to the social, technological, regional, national and world economic requirements; it must

be taken into account that what positions other countries as technologically developed is not only that they are constantly creating new products to the market; rather, they implement strategies to cover the needs of society, maintaining a strong relationship between the university and the company focused on efficiency and services.

Since 1986, several studies have been carried out to identify the factors that influence TT (Lopez-Mendoza and Mauricio, 2018); factors such as the cost of the product or service that require imported technologies, sources of financing or incentives, structure and culture of innovation in universities, among others, have been identified, but, despite this, the transfer process is not yet completely successful; that is why it is important to identify, *what are the factors for which technology is not transferred successfully and how these factors relate to the stages of the TT process?*

The present paper identifies eight new factors that influence the process of TT and in each of its stages, based on theories on which human and organisational behaviour are established. To validate the proposed factors, a study has been made based on the confirmatory factor analysis (CFA) and the model of structural equations on 85 universities that carry out TT from four countries of the Andean region: Colombia, Chile, Ecuador, and Peru; and 48 hypotheses are proposed that relate the factors and stages of the TT process.

The article is organised into seven sections. In Section 2, the literature review of the factors of TT is showed. Section 3 presents the methodology; the conceptual model of factors and phases is presented in Section 4; Section 5 shows the results. In Section 6, the discussion is proposed. Finally, in Section 7, the conclusions are showed.

2 Literature review

2.1 Factors of TT

The factors of TT are elements key to achieve an objective of an organisation, may be internal or external; these can be transformed into variables and their values, at a certain moment, are considered critical or unacceptable, affecting that is successful, Rockart (1979). To achieve a successful process, it is very important to identify the elements that affect each of the stages of the transfer process, as well as knowing the barriers so they can overcome.

In the paper of Lopez-Mendoza and Mauricio (2018) have been identified, in a general, the factors that positively and negatively influence the process of TT; to complement this study we have included articles that are detailed below:

Dueñas Quintero et al. (2015) synthesises factors that generate activities of knowledge and TT for the development of companies based on university-industry relations, and describes to the following: strengthening of research capacities in universities, generation of technology management processes in the companies, alliances in research projects, action and technological innovation, improvement of competitiveness and socio-economic development of the regions and support to companies for the development of activities that promote innovation; it also mentions obstacles that tend to arise in the transfer process, such as the low demand for technological knowledge and the absorption capacity of the productive sector.

Table 1 Factors that influence positively in the technology transfer

No.	*Factor*	*Reference*
1	Environmental competition	Farzin et al. (2014)++ and Huynh (2018)++
2	Legal standards	Park et al. (2010)++
3	Engagement and commitment from senior management	Rasli et al. (2012)++, Nguyen and Aoyama (2014)+, Talukder (2012)++, Farzin et al. (2014)++, Morgan Rozas and Llinàs (2017)++ and Alhomayden (2017)++
4	Communication or diffusion	Rasli et al. (2012)++, Farzin et al. (2014)++ and Susanty et al. (2012)++
5	Learning culture	Susanty et al. (2012)++ and Finardi and Breznitz
6	Organisational culture	Sharif and Huang (2012)++, Susanty et al. (2012)++, Nguyen and Aoyama (2014)+, Farzin et al. (2014)++, Morgan Rozas and Llinàs (2017)++, Finardi and Breznitz (2017)++ and Huynh (2018)++
7	Work description	Rasli et al. (2012)++
8	Organisational design	Necoechea et al. (2013)+, Susanty et al. (2012)++ and Farzin et al. (2014)++
9	Mechanism and efficiency of management	Rasli et al. (2012)++ and Tseng et al. (2018)++
10	Organisational image	Rasli et al. (2012)++ and Necoechea et al. (2013)+
11	Performance evaluation	Rasli et al. (2012)++
12	Leadership	Rasli et al. (2012)++, Farzin et al. (2014)+ and Park et al. (2010)++
13	Peer support	Rasli et al. (2012)++, Min and Kim (2014)+ and Susanty et al. (2012)++
14	Active participation	Nguyen and Aoyama (2014)+
15	Group cohesion	Rast et al. (2015)+
16	Social relation	Susanty et al. (2012)++
17	Training, and human formation	Rasli et al. (2012)++ and Talukder (2012)++
18	Aptitude	Park et al. (2010)++
19	Perceived self-efficacy	Susanty et al. (2012)++ and Farzin et al. (2014)++
20	Confidence, and safety	Necoechea et al. (2013)++
21	Language proficiency	Rasli et al. (2012)++
22	Experience	Talukder (2012)++
23	Frankness	Rasli et al. (2012)++
24	Knowledge management	Johannessen and Olsen (2003)++
25	Staff skills	Rasli et al. (2012)++ and Morgan Rozas and Llinàs (2017)++
26	Technological skills	D'Este and Patel (2007)++, Gholipour et al. (2010)+ and Matin et al. (2010)+
27	Productivity group	Rasli et al. (2012)++
28	Age of researchers	D'Este and Patel (2007)+ and Azagra-Caro et al. (2006)+

Note: $^{++}$Tested factors; $^{+}$factors not tested.

Source: Adapted and complemented by the paper of Lopez-Mendoza and Mauricio (2018)

Table 1 Factors that influence positively in the technology transfer (continued)

No.	*Factor*	*Reference*
29	Work performance	Rasli et al. (2012)++
30	Technological infrastructure	Necoechea et al. (2013)+
31	IT awareness	Rasli et al. (2012)++
32	TT conditions, and efficiency	Necoechea et al. (2013)++ and Phang and Foong (2010)+
33	Innovation	Talukder (2012)+, Dueñas Quintero and Oliva (2015)++ and Tseng et al. (2018)++
34	Use of technology	Talukder (2012)++
35	Infusion of government funds	Phang and Foong (2010)+ and Farzin et al. (2014)++
36	Strengthening of research capacities in	Dueñas Quintero and Oliva (2015)++
37	Generation of technology management processes	Dueñas Quintero and Oliva (2015)++
38	Alliances in research projects	Dueñas Quintero and Oliva (2015)++
39	Improvement of competitiveness	Dueñas Quintero and Oliva (2015)++
40	Socio-economic development of the region	Dueñas Quintero and Oliva (2015)++
41	Responsible and committed to research	Morgan Rozas and Llinàs (2017)++
42	History	Finardi and Breznitz (2017)++
43	Industrial environment	Finardi and Breznitz (2017)++
44	Business activity	Finardi and Breznitz (2017)++
45	Availability of resources	Alhomayden (2017)++
46	Capabilities of university technology transfer office (UTTO)	Alhomayden (2017)++
47	Awareness of commercialisation	Alhomayden (2017)++
48	Incentivisation to commercialise	Alhomayden (2017)++
49	Quality of research activities	Alhomayden (2017)++
50	Reputation of UTTO	Alhomayden (2017)++
51	Understanding of commercialisation process	Alhomayden (2017)++
52	Focus of research activities	Alhomayden (2017)++
53	Location of university	Alhomayden (2017)++
54	Stability of commercialisation initiatives	Alhomayden (2017)++
55	Research mission of higher education institutions	De Ita (2018)++
56	Human and technological capital of excellence	De Ita (2018)++
57	Consulting, development and innovation through research under contract with third	De Ita (2018)++
58	Profit management of commercial exploitation	De Ita (2018)++
59	Mixed university-industry laboratories	De Ita (2018)++
60	Reward system	Tseng et al. (2018)++

Note: ++Tested factors; +factors not tested.

Source: Adapted and complemented by the paper of Lopez-Mendoza and Mauricio (2018)

Table 2 Factors that influence negatively in the technology transfer

No.	*Negative factor*	*Reference*
1	Lack of public aid to promote R+D	Kaushik et al. (2014)-
2	Scientific or technological uncertainties	CyD (2006)-
3	Excess virtual environment	Paramkusham (2013)-
4	Policy implications	Min and Kim (2014)-
5	Damage to morale	Franza et al. (2012)-
6	Excessive compliance with government directions	Park et al. (2010)--
7	University governance	Kaushik et al. (2014)-
8	Inappropriate marketing, on marketing	Kaushik et al. (2014)- and Park et al. (2010)--
9	University bureaucracy or in management	Kaushik et al. (2014)- and Alhomayden (2017)-
10	Duplication of institutional efforts	Kaushik et al. (2014)-
11	Excessive technicality of teachers	Kaushik et al. (2014)-
12	Multiple project assignments	Paramkusham (2013)-
13	Low levels of interaction	Paramkusham (2013)-
14	High centralisation	Susanty et al. (2012)-
15	Organisational ambiguity	Farzin et al. (2014)--
16	Frequent change of director consortium	Park et al. (2010)-
17	Passive participation of members	Park et al. (2010)-
18	Conflict leadership	Park et al. (2010)-
19	Insufficient capacity for R+D	FECYT (2010)-
20	Lack of specialists	Kaushik et al. (2014)-
21	Insufficient and distributed experience	Paramkusham (2013)-
22	Informal training	Paramkusham (2013)-
23	Resource constraints	Franza et al. (2012)-
24	Inefficiencies in the management of technological capabilities	FECYT (2010)-
25	Low demand for technological knowledge	Dueñas Quintero and Oliva (2015)--
26	Absorption capacity of the productive sector	Dueñas Quintero and Oliva (2015)--
27	Cultural differences	Villani et al. (2017)-
28	Regulatory barriers	Villani et al. (2017)-
29	Geographical distance	Villani et al. (2017)-

Note: --Tested factors; -factor not tested.

Source: Adapted and complemented by the paper of Lopez-Mendoza and Mauricio (2018)

Morgan Rozas and Llinàs (2017) identify the following factors: qualified staff, responsible and committed to research; engagement and commitment from senior management; an organisational culture that encourages knowledge creation, sharing and use; and staff attitude and learning ability. The research is carried out among five Peruvian universities using a multiple case study methodology. Universities are among

the best rated Peruvian universities in the university rankings, so the resulting data may be applicable to universities in Peru and other emerging economies.

Villani et al. (2017), in his article, present the barriers between universities and industry such as cultural differences, regulatory barriers, and geographical distance; these can be minimised by the intermediary organisations to achieve cognitive proximity, geographical proximity, social proximity and organisational proximity. The intermediary organisations are the OTT, the university incubators (UI), and collaborative research centres (CRC).

Finardi and Breznitz (2017) show the external factors that affect the TT process such as history and the cultural and, industrial environment; while business activity and culture and the organisation of TT categorise them as internal factors.

Alhomayden (2017), in his doctoral thesis 'University Technology Transfer Performance in Australia', make a research to 40 universities and describe the following factors that influence the TT process: availability of resources, capabilities of university technology transfer office (UTTO), support of senior management, awareness of commercialisation, bureaucracy of university procedures, incentivisation to commercialise, quality of research activities, reputation of UTTO, understanding of commercialisation process, focus of research activities, location of university and, stability of commercialisation initiatives.

De Ita (2018) analyses the distinctive factors of the technological universities of Mexico in the university-industry relations such as: research mission of higher education institutions; human and technological capital of excellence; consulting, development and innovation through research under contract with third parties; business model and licensing; profit management of commercial exploitation and mixed university-industry laboratories. These factors are analysed to minimise the current gaps in the TT process.

Huynh (2018) identifies organisational, departmental and environmental factors; and in its article, he proposes the development of a TT model aimed at owners of firms, policymakers and technology managers to develop more sustainable strategies and improve competitive advantage.

Tseng et al. (2018) analyses three fundamental factors that influence the industrial university collaboration (UIC) environment, the management mechanism, the climate of innovation and the reward system, which they identify as critical elements of UIC.

Tables 1 and 2 summarise in a general 60 factors that affect positively and 29 factors that negatively affect the process of TT, the same that completes the investigation of (Lopez-Mendoza and Mauricio, 2018).

2.2 New factors of TT

This section introduces new factors that affect the transfer of technology based on theories on which human and organisational behaviour is based.

Adaptation to change and/or environment is the ability of organisations to change themselves to cope with the unpredicted changes that occur in their environment and is supported by organisational learning theory, resource dependency theory, and dynamic capabilities. Charles Darwin mentions that the strongest species do not always survive, but yes, the one that best adapts to the environment, similar cases are in companies, because not only survive the largest companies, but those that best adapt to the changes in their environment. The ability to adapt is one of the greatest indicators of personal,

organisational and professional leadership. Organisations must devote special attention to identifying, developing, protecting and displacing those resources and capabilities that ensure a competitive advantage. This factor is relevant given that TT is a process that involves the conversion, application or adaptation of people's inventions to obtain benefits (Phyllis, 2006). According to this concept, we can affirm that the optics with which the process of TT is observed have been changing historically; the economic and social aspects have been transformed to the vision that tries to integrate the acquisition of foreign technologies to the strategy of generation of scientific and technological capacities.

Government R+D policies are actions undertaken by national governments to improve the productivity of countries based on research, science, and technology and to solve the needs of the population; it is supported with stakeholder theory. This factor is important because TT generates profits that increase the competitive capacity of countries. Therefore, there must be an agreement on the suitability of state action in promoting technological innovation and the factors that make it possible. In this sense, guidelines should be established for a state policy on technological innovation, coordinating the efforts of all economic, public and social actors to promote the activities of technological innovation in the entity.

In the Andean region, the R+D policies are very similar, as described below, *Colombia*, through the National Council of Science, Technology, and Technological Innovation, develops its policy based on the generation of knowledge, governance and the transfer of knowledge and technology (National Council of Economic and Social Policy, 2017). In *Ecuador*, the National Secretariat of Science and Technology (SENESCYT) has established the National Science and Technology Policy under the following principles: human development, social and productive development, public communication of science, technology and innovation, transversality and convergence, which are aligned with the National Development Plan for Good Living (Secretariat of Higher Education, Science, Technology and Innovation, 2017). In *Perú*, the National Council for Science, Technology and Technological Innovation (CONCYTEC) has formulated the proposal for a National Policy for the Development of Science, Technology and Technological Research – CTI, based on excellence, sustainability, mainstreaming, equity, transparency and interculturality, aligning the results of research with the needs of the country, according to Supreme Decree No. 015-02016-PCM (National Council of Science, Technology and Technological Innovation, 2017). *Chile* has a policy management of science, technology, and innovation, and recognises the need for modern institutions, proposes to strengthen natural laboratories and support the development of the information industry with training plans, eliminating tax distortions, adapting the tax incentive to R+D, among others (National Commission of Scientific and Technological Research, 2017).

The project portfolio selection criterion is a decision process where a list of new products and new R+D projects are updated and constantly reviewed; it is based on portfolio theory and indicates that there must be an adequate selection of the project to be developed, contemplating the characteristics of risk and global return. This factor is important because new projects must be evaluated, selected, and ordered by priority and can be accelerated, changed in priority and, in some cases, terminated (Cooper et al., 2001).

The portfolio selection criterion provides a starting point for considerations of the impact and potential value of the transfer stages (Dissel et al., 2005).

Work environment or satisfaction of the members in the jobs is a set of internal characteristics relatively durable of the organisation, result of the conduct and regulations of its members which, when perceived by them, makes the entity is different to others. This factor is supported by socio-technical theory, which states that there must be an adequate degree of compliance of the person with respect to their work environment. The basic purpose is to create an environment that is excellent for employees and, in addition, that contributes to the economic health of the organisation. This factor is important because, in the institutions where the process of TT is developed, the quality of life at work must be considered as a philosophy or a set of beliefs and values that integrate all the efforts aimed at increasing productivity and improving morals of the workers of the organisation.

Degree of product satisfaction is subsequent assessment to the adoption of technology. The degree of satisfaction includes not only the characteristics of the main products or services that are offered, but also the characteristics of the services that surround them. It should be considered that the characteristics of the transfer process determine the level of customer satisfaction. It is supported by expectation confirmation theory and Delone and McLean (2014) IS success model. The satisfaction of the needs and expectations of the client is the most important element of quality management and the basis of success in the TT of a company. Therefore, it is essential to assess the process and, if possible, add value to increase customer satisfaction.

Entropy is defined as the degree of disorder that a system has. The order is a necessary condition of all that the human mind wishes to understand. The theory of entropy deals not with the probability of success in a series of elements, but with the global distribution of the types of elements in a given order; it is based on the entropy theory and information theory. Therefore, to obtain a successful process, an order or sequence of steps must be maintained in each of the stages.

Stress is a set of physiological and psychological reactions that the organism undergoes when submitted to strong demands of work, the same that can influence the levels of productivity; it is not necessarily harmful since it often helps to achieve the desired objectives. When people experience job stress, they often feel tense and distressed and feel that they cannot cope with situations. This factor is supported by the task closure theory and it is important because the people involved in the process of TT may be affected by the transfer process if it does not handle this factor adequately.

Ethics refers to the set of customs, principles, and norms that direct valuate human behaviour in a community; is also reflected in the culture of the companies to achieve greater harmony with society and allow better adaptation to all environments under conditions that means respecting the rights recognised by society and the values that this shares, that is why this factor must exist in the actors of TT, may these be suppliers, receivers or technology intermediaries, so that the process that is generating remains under policies of confidentiality and quality.

3 Methodology

3.1 Data collection

The questionnaire was used as a study instrument, which was designed by the National Council of Science, Technology and Technological Innovation (CONCYTEC) of Peru to

correct possible biases or omissions, to ensure the comprehensibility of the items, improving the quality, scope and content. Subsequently, a pilot survey was conducted that allowed for adjustments to the final questionnaire; CONCYTEC provided a list of universities in Peru that have OTT. Finally, the survey was applied to the directors of the OTT in Ecuador, Colombia, Peru, and Chile during the period December 2016 to June 2017 with the following structure: the first section contains the general data of the universities; section two describes the aspects that relate to each factor analysed; section three relates the factors to the stages of the transfer process, and section four relates the factors to success. The questions in section three and four were evaluated with the Likert scale according to a rating of five values (1: no influence, 2: low influence, 3: medium influence, 4: high influence, 5: fully influences). Ninety-eight emails were sent inviting the participation of the Google forms online survey and a response was obtained from 85 institutions. The survey is available at the following address: https://goo.gl/forms/NQLW8RchufFy0swO2.

3.2 Analysis of results

The results are oriented to statistically analyse sections 1 and 3 of the survey. The descriptive and statistical analysis was carried out using the SPSS and AMOS tools. The analyses carried out were as follows:

1 *Analysis of reliability and internal consistency*, using Cronbach's alpha, to determine the internal consistency of the questionnaire and that the items are highly correlated.

2 *Descriptive statistics*, to know the demographic characteristics of the respondents.

3 *CFA*, to synthesise the interrelations observed among the variables.

4 *Structural equation model (SEM)*, to contrast the models that propose causal relationships between variables, effects of measurement error and structural coefficients.

It is identified if all the estimators of the model are significant and, if some were not, the relation between the latent variable should be suppressed.

4 Conceptual model

The conceptual model represents new factors and their relation with the stages of the TT process, which is composed of eight found factors, six stages and 48 relations; factors sustained in the analysis of the theories of human and organisational behaviour, as shown at the end of the section in Figure 1.

4.1 Stages of the TT process

The stages are the different steps required to initiate, develop and complete the TT process, which must be defined and distinguished. Six stages have been considered in the TT process (see Table 3), based on the work of Lopez-Mendoza and Mauricio (2018).

Table 3 Stages of technology transfer process

Id	*Stage*	*Description*	*References*
S1	Research or search of the need	The technological need is identified based on the receiver's requirements.	TEURPIN (2001), Massachusetts Institute of Technology (2005), Gorschek et al. (2006), Molero (2008) and de la Fe (2010)
S2	Evaluation	A candidate solution is formulated; the impact on the market is analysed and evaluated.	TEURPIN (2001), Massachusetts Institute of Technology (2005) and Gorschek et al. (2006)
S3	Identification of the provider and/or receiver	Identification of the supplier and receiver of the product or service to be developed.	Gorschek et al. (2006), Molero (2008) and de la Fe (2010)
S4	Strategy	The resources and mechanisms for product development are analyse and established. It establishes intellectual protection, formulates a research and development plan, and determines negotiation agreements and marketing strategies.	TEURPIN (2001), Massachusetts Institute of Technology (2005), Gorschek et al. (2006), Molero (2008) and de la Fe (2010)
S5	Development	Development of the solution by the supplier and validation.	TEURPIN (2001) and Gorschek et al. (2006)
S6	Transfer and application	Delivery and implementation of the product or service to the recipient, marketing and income generation.	TEURPIN (2001), Massachusetts Institute of Technology (2005), Gorschek et al. (2006), Molero (2008) and de la Fe (2010)

4.2 New technology transfer factors

These new success factors have been obtained from the review and analysis of theories on which human and organisational behaviour is based, which are described in Table 4.

4.3 Hypothesis

4.3.1 Influence of the factor adaptation to change (F1)

If there are modifications in the research plan, marketing strategies, environment, financial rules, technology recipients, government policies, solution development plan and evaluation plan, the process must adapt to these new requirements and conditions without altering the quality to have a successful process. Then, the adaptation to change factor will affect all stages of the TT process.

Table 4 New technology transfer factors

Id	*Factors*	*Description*	*Sustentation*
F1	Adaptation to change and/or environment	The university and the industry must advance and adapt to changes in the environment. Organisations must devote special attention to identifying, developing, protecting, and displacing those resources and capabilities that ensure a competitive advantage.	Organisational learning theory (Jung and Takeuchi, 2010), resource dependency theory (Hillman et al., 2009), and dynamic (Piening and Salge, 2015)
F2	Government policies	Governments undertake actions to resolve the needs of the population under a legal and regulatory framework, contemplating improving financial conditions, and modernising public policy, coordinating the efforts of all economic, public, and social actors of the State to promote technological innovation activities in the entity.	Stakeholder theory (Miles, 2017)
F3	Criteria for selecting the project portfolio	It is a decision process where a list of new products and new R+D projects is constantly updated and revised.	Portfolio theory (Markowitz, 1952)
F4	Work environment or satisfaction of the members at work	There must be an adequate degree of conformity of the person with respect to their work environment. The quality of life at work should be considered as a philosophy, a set of beliefs and values that integrate all efforts aimed at increasing productivity and improving the morale of the workers of the organisation to have a successful technology transfer process.	Socio technical theory (Carvalho et al., 2017), and organisational behaviour theory (Larsen and Olaisen, 2013)
F5	Degree of product satisfaction	Satisfying customer needs and expectations is the most important element of quality management and the basis of success in technology transfer. The good or service that is generated must be evaluated and a value added to increase customer satisfaction.	Expectation confirmation theory (Hossain and Quaddus, 2011), DeLone and McLean IS success model (DeLone and McLean, 2014)
F6	Entropy	The degree of disorder that a system has. In order to carry out the technology transfer process successfully, an order or sequence of steps must be maintained in each of the stages.	Entropy theory (Bailey, 1990), and information theory (Thomas and Cover, 2006)
F7	Stress	When people experience work stress, they often feel tense and distressed and feel that they cannot cope with situations and the process of technology transfer can be affected. A similar process can occur in institutions that may affect corporate performance.	Task closure theory (Straub and Karahanna, 1998)
F8	Ethics	It means temperament, character, habit, and the way of being. Ethics is a theory or a treatise on habits, set of customs, principles, and norms that direct or value human behaviour in a community, is for this reason that all agents involved in the transfer process should be handled with confidentiality policies and quality in order to guarantee a successful transfer process.	Kant (1980)

Hypothesis H1.1 The 'adaptation to change' factor influences the 'research or need search' stage of the TT process.

Hypothesis H1.2 The 'adaptation to change' factor influences the 'evaluation' stage in the TT process.

Hypothesis H1.3 The 'adaptation to change' factor influences the stage of 'identification of the provider and/or receive' in the process of transfer technology.

Hypothesis H1.4 The 'adaptation to change' factor influences the 'strategy' stage in the TT process.

Hypothesis H1.5 The 'adaptation to change' factor influences the 'development' stage in the TT process.

Hypothesis H1.6 The 'adaptation to change' factor influences the 'transfer and application' stage in the TT process.

4.3.2 Influence of the government policies factor (F2)

In most countries, it has been identified that the research results and technological development do not respond to national needs because there are insufficient incentives for science, technology, and innovation, there are insufficient qualified human resources, among others. That is why government policies must prioritise national needs accompanied by legal instruments for compliance with a series of technical standards, both for the import and export of products to increase their productivity and competitiveness, allowing value to be added from research. Intellectual protection and negotiation agreements are also subject to the legal framework of the countries, as well as communication and dissemination plans that in turn will affect the marketing plan depending on what is intended to be disseminated. Negotiation agreements between the provider and receiver of technology will depend on the policies of the country where the transfer process is carried out and implemented. Therefore, government policies influence each of the stages of the TT process.

Hypothesis H2.1 The 'government policies' factor influences the 'research or search for need' stage in the TT process.

Hypothesis H2.2 The 'governmental policies' factor influences the evaluation stage of the TT process'.

Hypothesis H2.3 The 'governmental policies' factor influences the stage of 'identification of the provider and or receiver' in the process of TT.

Hypothesis H2.4 The 'government policies' factor influences the 'strategy' stage in the TT process.

Hypothesis H2.5 The 'government policies' factor influences the 'development' stage in the TT process.

Hypothesis H2.6 The 'government policies' factor influences the 'transfer and application' stage in the TT process.

4.3.3 Influence of the factor selection criteria of the project portfolio (F3)

To carry out a transfer process, the project must be analysed and prioritised depending on several aspects; for example, knowing if these projects meet the needs of the population; if there is demand with respect to the offer; if it meets size criteria, location, budget, quality, guarantee, government policies, environmental aspects, current rules on the origin of the supplier, marketing strategies established, among others (for example, in Colombia, the SECOP, through Colombia Compra Eficiente, in article 21 related to the treatment and preference of national products, it is indicated that the state entities will guarantee the participation of the suppliers of products and services of national origin, under competitive conditions of quality, opportunity and price, and for the foreign suppliers that are in equal conditions, the one with the greater incorporation will be preferred of national human resources, greater national component, and better conditions for TT). In this sense, the selection criterion of the project portfolio can affect all stages of the TT process.

Hypothesis H3.1 The 'criteria of selection of the project portfolio' factor influences the stage of 'research or search of necessity' in the process of TT.

Hypothesis H3.2 The 'selection criteria of the project portfolio' factor influences the 'evaluation' stage in the TT process.

Hypothesis H3.3 The 'selection criteria of the project portfolio' factor influences the stage of 'identification of the provider and/or receiver' in the process of TT.

Hypothesis H3.4 The 'selection criteria of the project portfolio' factor influences the 'strategy' stage in the TT process.

Hypothesis H3.5 The 'selection criteria of the project portfolio' factor influences the 'development' stage in the TT process.

Hypothesis H3.6 The 'selection criteria of the project portfolio' factor influences the 'transfer and application' stage in the TT process.

4.3.4 Influence of the work environment factor (F4)

To establish the adequate conditions, whether physical, human, psychological, environmental, organisational, of the provider and recipient of the transfer process, to have transparent evaluation plans, communication policies, training plans and performance compensation policies, as well as the compliance with international standards to facilitate competitiveness, can influence the success of the TT process. That is why the work environment can influence all stages of the TT process.

Hypothesis H4.1 The 'work environment' factor influences the stage of 'research or search of necessity' in the process of TT.

Hypothesis H4.2 The 'work environment' factor influences the 'evaluation' stage in the TT process.

Hypothesis H4.3 The 'work environment' factor influences the stage of 'identification of the provider and/or receiver' in the process of TT.

Hypothesis H4.4 The 'work environment' factor influences the 'strategy' stage in the TT process.

Hypothesis H4.5 The 'work environment' factor influences the 'development' stage of the TT process.

Hypothesis H4.6 The 'work environment' factor influences the 'transfer and application' stage in the TT process.

4.3.5 Influence of the product satisfaction factor (F5)

The preliminary study must be carried out to establish if the TT process to be carried out meets or exceeds market expectations and, thus, establishes that there is product satisfaction. The definition of economic, commercial, organisational, and technological evaluation parameters, among others, improves the satisfaction of the product and both the supplier and the recipient of technology will benefit. Depending on the level of customer satisfaction, you can know the degree of loyalty to a brand or company. The satisfied customer will remain loyal, but you can change your provider if you find another with a better offer. That is why product satisfaction will influence the stages of the TT process.

Hypothesis H5.1 The 'product satisfaction' factor influences the stage of 'research or search of necessity' in the process of TT.

Hypothesis H5.2 The 'product satisfaction' factor influences the 'evaluation' stage in the TT process.

Hypothesis H5.3 The 'product satisfaction' factor influences the stage of 'identification of the supplier and/or receiver' in the TT process.

Hypothesis H5.4 The 'product satisfaction' factor influences the 'strategy' stage in the TT process.

Hypothesis H5.5 The 'product satisfaction' factor influences the 'development' stage in the TT process

Hypothesis H5.6 The 'product satisfaction' factor influences the 'transfer and application' stage in the TT process.

4.3.6 Influence of the entropy factor (F6)

The fact that there is no succession of clearly defined steps or elements leads to a lack of organisation and causes an alteration in the normal functioning of things; not counting and not executing a development plan, selection plan of the technology provider and receiver, plan of evaluation of the transfer process and implementation plan can be a factor that influences the success of the transfer process, because, if there no exists these steps, whatever the marketing strategy that has been established, the transfer will not come to fruition. Therefore, entropy will influence the stages of the TT process.

Hypothesis H6.1 The 'entropy' factor influences the 'research or needs search' stage in the TT process.

Hypothesis H6.2 The ‘entropy’ factor influences technology in the ‘evaluation’ stage in the transfer process.

Hypothesis H6.3 The ‘entropy’ factor influences the ‘identification of the provider and/or receiver’ stage in the TT process.

Hypothesis H6.4 The ‘entropy’ factor influences the ‘strategy’ stage in the TT process.

Hypothesis H6.5 The ‘entropy’ factor influences the ‘development’ stage in the TT process.

Hypothesis H6.6 The ‘entropy’ factor influences the ‘transfer and application’ stage in the TT process.

4.3.7 Influence of the stress factor (F7)

Stress is a set of physiological and psychological reactions that the organism undergoes when subjected to strong demands of work, that is why there must be adequate conditions, both human, organisational and structural, in all stages of the transfer process for that success is achieved. Therefore, stress will influence in all stages of the TT process.

Hypothesis H7.1 The ‘stress’ factor influences the ‘research or needs search’ stage in the TT process.

Hypothesis H7.2 The ‘stress’ factor influences the ‘evaluation’ stage in the TT process.

Hypothesis H7.3 The ‘stress’ factor influences the ‘identification of the provider and/or receiver’ stage in the TT process.

Hypothesis H7.4 The ‘stress’ factor influences the ‘strategy’ stage in the TT process.

Hypothesis H7.5 The ‘stress’ factor influences the ‘development’ stage in the TT process.

Hypothesis H7.6 The ‘stress’ factor influences the ‘transfer and application’ stage in the TT process.

4.3.8 Influence of the ethics factor (F8)

Ethics is a set of customs, principles, and norms that guide value human behaviour in a society. People are immersed in all stages of the transfer process and, therefore, the way to act or conduct in each of the stages can influence a successful process. Therefore, ethics influences all stages of the TT process.

Hypothesis H8.1 The ‘ethics’ factor influences the ‘research or need search’ stage in the TT process.

Hypothesis H8.2 The ‘ethics’ factor influences the ‘evaluation’ stage in the TT process.

Hypothesis H8.3 The ‘ethics’ factor influences the ‘identification of the provider and/or receiver’ stage in the TT process.

Hypothesis H8.4 The ‘ethics’ factor influences the ‘strategy’ stage in the TT process.

Hypothesis H8.5 The 'ethics' factor influences the 'development' stage in the TT process.

Hypothesis H8.6 The 'ethics' factor influences the 'transfer and application' stage in the TT process.

Table 5 Hypothesis matrix: factors vs. stages

Factors / *Stages*	*Research or search of the need*	*Evaluation*	*Identification of the provider and/or receiver*	*Strategy*	*Development*	*Transfer and application*
Adaptation to change	H1.1	H1.2	H1.3	H1.4	H1.5	H1.6
Government policies	H2.1	H2.2	H2.3	H2.4	H2.5	H2.6
Criteria for selecting the project portfolio	H3.1	H3.2	H3.3	H3.4	H3.5	H3.6
Work environment	H4.1	H4.2	H4.3	H4.4	H4.5	H4.6
Degree of product satisfaction	H5.1	H5.2	H5.3	H5.4	H5.5	H5.6
Entropy	H6.1	H6.2	H6.3	H6.4	H6.5	H6.6
Stress	H7.1	H7.2	H7.3	H7.4	H7.5	H7.6
Ethics	H8.1	H8.2	H8.3	H8.4	H8.5	H8.6

Figure 1 Conceptual model

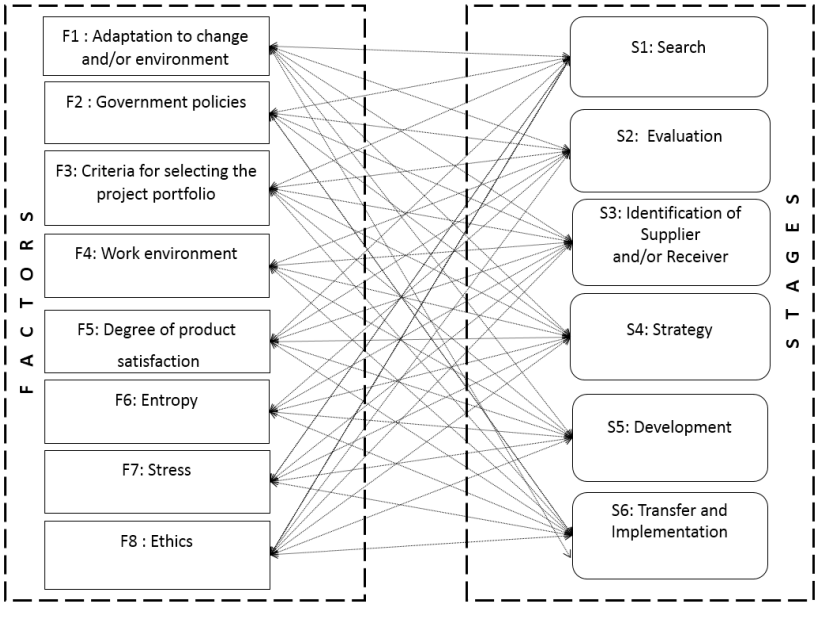


Table 5 shows a summary of the proposed hypotheses denoted by *Hx*, *y*; which means that the *Fx* factor influences the *Sy* stage in the TT process.

In summary, in Figure 1, we present the conceptual model that is made up of eight factors and six stages of the TT process and 48 relations.

5 Results

5.1 Reliability analysis

For reliability, Cronbach's alpha was used. The value obtained was 0.979 with 48 elements analysed and according to the criteria of George and Mallery (2003), it is evaluated as excellent, the closer the value of the alpha is to 1, the greater the internal consistency of the elements analysed, and the validity of the instrument is acceptable, as shown in Table 6.

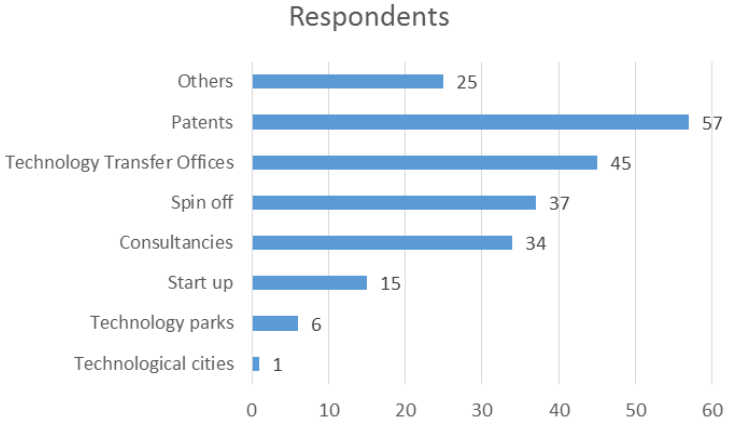
Table 6 Reliability statistics

Cronbach's alpha	*Number of elements*
0.979	48

5.2 Descriptive statistics

Of the 85 responses obtained, 55.30% belong to private universities and 44.70% to public universities. The average time of existence of the OTT is 6.08 years and with a confidence interval of 95%; the average time of existence of the OTT is between 5.19 and 6.98 years. Most OTTs have less than ten people as members (84.71%); 11.76% of universities have between 11 and 30 members and 3.53% have more than 31 members. Figure 2, shows that most universities use patents as a TT mechanism (67.05%), followed by OTT with 52.94%, spin-off (43.53%), consultancies (40%) and only 1.17% have technological cities and 7.06% technological parks. Figure 2 presents its classification.

Figure 2 Respondents classifications technology transfer mechanism (see online version for colours)



5.3 Confirmatory factor analysis

To perform the validation of the construct, the CFA is applied. It was not possible to perform ANF because the determinant of the correlation matrix is equal to 0, likewise, the Kaiser-Meyer-Olkin index (KMO) neither the structure matrix tables, nor the pattern matrix, are not shown, so what the analysis will be oriented to evaluate the theoretical model through models of structural equations.

5.4 Structural equation model

A theoretical model was carried out, solved by the method of unweighted squares minimes (MCnP) and minimum squares free of scale (MCLE), as shown in Table 7. It was not possible to estimate other types of models, such as maximum likelihood, the asymptotic free distribution, or the minimum square free scale, because the sample size is not enough (85 in this investigation), and in the other two the sample covariance matrix contains other coefficients product to the correlations of moments, as they are the tetrachoric correlations (Freiberg Hoffmann et al., 2013). The results were the following:

Table 7 Evaluation of the theoretical SEM model

Method	*CMIN*	*RMR*	*AGFI*	*NFI*	*PNFI*	*GFI*	*PGFI*
MCnP	903.95	0.096	0.960	0.961	0.907	0.963	0.873
MCLE	1655.22	0.096	0.936	0.938	0.885	0.942	0.853

In AMOS, the *chi-square* value is called *CMIN*, for the structural model, it is also called the discrepancy function, the likelihood ratio or the chi-square goodness of fit, the smaller this value, the better the adjustment is.

In *root mean square residual RMR*, the evaluation of its magnitude is subjective considering that a lower value than 0.05 is an indication of good fit, although authors suggest that it would be sufficient to be below 0.084.

The *goodness of fit index (AGFI)*, adjusted with values close to 1.00, indicate a good fit.

Normalised adjustment index (NFI), measures the proportional reduction in the adjustment function when we move to the null model to the proposed one.) The values of this index vary between 0 and 1, values greater than 0.9 is considered acceptable.

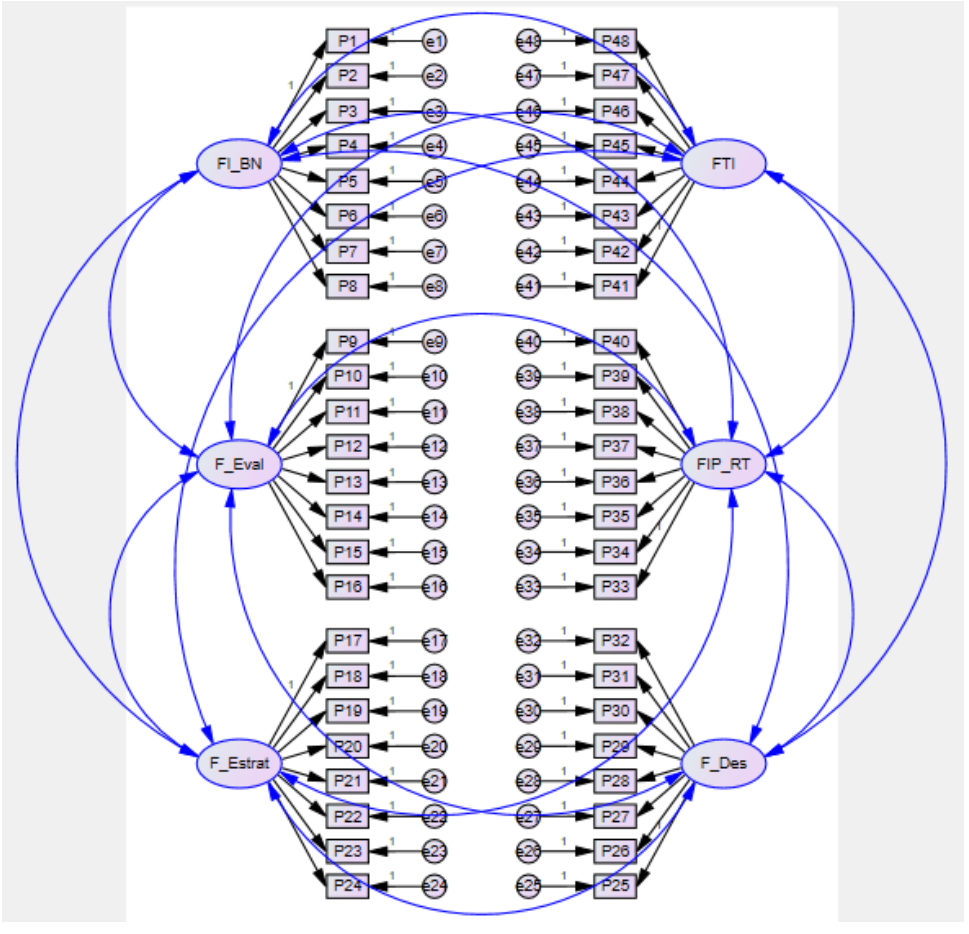
The *normalised parsimonic adjustment index (PNFI)* is a modification of the built-in standardised adjustment index and the degrees of freedom of the two alternative models that are intended to be compared. The high values of the PNFI are better. Minimum differences of 0.06 to 0.09 would be necessary to indicate substantial changes in the models.

Comparative adjustment index (CFI), measures the improvement in measuring the non-centrality of a model. The measurement ranges to 0 for a poorly adjusted model and 1 for a well-adjusted model.

Regarding the *index of goodness of fit (GFI)*, its value is between 0 and 1, indicating the latter a perfect fit.

Bonus index of parsimony adjustment (PGFI) presents a modification of the index of goodness of adjustment (GFI). The values are established from 0 to 1, the values closest to 1 being those that indicate the greatest balance (parsimony) in the model.

Figure 3 Theoretical structural equation model (see online version for colours)



When analysing the statistics of absolute adjustment measures, incremental adjustment measures and parsimony adjustment measures, the advantage of the MCnP solution method before the MCLE is clearly visible, so the analysis will be done on the theoretical model with the method of Estimation by MCnP. The theoretical SEM would be as shown in Figure 3.

Some of the structural equations for the measurement model are shown below:

$$P_1 = FI\_BN + 0.302$$

$$P_9 = F\_Eval + 0.317$$

$$P_{33} = FIP\_RT + 0.638$$

$$P_{41} = FTI + 0.488$$

Table 8 Correlations factors vs. stages

Correlations											
			F_Des	*Adaptation to change (F_Des)*	*Government policies (F_Des)*	*Criteria for selecting the project portfolio (F_Des)*	*Work environment (F_Des)*	*Degree of product satisfaction (F_Des)*	*Entropy (F_Des)*	*Stress (F_Des)*	*Ethics (F_Des)*
Rho Spearman	F_Des	Correlation coefficient	1.000	.396**	.277*	.635**	.877**	.705**	.908**	.870**	.851**
		Sig. (bilateral)	.	.000	.010	.000	.000	.000	.000	.000	.000
		N	85	85	85	85	85	85	85	85	85
	Adaptation to change (F_Des)	Correlation coefficient	.396**	1.000	.047	.125	.419**	.189	.348**	.269*	.386**
		Sig. (bilateral)	.000	.	.672	.255	.000	.083	.001	.013	.000
		N	85	85	85	85	85	85	85	85	85
	Government policies (F_Des)	Correlation coefficient	.277*	.047	1.000	.289**	.199	.190	.202	.188	.112
		Sig. (bilateral)	.010	.672	.	.007	.068	.081	.064	.085	.307
		N	85	85	85	85	85	85	85	85	85
	Criteria for selecting the project portfolio (F_Des)	Correlation coefficient	.635**	.125	.289**	1.000	.364**	.529**	.433**	.570**	.537**
		Sig. (bilateral)	.000	.255	.007	.	.001	.000	.000	.000	.000
		N	85	85	85	85	85	85	85	85	85
		Correlation coefficient	.877**	.419**	.199	.364**	1.000	.421**	.843**	.809**	.754**
		Sig. (bilateral)	.000	.000	.068	.001	.	.000	.000	.000	.000
		N	85	85	85	85	85	85	85	85	85
		Correlation coefficient	.705**	.189	.190	.529**	.421**	1.000	.547**	.549**	.475**
		Sig. (bilateral)	.000	.083	.081	.000	.000	.	.000	.000	.000
		N	85	85	85	85	85	85	85	85	85
		Correlation coefficient	.908**	.348**	.202	.433**	.843**	.547**	1.000	.737**	.810**
		Sig. (bilateral)	.000	.001	.064	.000	.000	.000	.	.000	.000
		N	85	85	85	85	85	85	85	85	85
		Correlation coefficient	.870**	.269*	.188	.570**	.809**	.549**	.737**	1.000	.590**
		Sig. (bilateral)	.000	.013	.085	.000	.000	.000	.000	.	.000
		N	85	85	85	85	85	85	85	85	85
		Correlation coefficient	.851**	.386**	.112	.537**	.754**	.475**	.810**	.590**	1.000
		Sig. (bilateral)	.000	.000	.307	.000	.000	.000	.000	.000	.
		N	85	85	85	85	85	85	85	85	85

Notes: **The correlation is significant at the 0.01 level (bilateral).
*The correlation is significant at the 0.05 level (bilateral).

Table 9 Regression weights: (group number 1 – default model)

			Estimate				*Estimate*				*Estimate*
P1	<---	FI_BN	1.000	P17	<---	F_Strat	1.000	P33	<---	FIP_RT	1.000
P2	<---	FI_BN	.383	P18	<---	F_Strat	1.181	P34	<---	FIP_RT	.905
P3	<---	FI_BN	.796	P19	<---	F_Strat	1.404	P35	<---	FIP_RT	1.348
P4	<---	FI_BN	1.195	P20	<---	F_Strat	1.887	P36	<---	FIP_RT	1.992
P5	<---	FI_BN	1.108	P21	<---	F_Strat	2.535	P37	<---	FIP_RT	.188
P6	<---	FI_BN	1.383	P22	<---	F_Strat	2.839	P38	<---	FIP_RT	1.481
P7	<---	FI_BN	1.255	P23	<---	F_Strat	3.276	P39	<---	FIP_RT	1.545
P8	<---	FI_BN	1.145	P24	<---	F_Strat	2.243	P40	<---	FIP_RT	1.519
P9	<---	F_Eval	1.000	P41	<---	FTI	1.000	P25	<---	F_Dev	1.000
P10	<---	F_Eval	1.039	P42	<---	FTI	1.793	P26	<---	F_Dev	.648
P11	<---	F_Eval	1.215	P43	<---	FTI	1.136	P27	<---	F_Dev	1.847
P12	<---	F_Eval	2.256	P44	<---	FTI	2.962	P28	<---	F_Dev	4.285
P13	<---	F_Eval	1.135	P45	<---	FTI	.822	P29	<---	F_Dev	2.344
P14	<---	F_Eval	2.117	P46	<---	FTI	2.054	P30	<---	F_Dev	4.526
P15	<---	F_Eval	2.307	P47	<---	FTI	2.690	P31	<---	F_Dev	4.368
P16	<---	F_Eval	1.858	P48	<---	FTI	2.378	P32	<---	F_Dev	3.868

Table 10 Variances: (group number 1 – default model)

	Estimate		*Estimate*		*Estimate*
FI_BN	.500	e13	.441	e47	.266
F_Eval	.219	e14	.257	e48	.325
F_Strat	.119	e15	.173	e33	.638
FTI	.082	e16	.483	e34	.592
FIP_RT	.283	e17	.315	e35	.548
F_Dev	.034	e18	.653	e36	.210
e1	.302	e19	.307	e37	.405
e2	.519	e20	.435	e38	.136
e3	.738	e21	.315	e39	.238
e4	.175	e22	.189	e40	.236
e5	.202	e23	.310	e25	.412
e6	.123	e24	.346	e26	.280
e7	.230	e41	.488	e27	.286
e8	.385	e42	.793	e28	.123
e9	.317	e43	.752	e29	.452
e10	.541	e44	.214	e30	.188
e11	.386	e45	.287	e31	.330
e12	.271	e46	.339	e32	.150

Interpreting it can be said: each equation P_1 (adaptation to the change or environment with the research stage), in relation to the factor and stage, would be an expression of the values of the dependent variable (*FI_BN* stage research) plus the value of the variable not observed (*e*).

To form the measurement model as the structural model, we obtained regression, variance and covariance data as shown below:

In Table 11, it can be seen the clear relation between the research stage or search of the need (FI_BN) and the identification stage of the provider and/or receiver (FIP_RT), being the best of all the covariances. In Table 12, it can be analysed that it is not necessary to eliminate any variable from the path since all standardised estimates are positive and less than unity.

Table 11 Covariances: (group number 1 – default model)

			Estimate	*S.E.*	*C.R.*	*P*	*Label*
FI_BN	<-->	F_Eval	.313				
FI_BN	<-->	F_Strat	.234				
FI_BN	<-->	FTI	.186				
FI_BN	<-->	*FIP_RT*	.369				
FI_BN	<-->	F_Dev	.120				
F_Eval	<-->	F_Strat	.167				
F_Eval	<-->	FTI	.133				
F_Eval	<-->	FIP_RT	.247				
F_Eval	<-->	F_Dev	.084				
F_Strat	<-->	FTI	.099				
F_Strat	<-->	FIP_RT	.178				
F_Strat	<-->	F_Dev	.062				
FTI	<-->	FIP_RT	.152				
FTI	<-->	F_Dev	.053				
FIP_RT	<-->	F_Dev	.096				

It was possible to verify that starting from the theoretical model, according to the sample size, in the number of variables and the universities that are the objects of this study, with respect to the generic or theoretical model, there are no changes. It would be pertinent to analyse the variables or questions P25, P26 and P37 since they present very low weights in their dimensions. These variables correspond to the following questions:

P25 *adaptation to the change or environment (F_Dev)*

P26 *government policies (F_Dev)*

P37 *satisfaction of the product or service (FIP_RT)*

- *Correlations*: Spearman rank correlation was performed between the different stages in which the contrast best used for ordinal scale variables are significant; most of them, including 1%, except for the variables 'government policies' and 'satisfaction of the product or service', are significant at 5%, and these two variables, together

with ‘adaptation to change or environment’, are those the less they explain in their dimensions, this evidences what was demonstrated previously by the SEM, in Table 8 show correlation.

Table 12 Standardised regression weights: (group number 1 – default model)

			Estimate				*Estimate*				*Estimate*
P1	<---	FI_BN	.789	P17	<---	F_Strat	.524	P33	<--	FIP_RT	.555
P2	<---	FI_BN	.352	P18	<---	F_Strat	.450	P34	<--	FIP_RT	.531
P3	<---	FI_BN	.548	P19	<---	F_Strat	.658	P35	<--	FIP_RT	.696
P4	<---	FI_BN	.896	P20	<---	F_Strat	.703	P36	<--	FIP_RT	.918
P5	<---	FI_BN	.868	P21	<---	F_Strat	.841	P37	<--	FIP_RT	.155
P6	<---	FI_BN	.942	P22	<---	F_Strat	.914	P38	<--	FIP_RT	.906
P7	<---	FI_BN	.880	P23	<---	F_Strat	.897	P39	<--	FIP_RT	.860
P8	<---	FI_BN	.794	P24	<---	F_Strat	.796	P40	<--	FIP_RT	.857
P9	<---	F_Eval	.639	P41	<---	FTI	.378	P25	<--	F_Dev	.276
P10	<---	F_Eval	.551	P42	<---	FTI	.498	P26	<--	F_Dev	.221
P11	<---	F_Eval	.675	P43	<---	FTI	.350	P27	<--	F_Dev	.537
P12	<---	F_Eval	.897	P44	<---	FTI	.877	P28	<--	F_Dev	.914
P13	<---	F_Eval	.625	P45	<---	FTI	.401	P29	<--	F_Dev	.541
P14	<---	F_Eval	.890	P46	<---	FTI	.710	P30	<--	F_Dev	.887
P15	<---	F_Eval	.933	P47	<---	FTI	.830	P31	<--	F_Dev	.814
P16	<---	F_Eval	.781	P48	<---	FTI	.766	P32	<--	F_Dev	.879

5.5 Hypothesis testing

It was not necessary to eliminate any variable of the path because all the standardised estimates are positive and they are less than the unit, synthesised in Table 13, in red the ones that have less relation are indicated; nevertheless, they are valid. According to the quantitative results obtained in the study, it can be said that:

- All the observed variables or questions that make up the dimension ‘research stage or search for need’ (FI_BN) have a direct relationship with that dimension, the factor "Government Policies" being the one that least explains this dimension.
- All the observed variables or questions that make up the ‘evaluation stage’ dimension (F_Eval) have a direct relationship with that dimension.
- All the observed variables or questions that make up the ‘strategy stage’ dimension (F_Strat) have a direct relationship with that dimension, being the ‘government policies’ factor the one that least explains this dimension.
- All the observed variables or questions that make up the ‘development stage’ dimension (F_Dev) have a direct relationship with that dimension, being the factors ‘adaptation to change or environment’ and ‘government policies’ the least explain this dimension.

- All the observed variables or questions that make up the dimension 'identification stage of the provider and/or technology recipient' (FIP_RT) have a direct relationship with that dimension, being, in turn, the factor 'satisfaction of the product or service' the least explain this dimension.
- All the observed variables or questions that make up the 'stage of transfer and implementation' (FTI) have a direct relationship with that dimension.

Table 13 Hypothesis testing factors vs. stages

Factors / *Stages*	*Research or search of the need*	*Evaluation*	*Identification of the provider and/or receiver*	*Strategy*	*Development*	*Transfer and application*
Adaptation to change	.78	.639	.555	.524	*.276*	.378
Government policies	*.352*	.551	.531	*.450*	*.221*	.498
Criteria for selecting the project portfolio	.548	.675	.696	.658	.537	.350
Work environment	.896	.897	.918	.703	.914	.877
Degree of product satisfaction	.868	.625	*.155*	.914	.541	.401
Entropy	.942	.890	.906	.914	.887	.710
Stress	.880	.933	.860	.897	.814	.830
Ethics	.794	.781	.857	.796	.879	.766

6 Discussion and future studies

6.1 Stages of the TT process

It has been identified that the stages of the TT process are not standardised in the literature, so several authors contemplate certain activities that in some of the cases are described with different names or are divided or grouped in different steps. For the present investigation, the following stages have been considered: investigation or search of the need, evaluation, identification of the provider and/or receiver, strategy, development, transfer, and application.

6.2 Factors of the TT process

Eight factors have been identified that relate to the six stages of the TT process, but, although all relationships are valid, certain factors have greater influence in the different stages.

Adaptation to change influences on a greater degree with the investigation stage or search of the need, given that in the case of any modification due to environmental

changes, the supplier, to be successful, must adapt to these new requirements without altering the quality of the process.

Government policies have more to do with the evaluation stage; when evaluating the process, it is necessary to consider the legal instruments generated by government policies that define the development of technological solutions as well as the available economic resources and the market to which the product is directed.

Selection of the project portfolio has greater influence with the identification stage of the provider and/or receiver; it is important to identify who performs and to whom the transfer process is intended, these can be analysed based on technical, economic, experience, image, compliance, guarantees, trust relation, and current regulations. Both the supplier and the receiver are responsible for the quality of the process.

Work environment influences on a greater degree with the identification stage of the supplier and the development stage; the adequate conditions must be in place so that suppliers and recipients of technology can be managers or beneficiaries of a solution trying to maintain values of physical and psychological integrity. At the development stage, internal rules, communication policies, training plans, performance compensation policies and the marketing plan must be established to achieve a successful transfer.

Degree of product satisfaction has greater influence with the research stage or search of the need; a preliminary study must be done to see if the process to be carried out meets or exceeds market expectations, if it is affirmative, it can be said that there is product satisfaction, in this way, it must be considered that the characteristics of a product or service determine the level of customer satisfaction.

Entropy has greater influence with the research stage or search of the need, if the steps for the analysis of the requirements of the product or service are not defined, it could affect the transfer process.

Stress has more influence on the evaluation stage; the evaluations carried out in this stage will determine if the process that has been developed meets the expectations of quality and purpose for which they were created.

Ethics has a greater influence on the development stage; the process must be correctly developed as long as the principles and rules are respected by the people who carry it out.

Based on the descriptive analysis, it is required that companies, universities, and government adopt and potentialise certain TT mechanisms such as start-up, parks and technology cities, which are inclusion mechanisms to incorporate knowledge and create products with high scientific content, and technological.

6.3 Future studies

The activities must be specified in each of the stages of the transfer process, considering the factors analysed. It is suggested to analyse if the factors of technological transfer existing in the literature are verified in the Andean countries.

7 Conclusions

Eight new factors of the TT process are identified: adaptation to change, government policies, project portfolio selection criteria, work environment, product satisfaction, entropy, stress, and ethics, which are related to the research stages, strategy,

development, evaluation, identification of the provider and/or receiver of technology, and transfer and application.

Forty-eight relations were established between stages and factors, which have a direct relation; however, a weak relation was obtained in the following relation: 'research stage or search for need' → factor 'government policies'; 'strategy' → factor 'government policies'; 'development stage' → factor 'adaptation to change or environment'; 'development stage' → factor 'government policies'; 'identification stage of the provider and/or technology recipient'→ factor 'satisfaction of the product or service'.

The Andean countries have similar policies for science and technology, because they create and regulate norms that support the intellect of their participants who promote the generation of knowledge and TT, so, universities must transfer technology so that the State benefits.

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