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DEVELOPING THE TRIPLE HELIX MEASURE AND EXAMINING ROLE IN KNOWLEDGE TRANSFER AND INNOVATION SYSTEMS

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Abstract

Advancing times and rapidly developing technology put pressure and responsibility on the management of organizations. Organizational ambidexterity is a concept for an organization that can balance profitability with innovation and development. This study examined the relationship between the triple helix and innovation systems mediated by knowledge transfer to give management an advantage in addressing this problem. Quantitative analysis methods using PLS-SEM (Partial Least Square-Structural Equation Modeling) were employed in this study. This study was conducted in Indonesia with 400 respondents participating in the data collection, 360 of which were declared valid after filtering. The results of this study demonstrate that the role of the triple helix in developing innovation systems is significant. The framework for innovation systems presented in this study may be helpful for future research in this field. This study can be further developed for future research, especially by adding new external variables that change over time and focusing more on a specific organization. At the very least, this study is relevant for researchers and practitioners to improve business quality using the concept of the triple helix, innovation systems mediated by knowledge transfer.

***Keywords*:**
Triple Helix, Knowledge Transfer, Innovation Systems, Organizational Ambidexterity

1. Introduction

The space of science and technology development, universities, and industry today must bind one another. Universities and industry function to carry out their duties as actors that drive change in an applicable way, it requires a synergy from both. Building a relationship between the two is currently a subject in developing science and technology at various levels. The university-industry-government relationship can be considered a triple helix. This triple helix is more complex than the reciprocal interaction between the double helix which was the previous model.

The evolution that occurs between technological developments and cognitive values in the environment in an institution can change the infrastructure of one knowledge. In a triple helix configuration, a network of research, technology, and knowledge development increasingly transforms the environment into a more relevant one. However, the latest research results support the role of education openly in higher education to carry out its function as knowledge transfer. Therefore, new policies are needed to formulate them according to the needs of today's science, so certain variables such as universities, industry, and government play an important role in determining this. Indeed, the evolution of knowledge transfer depends to a large extent on the contribution of these variables.

The focus of many researchers is to determine or find the right definition of knowledge on the triple helix variable and the final-oriented knowledge transfer determinants for the creation of an innovation system. However, it is indeed possible to describe knowledge, and to measure these variables in substance is not easy. Information that is not structured can be called information that arises from someone's perception.

In the epistemological aspect, there are two categories of knowledge: explicit knowledge and tacit knowledge. In the ontological aspect, there are three categories of knowledge: individual, team, and organization. Explicit knowledge is a part of individual knowledge that can be expressed using language and symbols. This knowledge is likened to the visible part of the iceberg [1]. Meanwhile, tacit knowledge represents the invisible part of the iceberg, which is knowledge obtained through direct individual experience that cannot be expressed through language [2]. Tacit knowledge is very personal and very difficult to express or communicate to others, part of this knowledge, for example, is a person's point of view, insight, hunch, or intuition. In addition, tacit knowledge is deeply rooted in individual actions and experiences, as well as in ideas, values, or emotions [3].

Socialization is a tacit process of knowledge transfer, which is the main process carried out by Japanese companies [4-5]. In this process, knowledge transfer becomes very important. However, the transfer of knowledge must be based on cultural behavior and local beliefs, this is based on a feeling of comfort for each employee to be able to share experiences with other employees. Outreach is also a transfer of best practices within the company. The tacit transfer of knowledge in the organization is used to solve internal problems.

Externalization is the process of converting tacit knowledge into explicit knowledge at the individual level [6]. Socialization is the process of creating knowledge through sharing of experiences, externalization is a way of tacit knowledge to be articulated into explicit messages and transferred to other employees through language or images. Externalization is based on different methods such as inductive and deductive logical analysis, or metaphor and analogy [7]. Metaphors are powerful tools for building semantic extensions and defining new semantic domains. For example, we can refer to the way different authors use metaphors to define the semantic domain of the concept of "knowledge", from being perceived as an object, to being considered a field of meaning and emotion.

2. Literature Review

Triple Helix explains the differences between innovation systems at different levels in the possible settings. The Triple Helix model can be translated as [8-9]: 1). Study a network of university-industry-government relations and offer a neo-evolutionary model of a knowledge-based economy; 2). Proposes three evolutionary functions that shape the environment of knowledge-based economic elections: (i) organized knowledge production, (ii) economic wealth creation, and (iii) reflexive control; 3). Suggests that reflexivity is always involved as one of them; the functions they serve are not given but are constructed socially as a coordination mechanism between humans of communication systems that develop in certain cultural settings.

In the Triple Helix coordination model, the selection dynamics are endogenous because actors in the three institutional environments relate reflexively. Integration and differentiation among subsystems are concurrent: functionally differentiated systems are capable of processing more complexity while integrating relationships and exchanges between subsystems makes it possible to change perspectives and develop new structures at the interface [10]. On the one hand, we can expect a configuration that will shape the generation of intellectuals in the academic environment, with the creation of intellectual property linked to industry, while control in the public sphere can be attributed to the government [11]. On the other hand, the triple helix variable relationship is expected to reflect the degree of integration. The degree of integration and synergy generated is an empirical question open to measurement [12].

2.1 University

Universities, like companies, vary widely in the extent to which they are involved and experiment with new mechanisms to promote the commercialization of academic research [13], and the extent to which they are successful in generating additional income from intermediary activities. Many questions have been raised about the reasons underlying this cross-institutional diversity and, from a science and technology policy perspective, it is imperative to get better information about their roles [14]. Some of the differences can be explained specifically by some countries that have already implemented the values and strategic roles of universities, such as the UK developing a policy of making intensive efforts to create incentives for universities to engage in systematic interactions with industry and society, meanwhile in Italy this policy has been introduced at the national level. However, on implementation, there is also a high degree of heterogeneity in the approaches taken by universities to interact with industry and society [15]. The characteristics of corporate, university and individual researchers are important in explaining the diversity of models [16]. In some cases, strategic decisions have been made at the university level to invest in knowledge transfer formation [17]. For example, universities that claim they are part of a university characterized by entrepreneurship; and finally, the characteristics of the demand side of the company and the open tendency to capture the flow of knowledge coming from the university are very important.

From a university perspective, the transfer of knowledge between universities and industry occurs through various mechanisms [18, 19]. This ranges from hiring university graduates to personnel exchanges, joint research, contract research, consulting, patents and publications, licensing, and industry-funded laboratories and other physical facilities, and also includes informal contacts such as meetings and conferences. According to D'Este and Patel, based on a sample of British scientists, it shows that the characteristics of individual researchers have a stronger impact than the characteristics of departments or universities. With regard to the diversity and frequency of interactions with industry. Researchers' previous experience in collaborative research, and higher academic status, had a significant and positive influence on the variety of interactions with industry. The quality of research in a department, on the other hand, has no impact on engagement on an interaction basis. [20] Provided evidence that academic reputation impacts the likelihood of innovation formation, but found no evidence that a researcher's academic reputation influences innovation potential regarding the value of a technology.

2.2 Industry

From a business perspective, Cohen et al. [21] and Arundel and Geuna [22] show that the industry relies on multiple sources of information from public research outputs and that there is no single source that is considered most important by the industry. The size of the firm and the industrial sector is the main factor explaining the type and level of interaction [23-25], large companies generally have spare resources to invest or deploy in various types of interactions with university researchers, while investment in resources and capacity of small to medium enterprises is involved. Directing with academics may have limitations. However, the development of the biotechnology industry has another view based on the university-industry relationship. In addition, the degree of complementarity between academic research and industrial applications is a key factor in driving interaction with industry. This most likely depends on the composition of the local industry structure and the presence of a large number of firms in the area. Calderini et al [26], underlined that policies related to university funding, which include the possibility of universities to increase industrial funding, must take into account the fact that the final outcome will depend on the characteristics of local scientific institutions and local industries. Chapple et al. [27] found that universities located in regions with higher levels of R&D and Gross Domestic Product (GDP) appear to be efficient in terms of knowledge transfer, implying a dominant influence on a region.

2.3 Knowledge Transfer

On a large or small scale on a job, one of the important tasks is to communicate with our team, colleagues, and customers. However, if we have several departments or units, it is very important to make sure that the information can flow properly to the right people [28]. It can be said as crossing lines, if the opposite happens it can lead to fatal miscommunication, and even cause prospects to fail [29]. This problem can be very detrimental to work [30]. Having easy communication and collaboration systems is key to avoiding this problem. Knowledge transfer systems help us simplify our knowledge, and ensure that everyone on our team has the information they need to keep our work running smoothly [31]. "Knowledge Transfer" is a practical method of transferring knowledge from one part of our work to another.

Knowledge Transfer can be valuable theory and practice, and it can be applied to our company culture and our business systems. Knowledge transfer is more than just communication [32]. Knowledge Transfer involves the circulation of information, ideas, tasks, processes, tools, documents, and more. Knowledge transfer is not the same as "training". It is not just the circulation of information (facts and data).

Although it includes these things, knowledge transfer has more to do with identifying and utilizing the skills and adaptability of our team members to apply information [33]. Transferring personal knowledge and experiences from one person to another is also difficult. So, knowledge transfer does its best to combine practice with personal in order to change team behavior and develop their skills. In terms of innovation and problem-solving, it may be difficult to turn abstract concepts into actual plans [34]. Beyond that, we need to find ways to apply that idea to the task at hand. Sharing knowledge is tricky because it involves measuring and qualifying the knowledge that is in mind. Knowledge transfer systems help us translate that knowledge into words, visuals, and processes which can then be shared with our team.

Knowledge transfer is important to our work because it enhances innovation, collaboration and understanding in our business [35]. Rather than relying on facts and data to share information across departments, we are better able to paint a holistic picture of complex concepts. Since we are talking about knowledge, this somewhat intangible thing is a very imperfect process. We surely can make an activity and guess our understanding of each other but it is unlikely that all the guesses are correct. In general, knowledge transfer can help our work in the following ways:

a. Accelerate the accumulation and dissemination of knowledge throughout our organization
b. Provide easy and fast access to knowledge to our team Eliminate time and space constraints in communication
c. Encourage colleagues to experience the value of sharing knowledge in providing services tailored to customer needs
d. Respect the dignity of each individual by fostering an environment that enhances his professional development and recognizing everyone as a valued member of a service-oriented team

Implementing knowledge transfer to our business circles also provides many other benefits [36], including a better corporate culture, better service quality, faster business processes, increased efficiency, and better use of technology and business resources [36-37]. Based on research, one source found that businesses that implemented a knowledge transfer system experienced a 50% increase in sales while their training costs decreased. If we are looking for ways to increase company efficiency, inspire innovation, and reduce harmful miscommunication, then it is worth building a knowledge transfer plan.

2.4 Innovation System

Innovation is a complex process, the main component of which is the sharing of modified and especially unmodified informal knowledge [38]. Knowledge innovation is difficult to construct but at the same time relatively easy to replicate [39], especially where the initial process is prominent, and the level of technology is relatively unsophisticated [40]. However, there are obstacles to learning and imitation through observation, because many aspects of service quality innovation depend on tacit knowledge [41]. This study adopts Hjalager's view that innovation in knowledge includes small- and large-scale adaptations of services and services, but rarely involves completely new services or new environments, but rather differentiation, improvement of services through consumer policies, or increased levels of interaction between consumers [41]. There are a number of innovation typologies, but for usability reasons, we focus on service and process innovation. Service innovation consists of improving the quality of service, while process innovation improves how services are performed. The latter is considered the most influential in the education sector.

In line with [38], this study describes that activities that adopt a developed process or service are called innovators. The industrial sector is more synonymous with barriers and constraints in the acceleration for innovative processes. These include low levels of links between industry and research and development, lack of resources, reluctance to take risks, lack of trust and cooperation between employers, rapid changes in ownership, poor research environment, low levels of education and training among staff, and turnover. Labor, low pay and unconventional working hours, and others [42]. The ability to assimilate knowledge is defined as absorption capacity [43]. Other determinants of absorption include organizational structure, management practices, and human capital, for example; level of relevance to operations and their peer network) [44].

3. Research Method

3.1 Developing Th, Kt, Is Instrument

In building the Triple helix (TH), Knowledge Transfer, and Innovation Systems variables, 3 systematic processes are used, which involve a number of methods to develop, refine, and validate triple helix measurements, and knowledge transfer in innovation systems. As shown in Figure 1, the three steps are (1) conceptual development and initial source collection, (2) conceptual refinement, feature modification, and pilot study, and (3) main study and validity testing. Tables 1 and 2. Show the main roles, definitions, and results of research participants in developing the effectiveness of Triple helix (TH), Knowledge Transfer, and Innovation Systems across the three stages.

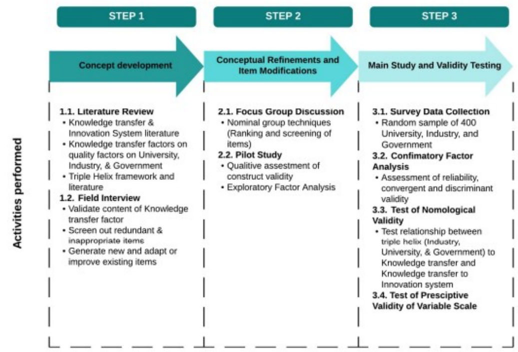


Figure 1. Overview of the scale refinement process

3.2 Concept Development

The first stage (literature collection) of this process is to factor in triple helix variable development, knowledge transfer, and innovation systems along with measurement items for each factor. First, we conduct a comprehensive review of previous studies in the fields of university, industry, and government. Previous research and publications were also carried out to ensure that no variables were left behind in constructing variable items. Table 1, is the conceptual and definition of the existing variables.

Table 1. Conceptual Definitions of the 5 Variables

Variable	Conceptual definition
University	University is a factor that has a role in providing services, facilities, and infrastructure that support knowledge transfer itself. They are also a sector from which to produce expertise from knowledge transfer.
Industry	The industrial sector tends to be more directed to take advantage of the knowledge transfer process. Even though this sector has a role that is almost the same as universities, they do transfer of knowledge, but what they do is still above business goals.
Government	Sectors such as universities have different roles, they can develop and transfer knowledge directly, the role of government is to regulate how the process works. The role of government in developing knowledge transfer is behind the scenes, but this role is often large and a balance of how the underlying variables carry out responsibility.
Knowledge Transfer	Knowledge transfer is the process of transferring knowledge from someone who is called a knowledge contributor to the knowledge recipient, who will later utilize this knowledge according to the needs of the knowledge recipient. The main focus and goal is to seek knowledge communication between individuals, groups or organizations in such a way.
Innovation System	The innovation system consists of all the determinants of the innovation process, that is, all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovation. The constituents of the innovation system are the components (organizations and institutions) and the relationships between them.

The second part (Field Interview) of our approach involves in-depth interviews with relevant experts. Several interviews were conducted with experts in their respective fields who certainly have experience in triple helix, knowledge transfer, and innovation development. From the experts' descriptions, we find that there is a concern about the perceived gap between industry players and users regarding the expectations of developing knowledge transfer and innovation. This group of experts seems suitable for obtaining all aspects of content relevant to the quality of knowledge transfer As a result of interviews in the field, we constructed 5 main variables, with 3 triple helix variables as the antecedent of knowledge transfer, and knowledge transfer as the connecting variable with the innovation system variable. Thus, the importance of the three triple helix factors in developing Knowledge transfer and creating innovation

Table 2. Roles of research participants

Participants	Number of participants	Activities or roles	Results
Head of department in university, industry and government	50	Generation of a ranked list of items; screening out redundant, inapplicable, or low-ranked items; rewording items to improve clarity (face validity); feedback on initial questionnaire draft	Conceptual framework for TH, KT and IS factors and initial item
Head of department in university, industry and government		Reduction of items and refinement of survey instrument	Initial item pool reduced to 24 items
Head of department in university, industry and government		Response to the final survey instrument	400 valid responses, 24 items, editorial changes to survey
Lecturer, Industry employee, and Government employee		Response to the final survey instrument	360 valid responses

3.2 Conceptual Refinement, Item Modification, and Testing Study

The five variables and variable items generated from Step 1 were then refined and modified through focus group discussions. For this FGD, thirty-five participants were invited, including academics, practitioners and the bureaucracy who on average have more than 3 years of experience in their respective fields, and 11 Knowledge Management researchers with special expertise in management, research and educational services. The specific objectives of the FGD are: (1) So that participants independently assess each item about the variables and variable items made; (2) Eliminating variable items that are deemed redundant, unenforceable, or low ranking; (3) Rearranging items to increase clarity or validity; (4) Obtaining feedback on length, format, and clarity of instructions and initial draft questionnaire. Based on the results of the FGDs, we reduced the initial sets from 30 items to 24 by filtering out redundant, unworkable, and low-ranking items and rearranging them to increase validity. In order to gather sufficient evidence on convergence, discriminant validity and predictability (nomological validity) of the proposed scale, we conducted a main study, using a survey involving universities, industry and government.

Table. 3. Items for the triple helix Scale, Sources, and Refinement Results

Variable name and abbreviation	Sources	Items	Results
		When it is about...	
University (Unv)	Unv1[45]	... customer-specific training and courses	Final item
	Unv2 [45]	... have the knowledge to answer customer questions	Final item
	Unv3[46]	... support needed to our individual needs	Final item
	Unv4[46]	... give individual attention to the user	Final item
	Unv5[new]	... give trust in customers	Final item
	Unv6[46]	... notifies the user exactly when the service will be performed	Final item
Industry (Ind)	Ind1[47]	... provide inbound and outbound systems to handle customer complaints	Final item
	Ind2[47]	... modify the contract parameters at a later stage	Final item
	Ind3[47]	... provide services at the promised time	Final item
	Ind4[48]	... fulfill contractual obligations	Final item
	Ind5[48]	... support of the latest and most up-to-date hardware, software, and netware technology	Final item
	Ind6[49]	... adequate number of service personnel dedicated to our company	Final item
Government (Gov)	Gov1[50]	... efficient disaster recovery	Final item
	Gov2[51]	... provide structured rules	Final item
	Gov3[51]	... establish quality standards and provide accreditation	Final item
	Gov4[51]	... provide assistance to other factors both material and labor	Final item
	Gov5[52]	... cooperate among other factors in creating new things	Final item
Knowledge Transfer (KnT)	KnT1[new]	... solve problems or operations skills that require the necessary knowledge	Final item
	KnT2[52]	... have the ability to apply knowledge	Final item
	KnT3[53]	... improve the communication function between the perpetrators	Final item
Innovation Systems (InS)	InS1[53]	... involves changing the relevant characteristics and design	Final item
	InS2[54]	... know the importance of knowledge development	Final item
	InS3[54]	... increase the use of a systems approach	Final item
	InS4[54]	... develop the number of institutions involved in knowledge creation	Final item

Two tests were carried out in this study to validate construct validity, namely: testing convergent validity and testing discriminant validity. Fornell and Larcker [55] state that the construct shows convergent validity if the indicator of the loading factor is greater than 0.5, the average variance extracted (AVE) is greater than 0.5, and the reliability is greater than 0.7. Table 3 shows that all constructs are in accordance with the suggestions proposed by Fornell and Larcker [55], which means that the convergent validity is correct. To test discriminant validity, the square root indicator of AVE is used, which if the square root of the AVE is greater than the construct correlation coefficient tested, it can be confirmed that it meets the discriminant validity requirements. Based on Table 4 and Table 5, the construct shows that it has met the standard of convergent validity and discriminant validity.

Table 4. Results of TH Scale or Loading Factor (Pilot Study)

Range of EFA loading factor					
Variable	Government	Innovation System	Industry	Knowledge Transfer	University
Government					
Gov1	**0.865**	0.687	0.578	0.809	0.782
Gov2	**0.916**	0.726	0.624	0.861	0.797
Gov3	**0.786**	0.857	0.732	0.795	0.743
Gov4	~~**0.377**~~	~~0.319~~	~~0.246~~	~~0.256~~	~~0.261~~
Gov5	**0.867**	0.892	0.761	0.805	0.820
Gov6	**0.916**	0.726	0.624	0.861	0.797
Gov7	~~**0.600**~~	~~0.491~~	~~0.418~~	~~0.455~~	~~0.458~~
Innovation System					
IS1	0.756	**0.885**	0.838	0.884	0.757
IS2	0.867	**0.892**	0.761	0.805	0.820
IS3	0.786	**0.857**	0.732	0.795	0.743
IS4	0.733	**0.900**	0.914	0.779	0.841
IS5	~~0.443~~	~~**0.514**~~	~~0.473~~	~~0.597~~	~~0.588~~
IS6	~~0.346~~	~~**0.408**~~	~~0.367~~	~~0.334~~	~~0.276~~
Industry					
Ind1	~~0.268~~	~~0.205~~	~~**0.202**~~	~~0.214~~	~~0.242~~
Ind2	~~0.456~~	~~0.661~~	~~**0.813**~~	~~0.600~~	~~0.604~~
Ind3	0.622	0.777	**0.917**	0.731	0.767
Ind4	0.733	0.900	**0.914**	0.779	0.841
Ind5	0.456	0.661	**0.813**	0.600	0.604
Ind6	0.622	0.777	**0.917**	0.731	0.767
Ind7	~~0.376~~	~~0.286~~	~~**0.321**~~	~~0.312~~	~~0.262~~
Ind8	0.786	0.857	**0.732**	0.795	0.743
Knowledge Transfer					
Knt1	0.756	0.885	0.838	**0.884**	0.757
Knt2	0.786	0.857	0.732	**0.795**	0.743
Knt3	~~0.443~~	~~0.514~~	~~0.473~~	~~**0.597**~~	~~0.588~~
Knt4	~~0.370~~	~~0.317~~	~~0.304~~	~~**0.453**~~	~~0.375~~
Knt5	~~0.083~~	~~0.011~~	~~-0.010~~	~~**0.101**~~	~~0.049~~
Knt6	0.916	0.726	0.624	**0.861**	0.797
University					
Unv1	0.803	0.829	0.809	0.760	**0.835**
Unv2	0.867	0.892	0.761	0.805	**0.820**
Unv3	0.680	0.775	0.748	0.697	**0.800**
Unv4	0.539	0.540	0.548	0.623	**0.725**
Unv5	~~0.443~~	~~0.514~~	~~0.473~~	~~0.597~~	~~**0.588**~~
Unv6	0.688	0.636	0.652	0.695	**0.809**
Unv7	~~0.160~~	~~0.172~~	~~0.240~~	~~0.144~~	~~**0.169**~~
Unv8	0.686	0.615	0.554	0.677	**0.772**

Table 5. Convergent Validity/Composite Reliability Results (Pilot Study)

Variable	Number of items	AVE	Composite Reliability	Cronbachs Alpha	Communality
Government	5	0.773	0.944	0.926	0.773
Innovation System	4	0.813	0.946	0.923	0.813
Industry	6	0.736	0.943	0.928	0.736
Knowledge Transfer	3	0.761	0.905	0.843	0.761
University	6	0.644	0.915	0.888	0.644

3.4 Main Study and Validity Testing

To test the validity of the 24-item variables, we built a new questionnaire consisting of 24 items from 5 variables. We sent this questionnaire based on a random sample. 11 companies represent industry, 20 universities, 15 education departments represent the government. Some of the data collected contained missing data, so there were 25 data that had to be deleted, from the final result we collected 360 data. The number of questionnaires that we distributed was 400. During the first survey, we explained in detail the variables related to the triple helix, knowledge transfer, and innovation systems. So that the indicators in our survey can be filled clearly by practitioners, academics, and the bureaucracy who have an important role in their respective fields of work. Furthermore, to ensure the validity of our respondents, we ensure that there is no bias, by asking them to fill in their experiences with knowledge transfer in each division they hold.

The pilot study in this study has a major role in determining the methodology in data collection, which in the end the data is processed to produce relevant information, which is used for decision making. Conversely, if the information is not relevant, it will have no value. This is very important not only for organizations but more for long-term policy making. Here are the demographics of the respondents we got. Because data were obtained from multiple respondents from each organization, we performed a Harman single factor test to ensure there was no common method bias [56]. We performed exploratory analysis on all variables, but there was no single factor that we found from the covariant variable (the largest limit for Harman single factor was 16.03 percent), this shows that there is no bias in the method we used in this study.

We used the Convergent and discriminant validity test in this study through assessment confirmatory analysis using SmartPLS 2.0 [57]. Some of the reasons for choosing Partial Least Squares (PLS) are: that it can be used to estimate reflective and formative indicators models simultaneously, can model latent constructs with non-normality conditions, and can calculate complex models, including many variables or indicators and their relationships, including the amount of data the little or the medium [57]. To measure convergent and discriminant validity indicators, the benchmarks used are the same as the pilot study. The results of convergent and discriminant validity can be seen in Tables 6, 7, and 8.

Table 6. Results of TH Scale or Loading Factor (Main Study)

	Range of Loading Factors each Items Variables				
Factors	Government	Innovation System	Industry	Knowledge Transfer	University
Government					
Gov1	**0.723**	0.527	0.520	0.562	0.536
Gov2	**0.881**	0.796	0.688	0.743	0.641
Gov3	**0.873**	0.674	0.586	0.684	0.523
Gov4	**0.853**	0.532	0.436	0.567	0.421
Gov5	**0.884**	0.685	0.562	0.713	0.480
Innovation System					
InS1	0.648	**0.961**	0.818	0.852	0.688
InS2	0.881	**0.796**	0.688	0.743	0.641
InS3	0.648	**0.961**	0.818	0.852	0.688
InS4	0.608	**0.852**	0.785	0.796	0.679
Industry					
Ind1	0.585	0.756	**0.883**	0.804	0.772
Ind2	0.607	0.825	**0.833**	0.871	0.660
Ind3	0.562	0.778	**0.877**	0.884	0.740
Ind4	0.575	0.727	**0.856**	0.708	0.883
Ind5	0.601	0.697	**0.863**	0.738	0.849
Ind6	0.507	0.681	**0.843**	0.711	0.871
Knowledge Transfer					
KnT1	0.846	0.698	0.618	**0.784**	0.548
KnT2	0.607	0.825	0.833	**0.871**	0.660
KnT3	0.562	0.778	0.877	**0.884**	0.740
University					
Unv1	0.471	0.470	0.578	0.490	**0.760**
Unv2	0.414	0.514	0.570	0.476	**0.719**
Unv3	0.507	0.681	0.843	0.711	**0.871**
Unv4	0.575	0.727	0.856	0.708	**0.883**
Unv5	0.445	0.552	0.718	0.588	**0.825**
Unv6	0.601	0.697	0.863	0.738	**0.849**

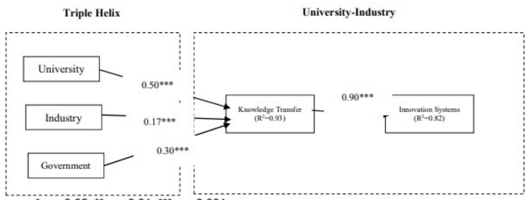
Table 7. Convergent Validity/Composite Reliability Results (Main Study)

Constructs	Number of items	Range of loading	Alpha	CR	AVE
University	6	0.760-0.883	0.902	0.925	0.672
Industry	6	0.833-0.883	0.929	0.944	0.738
Government	5	0.723-0.884	0.899	0.926	0.714
Knowledge Transfer	3	0.784-0.883	0.803	0.884	0.718
Innovation Systems	4	0.795-0.961	0.915	0.941	0.802

Table 8. Correlation Matrix

Latent construct	1	2	3	4	5
1. Government	**0.845**				
2. Innovation Systems	0.571	**0.895**			
3. Industry	0.668	0.571	**0.859**		
4. Knowledge Transfer	0.581	0.607	0.622	**0.847**	
5. University	0.619	0.753	0.518	0.570	**0.820**

The PLS concept is known as the inner model to explain the nomological or predictive validity tests, namely the structures path between constructs. To be declared significant, the t-value must be greater than 1.95. From the results of the nomological test analysis, it is concluded that the path coefficient of t-value, significance, and the results of hypothesis testing for the model in this study can be seen in Table 9 and illustrated in Fig. 2. All hypotheses formulated in the research are positive and significant.



* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Figure 2. Standardized path coefficients and significance of the inner model

Table 9. Nomological or predictive validity test

Constructs	Standard Deviation	Standard Error	T Statistics	Results
Government -> Knowledge Transfer	0,040	0,040	7,554	Accepted
Industry -> Knowledge Transfer	0,080	0,080	14,804	Accepted
University -> Knowledge Transfer	0,077	0,077	6,481	Accepted
Knowledge Transfer -> Innovation Systems	0,023	0,023	39,219	Accepted

To assess the mediating effect between government, industry and university variables on the innovation system, we used the Sobel test, where the t-value must be above 1.95 in order to be significant. The results of the Sobel test in this study are presented in table 10. All mediating effects are valued significantly.

Table. 10. Mediating test

Constructs	T Statistics	Sobel Test	P-Value	Results
Government -> Knowledge Transfer -> Innovation Systems	7,553 -> 39,219	7,417	0,001	Accepted
Industry -> Knowledge Transfer -> Innovation Systems	14,804 -> 39,219	13,850	0,001	Accepted
University -> Knowledge Transfer -> Innovation Systems	6,481 -> 39,219	6,394	0,001	Accepted

4. Discussion

In several sources, it is explained that government provisions for an innovation-oriented society are the basis of transformational change in the triple helix relationship, namely universities and other research institutions, the novelty of wealth creation in industry, and normative control from the aspect of government. On the other hand, each field can "take another role", for example, universities generate intellectual property through technology transfer, and carry out these tasks collaboratively. The advancement of technological developments in this era as a major force in the world economy shows the need for integration into global innovation networks. However, a recent review of research on various sectors initiating knowledge-based innovation also highlights a number of challenges facing companies, academia, government agencies and policymakers.

The main problem is, economic development and science and technology policies are very much dominated by the government, another problem that policies made to promote high-tech knowledge-based innovation are less supported by the capacity for knowledge and innovation embedded in the institutions in both. In the process of developing collaborative innovation in a triple helix relationship, the needs pursued by various institutions are still ambiguous requiring further understanding of the policy process. The key issue is how to increase the independence of academic and industrial actors, so that they can create new initiatives individually and cooperatively with other actors, and respond to the direction of government policies, thereby increasing the source of creative innovation capabilities in society

While increasing attention has been given to building innovation capacity through the development of physical infrastructure, the challenge is how to develop "software" and innovation environments that support and facilitate new ideas, and knowledge flow in the triple helix innovation network. Research on innovation development is primarily focused on quantitative measurements in research investment and technology output. The lack of studies on changes in an institution and culture helps develop innovation capabilities independently of the company. This suggests the need for more qualitative case studies of the change process in the triple helix innovation network at the institutional, organizational, and individual levels to enhance our understanding of the political, economic, and social issues involved in the knowledge transfer process.

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