Research Article

Assessing impact of triple helix variables to knowledge transfer variable and innovation systems

Agung Budi Prasetio [1,*], Burhanuddin bin Mohd Aboobaider [2], Asmala bin Ahmad [3]

[1*] Faculty of Computer Science Institute Technology Tangerang Selatan, Indonesia
E-mail: [1]agung@itts.ac.id

[2,3]Faculty of Information & Communication Technology, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia.
E-mail: [2]burhanuddin@utem.edu.my; [3]asmala@utem.edu.my

***Article History**: Received: 11 January 2021; Accepted: 27 February 2021; Published online: 5 April 2021*

Abstract— The purpose of this study was to examine the role of the triple helix (TH) variable in knowledge transfer and innovation systems. TH is divided into 3 variables, namely Industry, University and Government. This study examined three TH knowledge transfer variables and innovation systems and the items variables that supported them. This study involved 360 respondents who were selected through an interception and online survey approach and had 4 hypotheses. This study used a structural equation model to test the hypothesis. The findings showed that TH which consisted of 3 variables had a direct relationship with knowledge transfer. Meanwhile, knowledge transfer was directly related to innovation systems. Although the TH concept had been explored in some previous literature, the role of TH and knowledge transfer had not been the concern of many researchers in creating innovation systems. Implications for practitioners, these findings confirmed that Innovation systems can be formed from an early age starting from the university environment and good government policies. These findings also indicated that knowledge transfer related to TH services needed to be studied from a broader perspective. Therefore, handling TH required synergy and a special strategy to take advantage of knowledge transfer in order to create an innovation system. Originality of this study, integrated the TH dimension with knowledge transfer and Innovation Systems.

Keywords— Triple Helix, knowledge transfer, Innovation Systems, Integrated Model

1. Introduction

In recent times, interest in knowledge transfer is expanding in several developed countries. Some of these countries have supported initial initiatives for open knowledge transfer. The idea of a university as a measure of education is well known and has often been discussed in previous studies. However, the latest research results support the role of education openly in higher education to carry out its function as a contributor to knowledge. Therefore, a new policy is needed to formulate it according to the needs of current science, so certain variables play an important role in determining this. Indeed, the evolution of Knowledge Transfer from a regional perspective depends heavily on the contribution of this variable. Previous studies have summarized the ambivalent developments of knowledge transfer and innovation [1,2]. Finding or finding an accurate definition of knowledge is the focus of many researchers. However, in general knowledge can be defined as the content of an existing structure in a system or on individual understanding. A content can be seen as unstructured or unorganized information, which later can be referred to as knowledge, which comes from one's understanding. The cognitive system is a combination of beliefs, values, attitudes, assumptions, opinions and memories that are conveyed simultaneously, with the values derived from the content. Researchers such as [3] define knowledge as a value that comes from a thought. Knowledge itself can be divided into two dimensions. Explicit knowledge that exists in the epistemological dimension, where the implications are possible in writing or in a particular format. Besides that, there is tacit knowledge, its location is in the ontological dimension, the use of tacit knowledge requires the use of metaphors and extension socialization processes. In whatever dimension the knowledge is located, the transfer of that knowledge constitutes the largest part of a transfer of information. This information can be in the form of code, writing, communication metaphors or even formats of observable behavior. One perspective is multi-variable in analyzing innovation systems for the development of knowledge transfer, namely the triple helix (TH), which consists of the role of government, the role of universities, and the role of industry [4]. Since the three variables in the TH model participate in the same area, these variables can change the transfer of certain Knowledge, generating value through policy, innovation, and technology development [5]. The TH model relies on innovation activity at a certain level, taking into account the geographical characteristics that influence innovation activity and the involvement of each variable [6]. Because the TH variable is an important variable for the implementation of knowledge transfer [7], we adopt the TH model to understand and measure the existing variables, to contribute to integrating these variables in order to form a measurable policy, knowledge, and practice. The literature on knowledge systems has not systematically and empirically discussed the contribution of the TH variable to the development of knowledge transfer. There are gaps in the literature for understanding TH contextual factors for knowledge transfer, as well as innovation systems, and our paper helps fill this gap by examining the factors that exist to shape innovation systems [8,4].

Recent studies have shown that Knowledge transfer is useful for policies in implementing an innovation, for example, policies that focus on creating educational solutions and conditions to support the development of knowledge transfer in a city [9]. Frank et al. [9] showed that in making a policy to increase knowledge creation, cooperation between stakeholders, such as government, is needed. This results in a higher level of Knowledge transfer development. However, their study does not show what variables contribute to the making of each of these policies apart from the government aspect, which is our main concern in this study. In this regard, previous investigations have suggested that a deeper involvement of the TH variable will be required for knowledge development and innovation [10]. In this study, the TH variable used refers to the Hybrid TH model with a more strategic contribution from these variables [4]. There is a lack of studies linking the role of TH with knowledge transfer and innovation systems [11-13], while the specific contributions to innovation system variables are usually ignored [14], especially when considering their contribution to a knowledge transfer policy and innovation system development. This study addresses these problems that contribute to the integration of the TH variable in knowledge transfer and innovation systems. Although the innovation literature assumes that all TH variables or actors are essentially necessary for any innovation system [4], our research questions assume that variables can contribute differently to innovation policy development and knowledge transfer. This study aims to measure and analyze the contribution of three TH variables, namely, government, universities, and the private sector to the development of knowledge transfer and the development of innovation systems.

2. Literature review & Hypothesis

2.1. Triple Helix for knowledge transfer and innovation systems

Several models have been proposed to discuss how the innovation system can be implemented properly. Some of them are the innovation system model, the triple helix model, the open innovation model, and the quadruple and quintuple helix model [15]. As analyzed by Villarreal and Calvo [15], each of these models considers different perspectives on how knowledge is transferred among stakeholders to create value in an innovation system. Some of these models focus more on the interaction of variables to create synergies, such as a management perspective for knowledge transfer development [16,17], while others consider structural conditions in the system, such as those in innovation systems [15]. We adopt a third stream that focuses on the role of the variables, following the Triple Helix (TH) perspective. The TH model focuses on the contribution of the main actors in the development of the innovation system: universities, government, and the private sector [17]. The University understands, in general terms, activities including education and research in society. The TH model governance pillar considers at various levels of government, from national to local, who make public policies, including regulations. The TH model is very comprehensive in the industrial sector and includes all social initiatives. Other derivative models of the TH model have proposed new dimensions: the quadruple and quintuple helix, separating personal initiative from social engagement [15]. However, we adopt the most classic approach of these three dimensions, because it is a consolidated framework academically and policymakers or government, providing the preferred interface for empirical research. In this model, each of these variables plays an important role in the process of transferring knowledge and creating an innovation system [16]. TH therefore provides a suitable framework that looks at these actors as more on how to increase knowledge or how an innovation system is shaped.

Triple helix is very important to develop a sustainable innovation system, especially because knowledge management involves complex problems that cannot be solved by one variable alone [17]. Sustainable innovation projects can use the TH model to accelerate and implement these innovations. Many of the main actors who focus on knowledge transfer while shifting from conventional education to knowledge transfer are supported by education policies to achieve this goal [9]. Furthermore, according to Frank et al. [9], the TH variable can play a role as a motor for the development of knowledge transfer, while cooperation activities and local wisdom become the motor of science development.

The TH model can play an important role in developing innovation policies focused on developing Knowledge transfer. As an innovation policy, we refer to public policies that can be enforced in society to advance innovation. Coordinated action between government, universities and industry can help develop types of innovation policies that integrate the perspectives and interests of different parties. Previous studies have maintained the need for a policy perspective to support knowledge development [17]. In this regard, Frank et al. [9] proposed three main innovation policy criteria that can directly or indirectly influence the development of knowledge transfer:

Cooperative activities, local wisdom, and location factors. The collaborative activity criteria summarize a policy that is focused on creating a positive and cooperative environment for the implementation of knowledge transfer.

2.2. Hypothesis

In this section, we present our research hypothesis, which is based on the general theory of the triple helix model. The focus of this study is how each TH variable correlates with knowledge transfer, as well as the innovation system related to the industrial domain, which is represented in the figure. 1 and will be discussed in the following subsections. We use the term correlation to represent the connectedness of each TH variable in the industry domain, including participation in each activity and initiative or contribution to the development of Knowledge transfer.

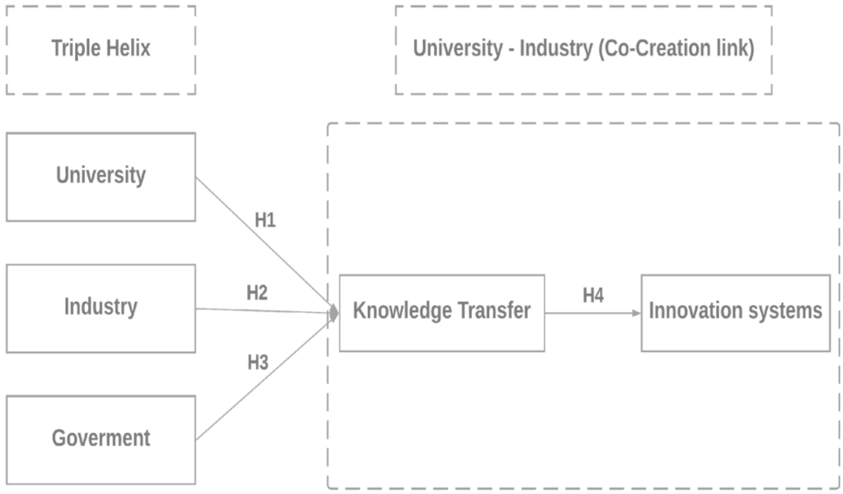

Fig. 1 Research Model Concept

1) Triple helix on the role of universities for knowledge transfer

Naturally, universities have an important role in transferring knowledge. While universities are responsible for educating and training new professionals in skills that are oriented towards the use of knowledge itself, they also play a key role in the advancement of knowledge transfer itself [18,19]. Transferring or conveying information from a professional understanding is part of the business that exists at the university itself. Based on our assumption, the role of the university itself is not just a transfer of knowledge but is also responsible for fully understanding the processes, methods, results of the delivery of knowledge itself, and even the role of educators in universities is in full control of innovations in the development of knowledge transfer. Moreover, universities can play a cooperative and important role, since they create a common discussion environment and generate ideas for the development of knowledge transfer. All these examples show the important role of TH in enhancing the role of universities in developing knowledge transfer. Although, the existence of these university variables does not guarantee that they will be cooperative with each other, each actor like them can make their own contribution, and there is a development of knowledge transfer. In this way we propose:

H1: University involvement positively and significantly has a role to higher knowledge transfer for knowledge development

2) Triple helix on the role of Industry for knowledge transfer

Unlike the university and government sectors, the industrial sector tends to be more aimed at taking advantage of the knowledge transfer process. Even though this sector has a role at almost the same level as universities, they still prioritize a business system in it. As a result of this same level, it is not uncommon for an industry to encourage education about knowledge transfer more than universities, for example a private course, they carry out a transfer of knowledge but what they do is still above business goals. However, this does not rule out the existence of a group or individual from a particular industry that intends to increase the quality of knowledge transfer voluntarily. Lastly, although the main objective of the industrial sector is to adapt knowledge and convert it into market value [20], the industrial sector can also support knowledge policies for knowledge transfer in several ways. Thus, large education-oriented companies can prepare programs to increase the workforce. For example, a large international private education firm recently established a program to support immigration of high-skilled workers to promote knowledge transfer [21]. In this way we propose:

H2: Positive and significant Industry involvement is associated with a higher transfer of knowledge for knowledge development

3) Triple helix on the role of Government for knowledge transfer

There are different roles as variables that develop and implement direct knowledge transfer such as universities, the role of government is to provide a regulation or regulation regarding how the process works. Although the role of government in developing knowledge transfer moves behind the scenes, this role tends to be large and as a counterweight to how the variables under them perform their duties. This can occur by establishing government institutions that focus on education [22] or by creating funds and incentives for education programs in cities and regions [23]. When governments of various levels are involved in developing the transfer of knowledge itself, they can promote not only its progress but also welfare on other variables, creating a knowledge development cycle. In addition, education for society with sustainable content in the curriculum can be a form of government contribution in developing knowledge transfer. In this way we propose:

H3: Government involvement is positively and significantly related to higher knowledge transfer for knowledge development

4) Knowledge transfer to Innovation Systems

TH is a model which is basically related to the creation of scientific innovations [24]. In particular, higher education is very important for the development of science and technology for knowledge transfer [25]. Naturally, universities play an important role as knowledge transfer generation [26]. While universities are responsible for educating and training new professionals in skills that are oriented towards the use of knowledge itself, playing a key role in the advancement and evolution of knowledge [27,18], the government acts proactively as an integrative agent between the science and technology infrastructure. The government can create strategic programs to encourage knowledge generation in knowledge transfer [19]. This can occur by establishing government institutions that focus on education [22] or by creating funds and incentives for education programs [23]. Lastly, although the main objective of the industrial sector is to adapt knowledge and convert it into market value [20], the industrial sector can also support knowledge policies for knowledge transfer in several ways. Thus, large education-oriented companies can prepare programs to increase the workforce. For example, a large international private education firm recently established a program to support immigration of high-skilled workers to promote knowledge transfer [21]. Companies can also engage with the government to determine infrastructure and facility requirements for professionals that will affect labor incentives and legislation [28,29] and provide training for a generation of educators [30]. In addition, companies can develop their R&D centers and committees to build an innovation, which enables them to generate internal knowledge that will support broad knowledge in all aspects [31]. Based on these arguments, we propose the following hypothesis:

H4: There is a very strong involvement in the transfer of knowledge to develop an innovation system

3. Research Method

The hypothesis in this research model integrates TH with knowledge transfer and an innovation system tested empirically using a survey method collected from users (Figure 1). The questionnaire items in this study used a scale applied to previous studies to ensure content validity and appropriate revisions were made to fit the context [32-34]. Three procedures were carried out to screen the questionnaire items to improve measurement accuracy. First, items selected from previous studies were translated into Indonesian. Second, validation of the TH focus study group, including TH researchers and practitioners to examine each item in the measurement to ensure that they can be read and understood. Third, measurement items are evaluated and refined in a pilot study to ensure content validity. In the first part of the two-part questionnaire, a nominal scale was used to collect baseline data, including gender, age, education, occupation, and work experience. Each item is measured on a seven-point Likert scale ranging from strongly disagree (1) neutral (4) to strongly agree (7).

To measure the 5 existing variables and the implications of knowledge transfer and innovation systems, they were assessed based on an online survey of the experiences of TH actors in Indonesia. We use the online survey method because it has several advantages over paper-based data collection, namely: the advantages of online investigations include fast response, low cost, and no geographic boundaries [35]. To ensure that participants did not fill out the questionnaire more than once, each participant was asked to provide an e-mail address. After eliminating invalid responses through data filtering, the final valid sampling was 360 subjects. Table 1 presents the sample demographic data. Measurement items are taken based on the research objectives mentioned earlier, through the research framework, as well as the relevant literature. This questionnaire was discussed with researchers who have expertise in the field of HT, as well as practitioners and have been revised several times following the pretest method. To formulate measurement items, this study refers to credible literature. The questionnaire survey period is from 11 September 2020 to 12 January 2021.

TABLE I
DEMOGRAPHICS OF THE SAMPLE

Characteristics	Frequency	(%)
Gender		
Male	220	61.11
Female	140	38.89
Total	360	100
Age		
<35	169	46.94
>35	191	53.06
Total	360	100
Degree		
Undergraduate	207	57.50
Post undergraduate	153	42.50
Total	360	100
Experience		
1 year	65	18.06
3-5 years	122	33.89
>5 years	173	48.06
Total	360	100
Occupations		
Private sector	188	52.22
Public sector	172	47.78
Total	360	100

4. Research Analysis

In this study we used partial least squares (PLS) to test and verify the model hypothesis and test stability. To process and analyze data the software used is SmartPLS version 2.0. PLS is a structural equation model (SEM) technique which is based on path analysis and regression analysis. PLS is used as a technique in analyzing models that have a causal relationship with several constructs. According to researchers PLS is superior to SEM in terms of covariance based on the following four reasons [36-38]. (1) PLS can be used simultaneously to process reflective indicators and formative indicators; (2) PLS produces stable parameter values even from small sample data; (3) PLS excels in overcoming multicollinearity problems; (4) PLS can analyze complex prediction models with many constructs and research variables. In this study PLS is used here as a method of analysis due to factors. First, it is used to integrate TH. A number of constructs are built on this framework, namely knowledge transfer and innovation systems. On the other hand, PLS does not test for significance, so the resampling procedure is used for significance testing.

In this context, to measure significance using the bootstrapping method, measurements were carried out repeatedly using a random sample. The appropriate simulation results are then used to perform statistical evaluation and testing. Based on the suggestion put forward by Chin and Newsted [39], the number of resampling is set at 1000 to achieve a stable parameter estimate.

4.1. Outer Model

To measure the relationship between latent constructs and indicators in PLS it is known as the outer model. The indicators used in the outer model are the loading factor and the value of the reliability test results of various construction items. In addition, the value of Cronbach's α and the value of composite reliability is also measured, in order to be declared reliable and acceptable, the value must be 0.7 or greater. Table 2 shows that the existing construct has met the criteria and can be declared acceptable reliable.

TABLE 2
RELIABILITY ANALYSIS AND CONVERGENT VALIDITY

Constructs	**Items**	**Loadings**	**Alpha**	**CR**	**AVE**
University Aspect	Unv 1	0.760	0.902	0.925	0.672
	Unv 2	0.719			
	Unv 3	0.871			
	Unv 4	0.883			
	Unv 5	0.825			
	Unv 6	0.849			
Industry Aspect	Ind1	0.883	0.929	0.944	0.738
	Ind2	0.833			
	Ind3	0.877			
	Ind4	0.856			
	Ind5	0.863			
	Ind6	0.843			
Government Aspect	Gov 1	0.723	0.899	0.926	0.714
	Gov 2	0.881			
	Gov 3	0.873			
	Gov 4	0.853			
	Gov 5	0.884			
Knowledge Transfer	KnT 1	0.784	0.803	0.884	0.718
	KnT 2	0.871			
	KnT 3	0.884			
	InS1	0.961			

Innovation Systems	InS2	0.796	0.915	0.941	0.802
	InS3	0.961			
	InS4	0.852			

4.2. Common method variance testing

We used the common method variance (CMV) to deal with the problem of bias in the questionnaire survey. Referring to Podsakoff et al. [40], the questionnaire was designed with a strict control process. The questionnaire is designed, reviewed and revised based on comments or suggestions made by experts who have experience in the relevant fields. In addition, a pre-test was performed to modify the semantics of the questionnaire. Harman's single factor test was used to test for the presence of CMV [41]. Based on the advice from Harman's single factor test that CMV can be said to be confirmed if a single factor can explain most of the co-variance variables. In this study the test results were declared relevant because the single factor failed to explain 50% of the variance, this indicates that the questionnaire did not show the presence of CMV.

Two tests were carried out in this study to validate construct validity, namely: testing convergent validity and testing discriminant validity. Fornell and Larcker [42] 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 [42], 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 EVA is greater than the construct correlation coefficient tested, it can be confirmed that it meets the discriminant validity requirements. Based on Table 3 and Table 4, the construct shows that it has met the standard of convergent validity and discriminant validity.

TABLE 3
FORNELL AND LARCKER CRITERIA

	Gov	InS	Ind	KnT	Unv
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
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
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
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
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 4
CORRELATION MATRIX

	Gov	InS	Ind	KnT	Unv
Gov	**0.845**				
InS	0.771	**0.895**			
Ind	0.668	0.871	**0.859**		
KnT	0.781	0.907	0.922	**0.847**	
Unv	0.619	0.753	0.918	0.770	**0.820**

4.3. Inner model

The concept of PLS is also known as inner model namely structures path between constructions. The T-value line coefficient, significance, and the results of hypothesis testing for the model in this study can be seen in Table 5 and are illustrated also in figure 2. All hypotheses are formulated in positive and significant value studies.

TABLE 5
Summary of hypotheses testing results

	Standard Deviation (STDEV)	Standard Error (STERR)	T Statistics
Gov -> KnT	0.040	0.040	7.55
Ind -> KnT	0.080	0.080	14.80
KnT -> InS	0.023	0.023	39.22
Unv -> KnT	0.077	0.077	6.48

5. Conclusions and Discussion

The core concept of the triple helix approach is through the involvement of each variable from government, industry, and universities, so that knowledge transfer can lead to innovation. This study examines whether the innovation system can be driven by knowledge transfer, which is spurred by engagement between government, industry and universities. This study shows that the triple helix approach can be very useful to be applied to the interaction of each variable involved in the development of knowledge transfer. This study also shows that the application of the triple helix approach can be very effective for each of the variables associated with the formation of knowledge transfer and the formation of innovation systems. The reason is that the interactions between the three helices occur in most of the relevant planning steps. Within the research framework, it has been possible to identify three interaction variables, each of which has implications for the application of the TH approach to the development of knowledge transfer through these three TH variables. The differentiation between the transfer of knowledge can serve for the emergence of cultural and technological evolution, which can create a balance in organizations. From a long-term perspective, the knowledge systems model provides options for simulation, whereas the TH model allows us to measure the efficiency of variable mechanisms that can be harnessed for knowledge development and innovation.

The TH model provides a clear picture to determine the process of knowledge transfer on each variable from different perspectives and different institutional roles. This research confirms that the transfer of knowledge at a certain level can lead to redundancy, thus enriching and triggering an innovation process. The stronger a context on knowledge transfer will push us to the value and legitimacy of a knowledge decision.

Acknowledgement:

The authors would like to thank BIOCORE Research Group, Center for Advanced Computing Technology (C-ACT), Fakulti Teknologi Maklumat dan Komunikasi (FTMK), Centre for Research and Innovation Management, Universiti Teknikal Malaysia Melaka and Ministry of Higher Education Malaysia for providing the facilities and support for this research.

References

[1] A. Lema and K. Ruby, “Between fragmented authoritarianism and policy coordination: Creating a Chinese market for wind energy,” Energy Policy, vol. 35, no. 7, pp. 3879–3890, 2007, doi: 10.1016/j.enpol.2007.01.025.
[2] Y. Cai and Y. Aoyama, “Fragmented authorities, institutional misalignments, and challenges to renewable energy transition: A case study of wind power curtailment in China,” Energy Res. Soc. Sci., vol. 41, no. April, pp. 71–79, 2018, doi: 10.1016/j.erss.2018.04.021.
[3] G. D. Bhatt, “Organizing knowledge in the knowledge development cycle,” J. Knowl. Manag., vol. 4, no. 1, pp. 15–26, 2000, doi: 10.1108/13673270010315371.
[4] H. Etzkowitz and L. Leydesdorff, “The dynamics of innovation: From National Systems and ‘mode 2’ to a Triple Helix of university-industry-government relations,” Res. Policy, vol. 29, no. 2, pp. 109–123, 2000, doi: 10.1016/S0048-7333(99)00055-4.
[5] M. Perkmann et al., “Academic engagement and commercialisation: A review of the literature on university-industry relations,” Res. Policy, vol. 42, no. 2, pp. 423–442, 2013, doi: 10.1016/j.respol.2012.09.007.
[6] Ø. Strand and L. Leydesdorff, “Where is synergy indicated in the Norwegian innovation system? Triple-Helix relations among technology, organization, and geography,” Technol. Forecast. Soc. Change, vol. 80, no. 3, pp. 471–484, 2013, doi: 10.1016/j.techfore.2012.08.010.

[7] M. Greene and F. Fahy, “Steering demand? Exploring the intersection of policy, practice and lives in energy systems change in Ireland,” Energy Res. Soc. Sci., vol. 61, no. October 2019, p. 101331, 2020, doi: 10.1016/j.erss.2019.101331.
[8] L. Saganeiti, A. Pilogallo, G. Faruolo, F. Scorza, and B. Murgante, “Territorial fragmentation and renewable energy source plants: Which relationship?,” Sustain., vol. 12, no. 5, 2020, doi: 10.3390/su12051828.
[9] A. G. Frank, W. Gerstlberger, C. A. Paslauski, L. V. Lerman, and N. F. Ayala, “The contribution of innovation policy criteria to the development of local renewable energy systems,” Energy Policy, vol. 115, no. January, pp. 353–365, 2018, doi: 10.1016/j.enpol.2018.01.036.
[10] H. Etzkowitz and J. Dzisah, “Rethinking development: Circulation in the triple helix,” Technol. Anal. Strateg. Manag., vol. 20, no. 6, pp. 653–666, 2008, doi: 10.1080/09537320802426309.
[11] A. Klitkou and H. Godoe, “The Norwegian PV manufacturing industry in a Triple Helix perspective,” Energy Policy, vol. 61, pp. 1586–1594, 2013, doi: 10.1016/j.enpol.2013.06.032.
[12] M. Deakin and A. Reid, “Smart cities: Under-gridding the sustainability of city-districts as energy efficient-low carbon zones,” J. Clean. Prod., vol. 173, pp. 39–48, 2018, doi: 10.1016/j.jclepro.2016.12.054.
[13] S. Hettinga, P. Nijkamp, and H. Scholten, “A multi-stakeholder decision support system for local neighbourhood energy planning,” Energy Policy, vol. 116, no. February, pp. 277–288, 2018, doi: 10.1016/j.enpol.2018.02.015.
[14] I. A. Ivanova and L. Leydesdorff, “Rotational symmetry and the transformation of innovation systems in a Triple Helix of university-industry-government relations,” Technol. Forecast. Soc. Change, vol. 86, pp. 143–156, 2014, doi: 10.1016/j.techfore.2013.08.022.
[15] P. Söderholm, H. Hellsmark, J. Frishammar, J. Hansson, J. Mossberg, and A. Sandström, “Technological development for sustainability: The role of network management in the innovation policy mix,” Technol. Forecast. Soc. Change, vol. 138, no. October, pp. 309–323, 2019, doi: 10.1016/j.techfore.2018.10.010.
[16] D. Newell, A. Sandström, and P. Söderholm, “Network management and renewable energy development: An analytical framework with empirical illustrations,” Energy Res. Soc. Sci., vol. 23, pp. 199–210, 2017, doi: 10.1016/j.erss.2016.09.005.
[17] O. Villarreal and N. Calvo, “From the Triple Helix model to the Global Open Innovation model: A case study based on international cooperation for innovation in Dominican Republic,” J. Eng. Technol. Manag. - JET-M, vol. 35, pp. 71–92, 2015, doi: 10.1016/j.jengtecman.2014.10.002.
[18] M. Qu, P. Ahponen, L. Tahvanainen, D. Gritten, B. Mola-Yudego, and P. Pelkonen, “Chinese university students’ knowledge and attitudes regarding forest bio-energy,” Renew. Sustain. Energy Rev., vol. 15, no. 8, pp. 3649–3657, 2011, doi: 10.1016/j.rser.2011.07.002.
[19] A. Assali, T. Khatib, and A. Najjar, “Renewable energy awareness among future generation of Palestine,” Renew. Energy, vol. 136, pp. 254–263, 2019, doi: 10.1016/j.renene.2019.01.007.
[20] J. Horbach and C. Rammer, “Energy transition in Germany and regional spill-overs: The diffusion of renewable energy in firms,” Energy Policy, vol. 121, no. June, pp. 404–414, 2018, doi: 10.1016/j.enpol.2018.06.042.
[21] N. Luke, C. Zabin, D. Velasco, and R. Collier, “Diversity in California’s Clean Energy Workforce: Access to Jobs for Disadvantaged Workers in Renewable Energy Construction,” no. August, pp. 1–19, 2017.
[22] “The Role of Government and Its Provision on the Quality of Education : The Case of Public Junior High School among Province in Indonesia Period 2000-2004,” Bul. Stud. Ekon., vol. 19, no. 1, 2016.
[23] P. D. Lund, “Effects of energy policies on industry expansion in renewable energy,” Renew. Energy, vol. 34, no. 1, pp. 53–64, 2009, doi: 10.1016/j.renene.2008.03.018.
[24] M. Ranga and H. Etzkowitz, “Triple Helix Systems: An Analytical Framework for Innovation Policy and Practice in the Knowledge Society,” Ind. High. Educ., vol. 27, no. 4, pp. 237–262, 2013, doi: 10.5367/ihe.2013.0165.
[25] A. Mallett, “Social acceptance of renewable energy innovations: The role of technology cooperation in urban Mexico,” Energy Policy, vol. 35, no. 5, pp. 2790–2798, 2007, doi: 10.1016/j.enpol.2006.12.008.
[26] F. J. W. Osseweijer, L. B. P. van den Hurk, E. J. H. M. Teunissen, and W. G. J. H. M. van Sark, “A comparative review of building integrated photovoltaics ecosystems in selected European countries,” Renew. Sustain. Energy Rev., vol. 90, no. October 2017, pp. 1027–1040, 2018, doi: 10.1016/j.rser.2018.03.001.
[27] A. Mallett, “Social acceptance of renewable energy innovations: The role of technology cooperation in urban Mexico,” Energy Policy, vol. 35, no. 5, pp. 2790–2798, 2007, doi: 10.1016/j.enpol.2006.12.008.
[28] U. Lehr, J. Nitsch, M. Kratzat, C. Lutz, and D. Edler, “Renewable energy and employment in Germany,” Energy Policy, vol. 36, no. 1, pp. 108–117, 2008, doi: 10.1016/j.enpol.2007.09.004.
[29] Y. Mu, W. Cai, S. Evans, C. Wang, and D. Roland-Holst, “Employment impacts of renewable energy policies in China: A decomposition analysis based on a CGE modeling framework,” Appl. Energy, vol. 210, no. October 2017, pp. 256–267, 2018, doi: 10.1016/j.apenergy.2017.10.086.

[30] J. Noailly and V. Shestalova, "Knowledge spillovers from renewable energy technologies: Lessons from patent citations," Environ. Innov. Soc. Transitions, vol. 22, pp. 1–14, 2017, doi: 10.1016/j.eist.2016.07.004.
[31] L. Leydesdorff and M. Deakin, "The triple-helix model of smart cities: A neo-evolutionary perspective," J. Urban Technol., vol. 18, no. 2, pp. 53–63, 2011, doi: 10.1080/10630732.2011.601111.
[32] S. C. Chen and C. P. Lin, "Understanding the effect of social media marketing activities: The mediation of social identification, perceived value, and satisfaction," Technol. Forecast. Soc. Change, vol. 140, no. July 2018, pp. 22–32, 2019, doi: 10.1016/j.techfore.2018.11.025.
[33] T. Hariguna, C. W. Hung, and H. T. Sukmana, "The antecedent of citizen intention use of e-government service," Telkomnika (Telecommunication Comput. Electron. Control., vol. 17, no. 1, pp. 202–209, 2019, doi: 10.12928/TELKOMNIKA.v17i1.11588.
[34] Q. Yang, C. Pang, L. Liu, D. C. Yen, and J. Michael Tarn, "Exploring consumer perceived risk and trust for online payments: An empirical study in China's younger generation," Comput. Human Behav., vol. 50, pp. 9–24, 2015, doi: 10.1016/j.chb.2015.03.058.
[35] M. Tan and T. S. H. Teo, "Factors Influencing the Adoption of Internet Banking," J. Assoc. Inf. Syst., vol. 1, no. 1, pp. 1–44, 2000.
[36] J. F. H. Jr., L. M. Matthews, R. L. Matthews, and M. Sarstedt, "PLS-SEM or CB-SEM: updated guidelines on which method to use," Int. J. Multivar. Data Anal., vol. 1, no. 2, p. 107, 2017, doi: 10.1504/ijmda.2017.087624.
[37] J. F. Hair, M. Sarstedt, L. Hopkins, and V. G. Kuppelwieser, "Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research," Eur. Bus. Rev., vol. 26, no. 2, pp. 106–121, 2014, doi: 10.1108/EBR-10-2013-0128.
[38] P. B. Lowry and J. Gaskin, "Partial least squares (PLS) structural equation modeling (SEM) for building and testing behavioral causal theory: When to choose it and how to use it," IEEE Trans. Prof. Commun., vol. 57, no. 2, pp. 123–146, 2014, doi: 10.1109/TPC.2014.2312452.
[39] W. W. Chin and P. R. Newsted, "Structural equation modeling analysis with small samples using partial least squares," Stat. Strateg. small sample Res., vol. 1, no. 1, pp. 307–341, 1999.
[40] P. M. Podsakoff, S. B. MacKenzie, J. Y. Lee, and N. P. Podsakoff, "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies," J. Appl. Psychol., vol. 88, no. 5, pp. 879–903, 2003, doi: 10.1037/0021-9010.88.5.879.
[41] P. M. Podsakoff and D. W. Organ, "Self-Reports in Organizational Research: Problems and Prospects," Journal of Management, vol. 12, no. 4. pp. 531–544, 1986, doi: 10.1177/014920638601200408.
[42] D. F. Fornell, C., & Larcker, "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," J. Mark. Res. This, vol. 18, no. 1, pp. 39–50, 2016.