

# **A Systematic Literature Review of Technology Transfer Office: Research Trends, Methods, and Topics**

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## **Abstract**

This study aims to review literature in Technology Transfer Office (TTO) which identifies and analyzes the research trends, methods, and topics, and directions for future research. The methodology used in this paper is a systematic literature review, which collects data from the Scopus and Web of Science databases and based on the specified research questions, 86 papers selected objectively were published from 2000 to May 2020. This study finds a sharp growth of publications on the topic after 2000 until now. Journal of Technology Transfer is the journal that has the most articles with a total of seventeen articles, and the most active authors with a minimum of three articles in the TTO field of four authors. The topics in the TTO field are grouped into seven groups, role of TTO, assessment, measurement, and performance of TTO, organizational structure of TTO, collaboration forms, model of TTO, commercialization, and knowledge transfer. Moreover, the research methods used are quantitative method, qualitative method and mixed-method, and data collection methods are interviews, analyzing previous data/databases, questionnaires, surveys, and case studies. Research tools used are regression, multi-criteria and decision making (MCDM), literature review, multivariate analysis, descriptive statistics, design experiment, focus group discussion, and empirical analysis. The findings and future research directions of the study offers a new avenue for further exploration and contribution to this discipline.

## **Keywords**

Technology Transfer Offices, Collaboration, Assessment, and Model

## **1. Introduction**

TTO is committed and facilitates the process of transfer (Villani et al., 2017) and commercialization of academic knowledge (O'Kane et al., 2015), and as an intermediary supplier or promoters of innovation and technology for those who have the potential to commercialize it (Beltran et al., 2020; Mohammed et al., 2018; Donald S Siegel et al., 2007). Abbas et al. (2018) and Hidalgo & Albers (2011) have conducted in-depth studies related to the role and the underlying factors of TTO in the transfer of knowledge from research universities to industry, meanwhile Berbegal-Mirabent et al. (2012) making the conceptual framework of TTO as knowledge brokers. Furthermore Martin-Rubio & Andina (2016) stated that the TTO as a knowledge broker, which impacts socio-economic benefits, also plays a role in increasing university income and job creation in the region.

TTO has a role as a seller of technological inventions from several research laboratories at universities and can build a reputation (Macho-Stadler et al., 2007), technology transfer (Feng et al., 2012) and creation of spin-offs (P Gubitta et al., 2016; Shane et al., 2015). Several studies (Blankestijn et al., 2020; Bolzani et al., 2020; R Zhou & Tang, 2020)

(Weckowska, 2015) have discussed other roles of TTO. Various forms of TTO collaboration with other parties have been widely studied, namely long term partnership and contract (Abbas et al., 2018; Alexander & Martin, 2013; Fadeyi et al., 2019; Holgersson & Aaboen, 2019; Link, 2000), networks (Brescia et al., 2016; Fai et al., 2018; G Secundo et al., 2017; Senoo et al., 2009; D S Siegel et al., 2003), patenting and licensing (S J Smyth et al., 2016; Zheng et al., 2013). The role of the TTO in various activities shows that this is an important part of university-based research. This study aims to identify and analyze the research trends, collaborations, assessment, and frameworks and directions for future research in TTO from papers and articles of the journal between 2000 to May 2020.

This article is organized as follows: section one is an introduction to the theme “*technology transfer office*”; section two, outlines of review methodology; section three, descriptive statistics and finally, section four is review discussion.

## 2. Review Methodology

In research work and making research maps, the literature review is one of the important things. Based on the analysis of the literature review, the research gaps will be formulated. The methodology performed in this paper is a systematic literature review (Boell & Cecez-Kecmanovic, 2015) and refers to the stages that have been done in two papers (Mauricio Sanchez & López Mendoza, 2018; Wahono, 2015). These stages can be explained in 3 stages: *planning, development/conducting, and reporting/results*.

### 2.1. The Planning Stage

In this stage, the formulation of the research question (RQ) and the type of document/publication to be used is determined. The formulation of the RQ can be seen in table 1 and the type of document/publication chosen is the article in the two electronic journal databases from Scopus and Web of Science (WoS) core.

Table 1. Research Question

No.	Research Question
RQ1	Which journal is the most significant TTO journal?
RQ2	Who are the most active and influential researchers in the TTO field?
RQ3	What kind of research topics are selected by researchers in the TTO field?
RQ4	What kind of methods and data collection techniques is the most used for TTO research?

### 2.1. The Development/Conducting Stage

At the development/conducting stage, the process carried out is a selection of digital libraries, defining keywords of title and search string, retrieving an initial list, exclusion of primary studies based on full text and making a final list of include primary studies. The process in detail can be seen in Figure 1.

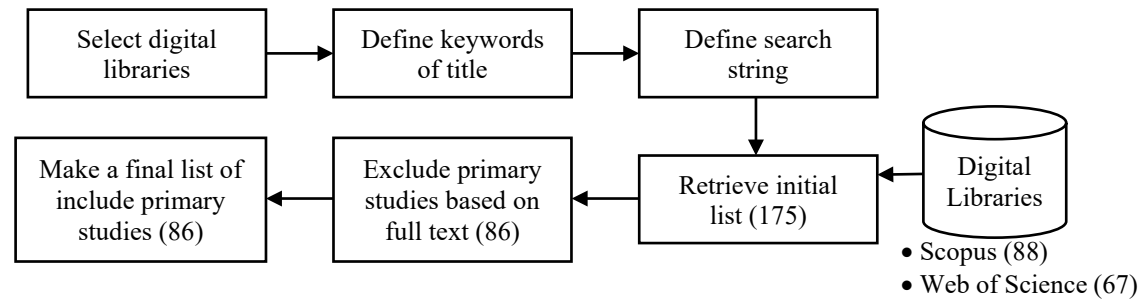


Figure 1 The flowchart of the development stage

The keywords of the title used in this literature review are based on (Brescia et al., 2016) which states that the similarities in the definitions of Knowledge Transfer Offices (KTO) is TTOs (Technology Transfer Offices), ILOs (Industrial Liaison Offices), OTLs (Offices of Technology Licensing) and UTTOs (University Technology Transfer Offices). In translating keywords, the search string is used and the number of articles found can be seen in table 2. The number of articles from two journal databases is 175 articles (88 articles from Scopus and 67 articles from Web of Science). After reading the full and in-depth text articles, there were a total of 86 articles that met the criteria.

### 2.3. The Reporting/Results

The reporting/results consist of the results from the descriptive statistics, reviews and discussions that have been carried out will be presented, shown in Sections 3 and 4. These will answer the research questions (RQ) stated in section 2.1

Table 2. Keywords used to search articles

Scopus	Web of Science
TITLE ("Techno* Transfer Office*" OR "Knowledge* Transfer Office*" OR "University-Industry Technology Transfer" OR "technology licensing office*") AND DOCTYPE (ar OR re) AND PUBYEAR > 1999 AND (LIMIT-TO ( LANGUAGE, "English" ) )	(TI=("Technol* Transfer Office*" OR "Knowledge* Transfer Office*" OR "University-Industry Technology Transfer" OR "technology licensing office*")) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article) Timespan: 2000-2020. Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI.

## 3. Descriptive Statistics

### 3.1. Number of Article and Cite Number of Article

This sub-section will answer RQ 1 and RQ 2, related to articles, journals and author used in this study will be explained statistically using Microsoft Excel. Based on eighty-six articles on TTO showing increasing trends every year. A significant increase in the number of items began in 2010 to the present. In 2017 is the year with the highest amount of TTO research. Figure 2 shows the detail number of article per year and trend from TTO research. The increasing number of article per year show that TTO has a significant impact on commercializing university research result (Fai et al., 2018).

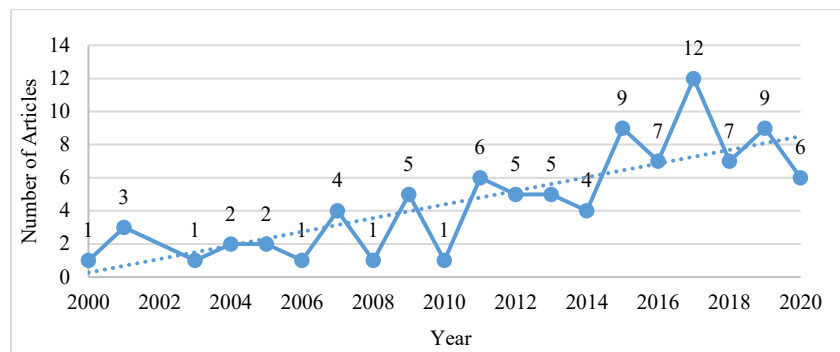


Figure 2. Number of Articles per year

The number of article databases that use in this research is fifty-three journals. Figure 3 shows fourteen journals, which have at least 2 articles related to TTO, and the most prominent place to publish articles is "Journal of Technology Transfer" where seventeen articles have been posted. Based database July 2020, the majority of the fourteen journals in the Scopus and Web of Science databases have indexes in Q1 and Q2 except for the Journal of Technology Management and Innovation in Q3 and International Journal of Innovation in WoS.

### 3.2. Co-occurrence keywords, average publication year, and Author

Figure 4 illustrates keywords from research in the field of TTO and their co-occurrence relationships. By using Vosviewer software, the results are grouped into 4 clusters and are distinguished by colour. Cluster # 1 is red, consisting of 9 items related to TTO and entrepreneurship, while Cluster # 2 is green, consisting of 9 items focusing on technology transfer and innovation. Cluster # 3 is blue, consisting of 9 items concerning university - industry and knowledge, and finally, Cluster # 4 with yellow, consisting of 4 items related to university, spin-offs and patents.

The results of more detailed information from the Vosviewer software, related to the co-occurrence keywords can be seen in table 4. There are 31 items/keywords obtained if at least 1 keyword is used at least 3 times, with the 5 keywords

most frequently used in this research are keywords related to technology transfer (Occ. = 41, TSL = 114), technology transfer offices (Occ. = 33, TSL = 62), innovation (Occ. = 14, TSL = 36), engineering education (Occ. = 10, TSL = 29), and university sector (Occ. = 9, TSL = 40). These keywords are important in determining TTO research topics and connecting key branches of science. According to the average publication year (APY), the keywords related to academic entrepreneurship (2018.33), entrepreneurial university (2017.29) and knowledge transfer (2016.00) are the keywords used in this recent research.

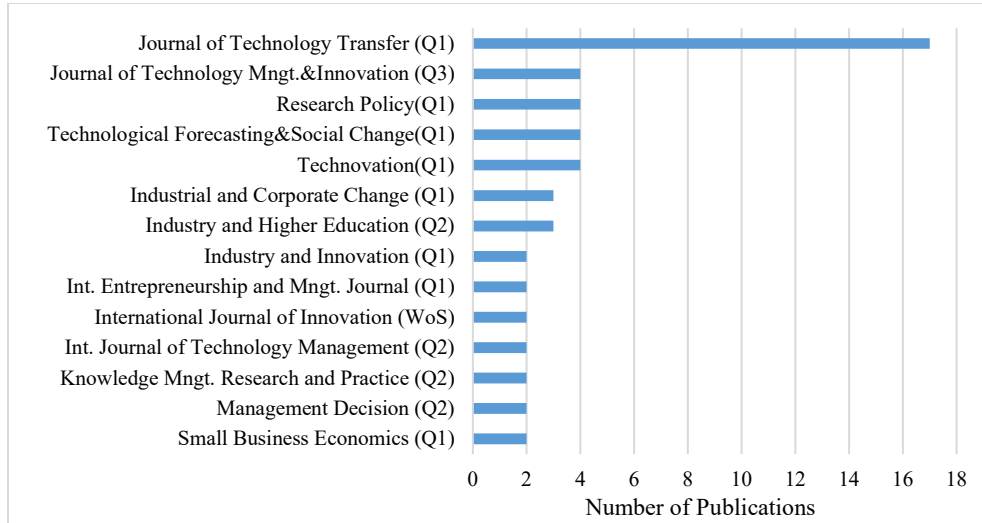


Figure 3. Cite Number of articles from each Journal

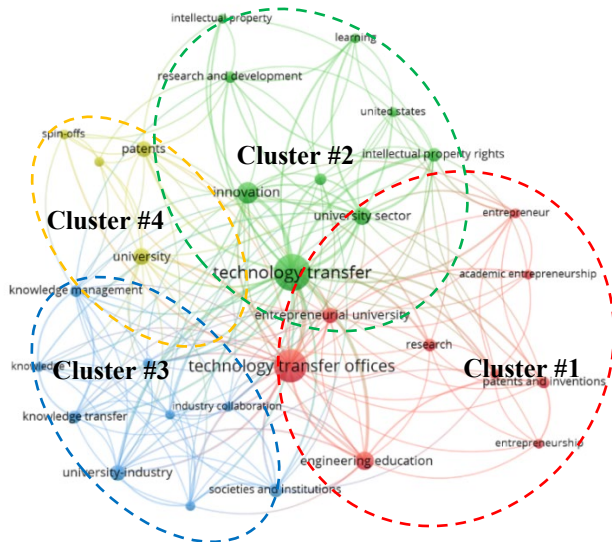


Figure 4. Network Visualization of co-occurred keywords



Figure 5. Co-authorship - Author

The authors who were active in the TTO articles between 2000 and May 2020 are shown in figure 5. They wrote at least 3 documents, either as main author or co-authors. They are Christle De Beer, Cornelius S. L. Schutte, Mike Wright, and Donald S. Siegel. In writing collaboration between Christle De Beer and Cornelius S. L. Schutte, they had written three articles together.

### 3.3. Topics of Research in TTO

This sub-section will answer RQ 3, related to topics of research in TTO. TTO has an important role as a bridge between academia and industry (Villani et al., 2017) and investors through sharing knowledge and innovation (Paolo Gubitta

et al., 2016). Many research topics are related to the field of TTO. In this review, the articles are grouped into 7 topics and 1 group others that consist of several topics, which can be seen in Table 5.

### 3.4. Methods and Data Analysis

This sub-section will answer RQ 4, related to methods and data collection techniques are the most used for TTO research. The methods from the previous study divided into a quantitative method, qualitative method and mixed-method. The most significant research method is qualitative methods (40.6%), then followed by almost the same value is mix method (39.1%) and the last is a quantitative method (20.3%).

Table 4. Summaries of co-occurrence keywords and average publication year

Cluster#1 (red) Size=71	Occ	*TLS	<sup>+</sup> APY	Cluster#2 (green) Size=87	Occ	TLS	APY
Academic entrepreneurship	3	8	<sup>x</sup> 2018.33	Higher education	4	15	2014.25
Commercialization	3	13	2013.67	Innovation	14	36	2015.71
Engineering education	10	29	2011.80	Intellectual property	3	7	2014.33
Entrepreneur	3	14	2014.33	Intellectual property right	6	25	2013.67
Entrepreneurial university	7	20	2017.29	Learning	3	12	2011.67
Entrepreneurship	3	7	2010.33	Research & development	4	17	2011.00
Patents and inventions	4	15	2013.50	Technology transfer	41	114	2013.80
Research	5	14	2011.20	United States	3	10	2010.00
Technology transfer offices	33	62	2015.52	University sector	9	40	2014.78
Cluster#3 (blue) Size=37	Occ	TLS	APY	Cluster#4(yellow)Size=21	Occ	TLS	APY
Industry collaboration	3	14	2012.33	Knowledge transfer office	3	6	2014.00
Italy	3	18	2016.33	Patents	7	15	2012.43
Knowledge	3	16	2016.00	Spin-off	3	8	2013.33
Knowledge management	4	22	2014.50	University	8	21	2014.62
Knowledge transfer	5	20	2016.40	Knowledge transfer office	3	6	2014.00
Organizational structure	3	19	2015.00				
Societies and institutions	6	20	2012.00				
University Technology transfer off	3	15	2015.67				
University-industry	7	26	2012.00				

\*TSL = Total Strength Link

<sup>+</sup>APY = average publication year <sup>x</sup>2018.33 = year 2018 & 0.33 year (April 2018)

Table 5. Topics Research in TTO

No	Topic/group	Article	Total Article
1	Role of TTO	(Abbas et al., 2018; Beltran et al., 2020; Berbegal-Mirabent et al., 2012; Bolzani et al., 2020; A Huyghe et al., 2014; Link, 2000; (Macho-Stadler et al., 2007); Martín-Rubio & Andina, 2016; Mohammed et al., 2018; Villani et al., 2017; Bigliardi et al., 2015; Chapple et al., 2005; Chugh, 2013; De Beer et al., 2017; Holgersson & Aaboen, 2019; Lafuente & Berbegal-Mirabent, 2019; Olaya-Escobar et al., 2020; Rahim et al., 2019; G Secundo et al., 2019; Giustina Secundo et al., 2017; Stephan, 2001; Ustundag et al., 2011; Weckowska, 2015)	23
2	Assessment, Measurement, and Performance of TTO	(Cartaxo & Godinho, 2017; Chapple et al., 2005; De Beer et al., 2017; Lafuente & Berbegal-Mirabent, 2019; Olaya-Escobar et al., 2020; G Secundo et al., 2019; Battaglia et al., 2017; Chakroun, 2017; Curi et al., 2015; Haney & Cohn, 2004; Link & Siegel, 2005; Marques et al., 2019; D S Siegel et al., 2003; Silva et al., 2018; Stuart J. Smyth et al., 2016; Soares et al., 2020; Stankevičienė et al., 2017; Tornatzky, 2001; Troshani et al., 2011; Tseng & Raudensky, 2014)	20
3	Organizational Structure of TTO	(Alexander & Martin, 2013; Battaglia et al., 2017; Brescia et al., 2016; Chakroun, 2017; Hülsbeck et al., 2013; Link & Siegel, 2005; Sengupta & Ray, 2017; Troshani et al., 2011; Zheng et al., 2013)	9
4	Collaboration Form	(Anderson, 2007; Blankesteijn et al., 2020; Fadeyi et al., 2019; Lissoni, 2012; Mowery & Sampat, 2004; Sellenthin, 2009; Senoo et al., 2009; Shane et al., 2015)	8
5	Model of TTO	(Andrade et al., 2017; Andreev et al., 2016; Baglieri et al., 2018; Feng et al., 2012; Olcay & Bulu, 2016; Poyago-Theotoky, 2009; Sierra et al., 2017)	7
6	Commercialization	(Bengtsson, 2017; Geoghegan et al., 2015; Hoyer & Pries, 2009; Pitsakis & Giachetti, 2019; Donald S Siegel et al., 2007; Viana et al., 2018)	6
7	Knowledge Transfer	(Alavi & Habek, 2016; Cesaroni & Piccaluga, 2016; Hidalgo & Albors, 2011; Pinto & Fernández-Esquinas, 2018; Sharifi et al., 2014; D S Siegel et al., 2001)	6
8	Others	(Closs et al., 2012; Derrick, 2015; Fai et al., 2018; Fitzgerald & Cunningham, 2016; Annelore Huyghe et al., 2016; Meysman et al., 2019; Muscio, 2010; Xu et al., 2011)	8

Tools that used to collect data from articles consist of an interview, analyzing previous data, questionnaire, survey and case study. Interview stakeholders that involve in TTO are the most significant method. This data collection method has a strong relationship with the type of research from the previous study. From previous studies, the most significant methods are qualitative, and the most significant ways are to collect the data are conduct interviews. Table 6 show research tool and article that use this data collection technique.

Table 6. Data Collection Technique

Data collection	Articles
Interview	(Alexander & Martin, 2013; Belitski et al., 2019; Derrick, 2015; Fai et al., 2018; Geoghegan et al., 2015; Haney & Cohn, 2004; Hidalgo & Albors, 2011; Hoye & Pries, 2009; A Huyghe et al., 2014; Annelore Huyghe et al., 2016; Link & Siegel, 2005; Marques et al., 2019; Mohammed et al., 2018; Mowery, 2011; Pitsakis & Giachetti, 2019; Rampersad et al., 2012; Stankevičienė et al., 2017; Troshani et al., 2011; Weckowska, 2015; Zheng et al., 2013)
Analyzing previous data/Database	(Algieri et al., 2013; Baglieri et al., 2018; Bengtsson, 2017; Berbegal-Mirabent et al., 2012; Brescia et al., 2016; Chakroun, 2017; Curi et al., 2015; Paolo Gubitta et al., 2016; Lafuente & Berbegal-Mirabent, 2019; Link, 2000; Olcay & Bulu, 2016; Pitsakis & Giachetti, 2019; D S Siegel et al., 2003; Stuart J. Smyth et al., 2016; Stephan, 2001; Viana et al., 2018; Zheng et al., 2013)
Questionnaire	(Bigliardi et al., 2015; Cartaxo & Godinho, 2017; Chapple et al., 2005; Fai et al., 2018; Hidalgo & Albors, 2011; Mascarenhas et al., 2019; Mohammed et al., 2018; Rahim et al., 2019; Giustina Secundo et al., 2017; Sellenthin, 2009; Senoo et al., 2009; Soares et al., 2020; Ustundag et al., 2011)
Survey	(Bolzani et al., 2020; Cesaroni & Piccaluga, 2016; De Beer et al., 2017; Haney & Cohn, 2004; Hidalgo & Albors, 2011; Hülsbeck et al., 2013; Annelore Huyghe et al., 2016; Meysman et al., 2019; Olaya-Escobar et al., 2020; Pinto & Fernández-Esquinas, 2018; G Secundo et al., 2019; Stuart J. Smyth et al., 2016; Xu et al., 2011; Ruoying Zhou & Tang, 2020)
Case studies	(Battaglia et al., 2017; Chugh, 2013; Closs et al., 2012; Fitzgerald & Cunningham, 2016; A Huyghe et al., 2014; Lecocq et al., 2009; Poyago-Theotoky, 2009; Sengupta & Ray, 2017; Tornatzky, 2001; Villani et al., 2017)

After knowing the most data collection technique, summary about research tools in technology transfer offices showed in table 7. From this review, it is known that the most significant method in TTO research is to make the multi-criteria and decision making (MCDM) method, multivariate analysis, followed by a regression model by looking at the relationship between the dependent and independent variables.

Table 7. Summary research tools.

Research Tools	Articles
Regression	(Fadeyi et al., 2019; Geoghegan et al., 2015; Pitsakis & Giachetti, 2019; Sellenthin, 2009; D S Siegel et al., 2003; Xu et al., 2011)
MCDM	(Chapple et al., 2005; Curi et al., 2015; Fadeyi et al., 2019; G Secundo et al., 2019; Donald S Siegel et al., 2007; Silva et al., 2018; Stankevičienė et al., 2017)
Literature review	(Fitzgerald & Cunningham, 2016; Holgersson & Aaboen, 2019; Lissoni, 2012; Sierra et al., 2017; Ustundag et al., 2011)
Multivariate analysis	(Feng et al., 2012; Fitzgerald & Cunningham, 2016; Hidalgo & Albors, 2011; Olaya-Escobar et al., 2020; Rahim et al., 2019; Sengupta & Ray, 2017; Stankevičienė et al., 2017)
Descriptive statistics	(Hülsbeck et al., 2013; Xu et al., 2011)
Design Experiment	(Shane et al., 2015)
Focus Group Discussion	(Rampersad et al., 2012; Troshani et al., 2011)
Empirical analysis	(Berbegal-Mirabent et al., 2012; Paolo Gubitta et al., 2016; Hülsbeck et al., 2013)

### 4.3. Reviews and Discussions

This study aims to review literature in TTO which identifies and analyzes the research trends, methods, and topics, and directions for future research, based on a systematic literature review. The development of research in the field of TTO published in journals has increased from year to year, and the majority are published in journals relating to technology and innovation. From articles that have been published in the journal, will result in methods, collecting data, and data analysis used and identification of TTO topics that provide opportunities for further research.

In data collection, something is interesting, that is the development of internet technology has helped accelerate this process through websites and online access. The use of online technology began in 2014, including the use of databases and annual reports from the TTO and KTO websites, verifying secondary data with data from websites, online surveys, online questionnaires, e-mail, and determining respondents obtained from the University's official website. From the results of this article, most data collection techniques are interviews and done offline. While other data collection techniques have been done online, except for case studies. There are great opportunities in the future to be done face-to-face online both in interviews and case studies. In future research, these are opportunities and challenges for online use in accelerating, simplifying, and saving the costs of research activities.

When related to the five keywords most frequently used in this research in the TTO field, those keywords are related to technology transfer, technology transfer offices, innovation, technical education, and the university sector, so this is highly correlated with the topics. Most TTO research fields have topics related to role, assessment, measurement, and performance of TTO, then followed by topics related to organizational structure, collaboration forms, models, commercialization, and knowledge transfer. Identification of TTO topics will provide opportunities for further research.

TTO topics have important opportunities to be developed, one of which is the topic of the role of TTO in the role of the process of research activities into a commercial process. The role of the TTO in the process are as facilitating the transfer of knowledge/technology from universities to industry, the commercial exploitation of research results, fostering patent and intellectual property, licensing university inventions, building legitimacy, creation of spin-offs, development of university start-ups, accommodate the specific needs of global spin-offs companies. Besides the role in the process, there are also others, such as a knowledge broker, an intermediary between suppliers of innovations and those who can potentially commercialize them, as an attraction for venture capital to fund spin-off companies, science and technology entrepreneurship education (STEE), facilitating the third mission of the university in community engagement activities, an innovation promoter in regional development, and a guideline for assessing the economic impact of universities' R&D. TTO has many roles, as already mentioned, but there is no research related to how the role of TTO in accelerating the process of academic research to the commercialization process.

In the topic of commercialization, several articles discuss commercialization strategies, 'repeat commercializes', legal patent for commercialization and the critical determinants of commercial orientation. Articles related to commercialization strategies, discussing licensing and spin-off strategy, the influence of autonomy, age, and membership into an association of technology transfer office with strategy. There are opportunities in the future related to research, how to shorten time to market and reduce investment costs in the commercialization process.

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