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Understanding Technology Transfer and Commercialization Success Factors Using Keyword-Assisted Topic Modeling

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ABSTRACT

This study investigates the success factors of technology transfer and commercialization by analyzing journal abstracts through a semi-supervised keyword topic modeling approach. Leveraging predefined topics and keywords based on prior research, it identifies key factors influencing technology transfer and commercialization within South Korea. The results highlight the persistent significance of company features, while CEO characteristics and business skills appear less impactful. Notably, collaboration factors were initially prominent but diminished over time, whereas technology and innovation features and government-led initiatives exhibited a distinctive "W"-shaped trend in importance. The findings suggest that, to bolster public technology transfer and commercialization, the South Korean government should prioritize enhancing business processes and knowledge management within public research institutes. Consistent with Chang (2022), the study calls for more qualitative improvements in patent performance, which could be achieved by fostering an environment supported by innovation-focused policies, strategic frameworks, and enhanced TTO activities. Future research is encouraged to employ validation methods, such as expert interviews, to refine topic interpretations and enhance data quality by broadening data sources.

1. Introduction

The global industrial development landscape has evolved, as intangible knowledge and innovation increasingly influence national competitiveness. In response, countries worldwide are expanding investments in research and development (R&D) (Congressional Research Service, 2020; Lee & Jo, 2018) and implementing policies to efficiently utilize the knowledge generated (Knoll, 2003; Wu et al., 2007). Hameed et al. (2018) observed that Korea is at a critical economic juncture, transitioning from a "catch-up" phase, which relied on technology adaptation, to fostering its own creativity and knowledge. Furthermore, experts are keenly observing how Korea navigates this transformation, particularly in comparison to Japan, which experienced an "economic miracle[1]" era followed by a "lost decade[2]" (Hameed et al., 2018; Zoli, 2017).

To address this transformation and mitigate the mass production of valueless patents, the Korean government has shifted its R&D focus toward an era of Research and Business Development (R&BD). This shift prioritizes enhancing the nation's technical capacity through increased R&D investment (Kim, 2001; Yang, 2011). The government has restructured the R&D ecosystem to emphasize investments that yield tangible profits and business achievements, rather than solely relying on performance indicators such as patents, publications, and the hiring of new R&D personnel. Policies and support programs now emphasize transitioning from resource expansion to a performance-oriented approach (Yang, 2011).

The enactment of the "Technology Transfer and Commercialization Promotion Act" in 2000, along with increased R&D expenditure and government support programs such as the "scale-up technology commercialization program," has stimulated patenting activities in universities at both domestic and international patent offices (Yang, 2011; Jung, 2021). However, its impact on technology transfer and commercialization activities has been minimal. Hyun et al. (2015) reported that 70% of public technologies ― innovations developed in government research institutes (GRIs) and public universities ― remain untransferred, while only 15% of the transferred technologies are successfully commercialized. Furthermore, according to the Korea Institute of Intellectual Property (KIIP) (2019), the technology transfer rate, defined as the ratio of technology transfer cases to newly developed technologies, was only 34.33% in 2019.

This study aims to identify the factors influencing the success of technology transfer and commercialization by conducting a topic modeling analysis on abstracts from prior research. The goal is to provide meaningful insights that can help South Korea and other countries enhance their technology transfer and commercialization activities.

The remainder of this study is structured as follows: Section 2 presents a literature review on South Korea's technology transfer and commercialization ecosystem, along with the identified research gaps. Section 3 outlines the research methods, including keyword-assisted topic modeling. Section 4 discusses the results of the topic modeling analysis, and Section 5 concludes with a discussion and implications.

1) The "economic miracle" is a term that describes a "period of rapid economic growth that exceeds expectations" (Business Dictionary, 2016a)

2) The "lost decade" is a term that describes the Japanese economy between the early 1990s and 2000s, in which the economic expansion came to a halt, and the real estate and the stock market crashed causing immediate debt crisis (Business Dictionary, 2016b)

2. Literature Review

2.1 Technology transfer and commercialization in South Korea

In South Korea, there are two primary types of technology transfer: (1) Private Firm-to-Private Firm transfer, referred to as Private Technology Transfer, and (2) Public Organization (University or Government Research Institute [GRI]) to Private Firm transfer, referred to as Public Technology Transfer (Park & Park, 2017). Private Technology Transfer is challenging to evaluate and track, as most private firms develop technologies for their own commercialization. Consequently, the frequency of Private Technology Transfers is low, and their success largely depends on the profitability of the developed technologies.

Conversely, Public Technology Transfer is more straightforward to track, as technologies developed by public organizations are often intended for transfer to the private sector. Park and Park (2017) also noted that while the concept of direct commercialization, such as the creation of spin-offs, is emerging in public organizations, technology transfer remains the preferred approach.

According to the Technology Transfer and Commercialization Promotion Act, technology transfer is prioritized for firms conducting production and sales activities within South Korea. The technology transfer process typically involves the firm initiating the agreement. Public research institutes (universities and GRIs) often facilitate the transfer by transferring ownership or licensing their technologies, which account for the majority of transfer cases (Park & Park, 2017).

When a technology transfer agreement is reached, the university/GRI and the firm negotiate the details of the licensing agreement. However, these agreements are subject to differing regulations on licensing and technology fee methods, governed by policies established by the Ministry of Science and ICT (MSIT) and the Ministry of Trade, Industry, and Energy (MOTIE). Following the signing of the licensing agreement, the university or GRI collaborates with its Technology Transfer Office (TTO) to provide the necessary documentation and information about the technology or patent to the receiving firm. The firm, in turn, reports on its commercialization progress and results, with the option to either terminate or extend the licensing agreement (Park & Park, 2017).

2.2 Technology transfer and commercialization policies and strategies in South Korea

In January 2000, the Technology Transfer and Commercialization Promotion Act was enacted under the jurisdiction of the Trade, Industry, Energy, SMEs, and Startups Committee. This act promotes technology transfer to the private sector and commercialization of technologies developed at public research institutes, while also supporting smooth transactions, transfers, and commercialization of technologies developed in the private sector (Lee & Kim, 2013; Park & Park, 2017; Yang, 2011).

Since the act's implementation, South Korea has established government-led technology transfer and commercialization initiatives and created various agencies and institutions (Yang, 2011). For instance, the Korea Technology Transfer Center (KTTC) was established in 2000 to advance technology transfer and commercialization activities. Although there were no recorded cases in the first year, by 2005, 256 consulting cases had been documented (Kim, 2001). The government's policies have also fostered infrastructure development for technology transfer, with university TTOs and technology trading/evaluation institutions playing central roles. These efforts have heightened interest among researchers, firms, and the public in strengthening the technology transfer ecosystem to enhance national competitiveness (Yang, 2011).

Technology transfer and commercialization policies have focused on technology transactions, assessments, and public-sector commercialization, with MOTIE playing a central role in setting policy and promotion goals. The Technology Transfer and Commercialization Promotion Plan, updated every three years under Article 5 of the act, provides a framework for these efforts (Kim & Kim, 2019). However, variations in regulations persist, such as the MSIT's guidelines for national R&D projects and MOTIE's operational guidelines for technology innovation projects (Lee & Kim, 2013).

Choi (2021) evaluated government support programs for technology transfer and commercialization in South Korea. The findings reveal that most programs focus on building the technology market and strengthening transaction capabilities. However, for successful commercialization, laboratory-developed technologies must undergo further refinement to become mature, market-ready products. This process requires significant time, effort, and funding—resources that government, corporations, universities, and research institutes are often reluctant to invest. Additionally, government funding for technology transfer and commercialization remains relatively low (1-2 billion won) compared to the resources needed for successful commercialization (Choi, 2021).

2.3 Government support to enhance technology transfer and commercialization activities in South Korea

By benchmarking foreign policies and technology commercialization organizations, South Korea has established a foundation for technology transfer and commercialization through key initiatives such as the Technology Transfer and Commercialization Promotion Act, the Technology Transfer and Commercialization Plan (TTCP), and the Special Act on Promoting Venture Companies (Han, 2018; Lee, 2013).

For instance, the Discovery of a Demanding Company to Support Technology Transfers program, managed by the Korea Institute for Advancement of Technology (KIAT), annually facilitates technology transfer by:

1. Assisting TTOs in identifying public institutions willing to transfer technologies.
2. Supporting receiving firms through funding and product development assistance.

Although participation in these programs has increased, firms have not shown significant improvements in sales, revenue, or other performance metrics (Park & Chang, 2020). Other financial support programs, such as the 2021 Excellent Technology Commercialization Support Project and the Scale-up Technology Commercialization Program, aim to assist firms in technology transfer and commercialization processes (Ministry of SMEs and Startups [MSS], 2021).

2.4 Prior research on the success factors of technology transfer and commercialization

Research on technology transfer has been conducted at multiple levels. At the national level, studies have assessed various government support programs that assist technology transfers. For instance, Park and Chang (2016) conducted an exploratory study using data from 1,222 SMEs. Woo et al. (2015) used cross-national panel data to estimate the direct and indirect impact of intellectual property rights on R&D development and industry value addition. Other studies compared technology transfer systems between countries (Schmoch et al., 1997) or focused on national policy frameworks (Bozeman, 2000).

At the industry level, some studies utilized firms as case studies to assess their technology transfer models (Amesse & Cohendet, 2001), while others evaluated different technology transfer and commercialization models for transfer leaders (Nevens, 1990a). Amadi-Echendu and Rasetlola (2011) proposed two model frameworks for technology commercialization. Kim et al. (2012) analyzed various case studies to identify the success and failure factors of commercialization efforts.

At the individual level, Perel (2007) examined how personality traits impact technology commercialization. The study used attitudes and Myers-Briggs tests to analyze 69 doctorates working in firms, exploring the role of individual attributes in the commercialization process.

Siegel et al. (2003) focused on improving the effectiveness of university-industry collaborations (UICs) by identifying factors and barriers in enhancing technology transfer. They emphasized the need for universities to adopt effective organizational and managerial practices, improve staff training in technology transfer offices (TTOs), allocate additional resources to technology transfer, encourage informal relationships and networks, and design flexible technology transfer policies to enhance outcomes.

Friedman and Silberman (2003) underscored the importance of inventors' incentives and royalties in ensuring successful university technology transfer. The authors concluded that greater rewards for faculty involvement in technology transfer, location of the university in a region with a concentration of high technology firms, a clear university mission in support of technology transfer, and the experience of the university's technology transfer office are all success factors to university technology transfer.

Other studies highlighted factors such as top management support, speed to market, effective internal communication, and product/technology advantages, all of which positively influenced the success of commercialization processes. Conversely, market uncertainty was found to hinder commercialization efforts. Additionally, the influence of factors like firm size and the intensity of market competition varied depending on cultural and regional contexts (Guerrero & Urbano, 2019).

2.5 Research gap

Despite significant efforts, South Korea continues to face low technology transfer and commercialization rates. Prior studies have primarily examined success factors using literature reviews, which face criticism for lacking rigor and methodological consistency (Snyder, 2019). To address this limitation, the present study adopts a topic modeling analysis approach, offering a broader and more holistic examination of the literature to identify success factors for technology transfer and commercialization.

3. Research Methods

3.1 Keyword assisted topic modeling

Topic modeling is widely used as an analytical tool to analyze extensive collections of documents, also known as the corpus. Various types of topic modeling methods exist, ranging from latent semantic indexing (LSI) to latent Dirichlet allocation (LDA). LSI, introduced by Deerwester et al. (1990), is considered the foundation of topic modeling but does not use probabilistic modeling (Liu et al., 2016). Hoffman (2001) advanced the field by proposing Probabilistic Latent Semantic Analysis (PLSA) based on LSI, and Blei et al. (2003) further extended this approach by introducing LDA. Since then, LDA has been widely employed in numerous studies.

Despite its popularity, LDA has significant drawbacks. It is an unsupervised analytical method, which means researchers may encounter undesirable features in the results and lack clarity on whether the model appropriately analyzes the corpus before execution (Eshima, Imai, & Sasaki, 2020). Furthermore, LDA does not label topics automatically, requiring researchers to make post-hoc interpretations of the topics and keywords generated. This subjective process introduces uncertainty and the need for external validation to ensure the topics align with the research objectives (Chang, 2022).

To address these limitations, Eshima et al. (2020) proposed Keyword-Assisted Topic Modeling (Key-ATM), a semi-supervised topic modeling method. Unlike fully unsupervised approaches like LDA, Key-ATM allows researchers to label topics and specify a small number of relevant keywords before running the analysis. This reduces the reliance on arbitrary post-hoc labeling and improves the interpretability and alignment of the topics with the research goals. Unlike earlier supervised models, which required comprehensive keyword sets and predefined concepts for every topic, Key-ATM works effectively with only a few pre-specified keywords.

One of the key improvements offered by Key-ATM is its integration of a fully Bayesian approach. This enhances model performance by incorporating prior knowledge into the topic modeling process, thereby improving the relevance and accuracy of the output topics. It builds on the semi-supervised method proposed by Jagarlamudi, Daum'e III, and Udupa (2012) but incorporates Bayesian principles to achieve greater flexibility and better results. The model is also implemented in the R package keyATM, which simplifies its use for researchers through accessible functions and built-in capabilities.

The Key-ATM package offers three main types of topic modeling. The first is the base topic modeling similar to the LDA, which is semi-supervised modeling with keywords. The second model is incorporating covariates for document-topic distribution using Dirichlet multinomial regression presented by Mimno & McCallum (2008). The third model is the dynamic model which can examine changing trends in topics over time, and is based on Hidden Markov model provided by Chib (1998).

In contrast to traditional LDA, where generating time trends for topics involves multiple data preparation steps using tools like the ggplot ( ) function in R, the Key-ATM dynamic model offers a streamlined plot_timetrend ( ) function that simplifies the visualization of time-based topic trends. This enhanced functionality makes Key-ATM more efficient and user-friendly, particularly for analyzing temporal dynamics in large datasets.

In addition, the Key-ATM represents a significant improvement over traditional topic modeling methods by addressing critical shortcomings, such as unsupervised learning's lack of guidance and post-hoc interpretative challenges. By incorporating researcher-specified keywords and a Bayesian framework, Key-ATM ensures more accurate and meaningful topic identification, making it a powerful tool for analyzing complex corpora. Key-ATM method has been applied to diverse studies by showing improved topic modeling results through domain-specific keyword guidance. Tushev et al. (2022) utilized Key-ATM to analyze public sentiment in mobile app reviews for food delivery platforms. Also, Eshima et al. (2020) used Key-ATM in social science research to uncover political trends by incorporating predefined keywords, improving interpretability.

4. Research Outcomes

4.1 Data collection and preprocessing

The study utilized Semantic Scholar as the primary database for identifying journal articles related to the success factors of technology transfer and commercialization. The search query was structured as follows:

(Technology AND ("Transfer" OR "Commercialization")) AND ("Success Factors")

This query was designed to capture a broad spectrum of studies related to technology transfer, commercialization, and the factors that contribute to their success. Initially, more than 3000 articles were identified. After filtering out articles without abstracts or open access, the dataset was narrowed down to 836 articles, which included titles, authors, abstracts, and publication years.

However, it was later discovered that some abstracts were truncated, necessitating an additional crawling process to retrieve the full text. To resolve this, the study crawled the articles' digital object identifiers (DOIs), allowing the cr_abstract ( ) function from the rcrossref package in R to extract the full abstracts. Unfortunately, not all abstracts could be retrieved using this function, so some articles were manually collected.

After gathering the abstracts, the study reviewed both the abstracts and journal titles to ensure they were relevant to the success factors of technology transfer and commercialization. After removing irrelevant or duplicate journals, the final dataset for analysis included 310 articles published between 1986 and 2022. The abstracts were then preprocessed by tokenizing them into words. During tokenization, unnecessary terms such as stop words (e.g., determiners, prepositions, conjunctions) were removed, as they are important for sentence structure but could skew the analysis during topic modeling. The study also removed numbers, punctuation, hyphens, and certain words (e.g., "abstract," "introduction," "research," "purpose," "methods," "implications"). Table 2 lists the R functions used for data preprocessing.

Table 1. Various functions for data pre-processing

Actions	Functions
Lowercasing	tolower ( )
Removing numbers	tokens (remove_numbers=TRUE, remove_punct=TRUE, remove_symbols=TRUE, split_hyphens=TRUE)
Removing Punctuation and Symbols, and split hyphens	
Removing Stop Words (Eng.)	tokens_remove (stopwords ("english"))
Removing Specific Words that may hinder the analysis	tokens_remove ( )
Removing Single Letter Words	tokens_remove ( )
Stemming	tokens_wordstem ( )

4.2 Identifying the number of topics

After preprocessing the data, the next step is to determine the number of topics, K, to be used in the topic modeling analysis. The number of topics is a critical parameter in topic modeling, as it can significantly affect the results. Zhao et al. (2015) emphasized that if K is too small, the model may fail to capture sufficient structure, whereas if K is too large, the model may become overly complex. The authors also noted that no universally accepted method exists for determining K, with various approaches such as trial and error and perplexity-based methods being commonly used.

Nikitina (2016) developed an R package called "ldatuning," which includes a topic number generation function, "FindTopicsNumber ( )," that combines four metrics to help determine the optimal number of topics. These metrics include: 1) Griffiths and Steyvers (2004), which uses the Gibbs sampler; 2) Cao et al. (2009), which evaluates topic density and average cosine similarity; 3) Arun et al. (2010), which calculates the symmetric Kullback-Leibler divergence; and 4) Deveaud et al. (2014), which uses the average Jansen-Shannon distance. The optimal number of topics is identified by minimizing the values of Cao et al. (2009) and Arun et al. (2010) and maximizing the values of Griffiths and Steyvers (2004) and Deveaud et al. (2014).

In this study, the FindTopicsNumber ( ) function was applied with topic numbers ranging from 2 to 50, incrementing by 1 (Fig. 1). The graph shows a continuous decreasing trend for Arun et al. (2010) and Deveaud et al. (2014). Griffiths and Steyvers (2004) values increased until reaching a peak at the 18th topic. The values for Cao et al. (2009) followed a more quadratic pattern. Since the optimal number of topics is identified when the values for the bottom two metrics are minimized and the values for the top two metrics are maximized, the study determined that 19 topics was the most appropriate choice, as the value for Cao et al. (2009) was noticeably smaller at 19 topics compared to 18 topics.

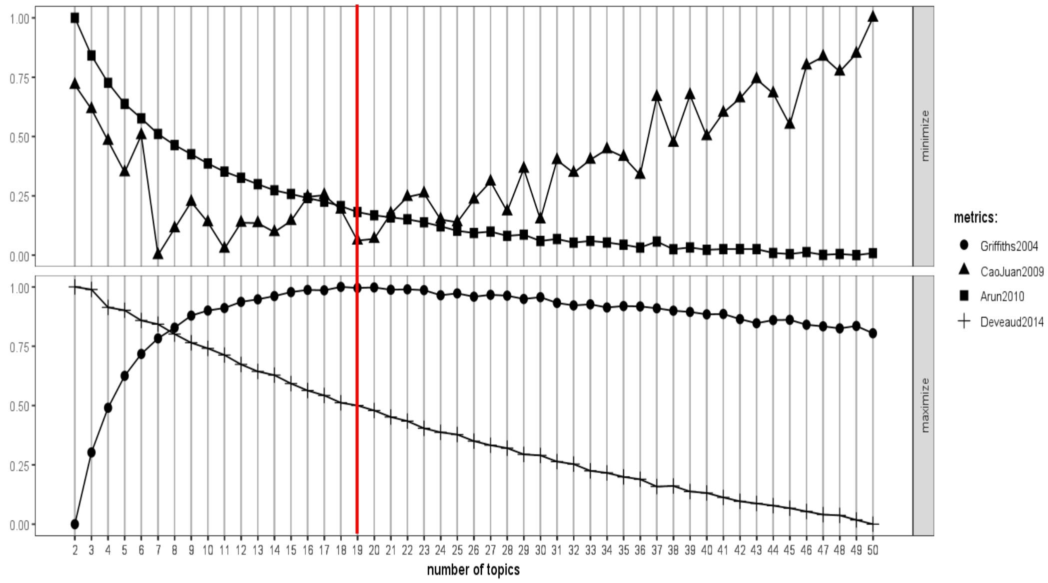

Fig. 1. Finding the optimal number of topics using FindTopicNumber ( ) function

4.3 Identifying keywords listings prior to the fitting of the model

Before conducting the keyword-assisted topic modeling, the study created a list of keywords. Chang (2022) examined factors affecting technology transfer and commercialization activities, summarizing the various factors identified in prior studies into different groups. Using these identified groups, the current study developed a list of keywords. A total of eight topics were initially identified, as shown in Table 2.

Table 2. Keyword listings identified

Topics	Keywords
Company	Firm Size; Management Support; Company Age; Return of Investment' Sales; Profit
University & GRI	TTO, Industry Motivation; Incentive Structure; Researcher Motivation
CEO	Personality; Business Skills; Marketing Experience; Industry Experience
Technology & Innovation	R&D Investment; R&D Personnel; Intellectual Property; Innovation Management; Technological Advantage; Product
Collaboration	Conglomerate; Subcontract; Inter-Organizational Communication; External Communication; Shared Vision
Market	Market Competition; Market Potential; Growth Stage; Industry Type
Location	Geography; Proximity
Government	Private Fund; Government Funding; Regulation; Policy

The study examined whether the frequency of keywords exceeded 0.1% of the corpus. Using the visualize_keywords ( ) function, the frequency of keywords by pre-determined topics was plotted, with the results shown in Fig. 2. The figure illustrates the proportion of each keyword, calculated as the number of occurrences relative to the total length of the corpus. Keywords such as innovation, management, policy, and role appeared most frequently, while geography, funds, regulations, proximity, and inter-organization were less commonly found throughout the corpus.

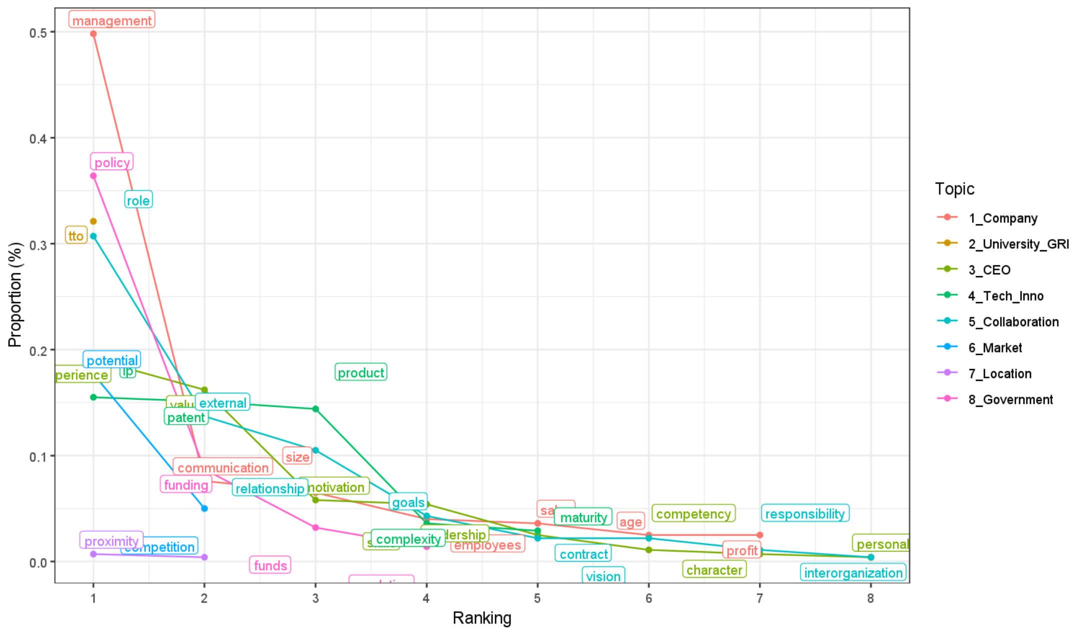

Fig. 2. Ranking proportions of keywords by topics prior to fitting

4.4. Fitting the model

The study fitted the keyword-assisted topic model with 19 topics, as identified in the previous section, using the dynamic model in the keyATM package. As a result, 8 pre-assigned topics and 10 additional topics, along with their top 10 keywords, are presented in Table 3.

Topic 1, assigned to company features, includes keywords such as process, knowledge, activities, and management. This suggests that business processes and knowledge management skills within companies may significantly impact technology transfer and commercialization activities.

Topic 2 focuses on universities and GRIs, with keywords such as technology transfer office (TTO), licensing, patents, and inventors. This can be interpreted as the TTO's ability to license patents being a crucial factor in technology transfer and commercialization for universities and GRIs.

Topic 3, related to the CEO, includes keywords like education, R&D, support, and value. This indicates that the CEO's educational background, values, and support for R&D may be key factors in technology transfer and commercialization activities.

Topic 4 centers around technology and innovation, with keywords like R&D, capacity, innovative, patent, researchers, and development. These suggest that R&D capacity, innovative researchers, and patents are central to successful technology transfer and commercialization.

Topic 5, on collaboration, includes terms like role, market, industry, and development. It is surprising that terms like communication, external, and international did not appear among the keywords. Nevertheless, the results imply that clarity of roles, collaborative marketing, and industry partnerships are critical factors in technology transfer and commercialization.

Topic 6 relates to market features, with keywords such as potential, performance, economy, and government. This suggests that the role of government in market economy, as well as market potential and performance, are key factors.

Topic 7 focuses on location, with keywords such as social, interaction, region, collaboration, and change. While geography and proximity did not appear prominently, the inclusion of region indicates that regional collaboration and interaction are crucial success factors in technology transfer and commercialization. Chang (2022) found that geographical proximity, the spatial distance between actors, is closely related to innovation (Bardon & Irena, 2012), but in this study, proximity did not emerge as a key factor.

Topic 8 is about government features, with keywords such as policy, implementation, innovation, importance, strategic, and system. This suggests that the implementation of innovation policies and the strategic role of innovation systems are vital for successful technology transfer and commercialization. Strategic innovation, as defined by Govindarajan & Trimble (2005), refers to business innovation that transforms businesses to achieve higher performance. Additionally, an innovation system, such as the National Innovation System (NIS), is crucial for the economic performance of a country.

Topics 9 to 19 were initially labeled as "others," but after reviewing the keywords, the study renamed these topics accordingly. Topic 9 is related to the BMO model, with keywords like laboratory, federal, center of excellence (COE), and points and score. The BMO model, used in various studies (Jeong, Han, & Kim, 2016; Min, Huh, & Han, 2018), appears to be an area requiring more research. Topic 10 focused on phase, criteria, specification, cost, and valuation, leading to its renaming as Analytical Hierarchy Process (AHP), a method used in studies such as Somsak & Laosirihongthong (2014) to prioritize factors in university business incubators.

Table 3. Top 10 Keywords for 19 Topics

Topics	Keywords
1: Company	process; knowledge; business; companies; activities; management; industry; different; support; effective
2: University & GRI	university; technology transfer office (TTO); licensing; academic; partnerships; years; patents; academia; around; inventors
3: CEO	education; value; R&D; institutions; support; public; data; performance; method; regression
4: Technology & Innovation	R&D; project; firms; capacity; development; government; innovative; patent; researchers; model
5: Collaboration	development; important; innovation; economic; role; market; public; industry; studies; environment

Table 3. Cont.

Topics	Keywords
6: Market	potential; performance; government; firm; university; entrepreneurship; entrepreneurial; economy; environmental; space
7: Location	university; engineering; software; social; interaction; region; collaboration; different; approaches; change
8: Government	Model; project; policy; implementation; management; innovation; importance; strategic; system; identified
9: Evaluating Model	laboratory; federal; commercial; model; ability; modern; center of excellence (COE); Bruce Merrifield-Ohe (BMO); points; score
10: Analytical Hierarchy Process (AHP)	phase; model; construction; decision; specifications; criteria; cost; valuation; technology incubator (TI); AHP
11: International Technology Transfer (ITT)	university; ITT; stage; intellectual property (IP); benefits; online; inventions; team; interests; understand
12: Intermediary	public-private partnership (PPP); investment; company; operations; private; financing; organizations; TLO; good; applied
13: Spinoff	spinoff; entrepreneurs; academic; venture; startups; ventures; entrepreneurship; incubator; enterprises; linear
14: Transferee	technology transfer (TT); process; information & communication technology (ICT); enterprise resource planning (ERP); model; top; adoption; marketing; transferee; managerial
15: Competitiveness	considered; lower; produce; ability; times; equity; define; cost; delivery; competitiveness
16: Entrepreneurial University	academic; entrepreneurial; inventions; entrepreneurship; entrepreneurs; startups; patenting; academics; performance; opportunity
17: Electronic Data Interchange (EDI)	EDI; level; dimension; approach; income; multiple; environmental; trading; power; individual
18: Policies for Small & Medium Enterprises (SMEs)	countries; policy; SMEs; institute; sector; developing; rate; firms; defense; development
19: Science and Technology Parks	least developed countries (LDCs); rapid; opportunities; engage; science & technology parks; industrialization; particular; science parks; science and technology industrial parks; gender

4.5 Validation of the model

According to Eshima et al. (2020), the keyATM package provides a function for diagnosing and exploring the fitted topic model. The authors emphasized that to validate the model using the plot_modelfit ( ) function, one should observe an increasing trend for the log-likelihood and a decreasing trend for the perplexity of the model. As shown in Fig. 3, the results of the analysis also show an increasing log-likelihood and a decreasing perplexity trend. Therefore, the study validates that the model is valid, in accordance with the criteria set by Eshima et al. (2020).

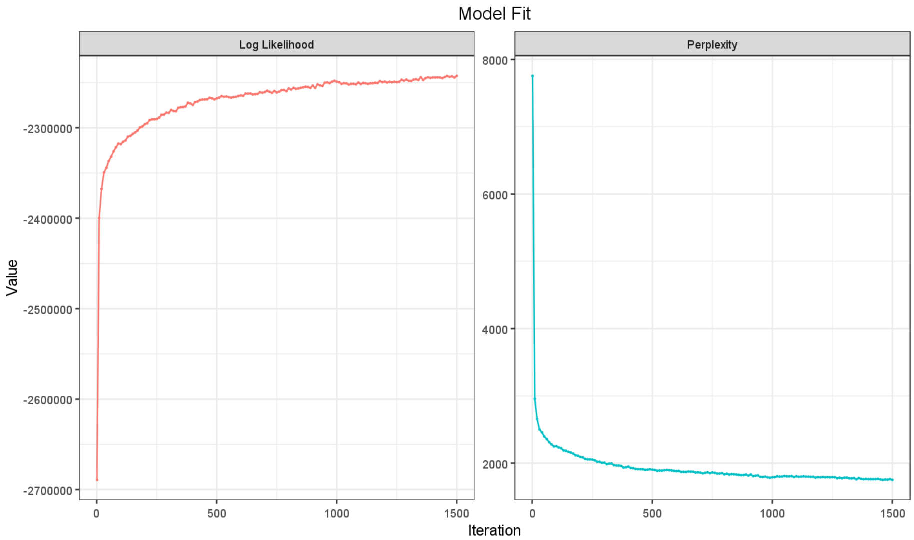

Fig. 3. Validation of the fitted model using log-likelihood and perplexity

4.6 Time trend analysis of topics

The final analysis conducted was a time trend analysis using the plot_timetrend ( ) function in the keyATM package. The time trend analysis spans from 1986, the year the first journal article related to the success factors of technology transfer and commercialization was identified, to 2022. Fig. 4 displays the results for the first 8 topics, which were pre-assigned prior to fitting the model. The graph uses time (year) on the x-axis, and the mean of theta (Θ), also known as the prevalence score, on the y-axis. The prevalence score measures how strongly a document (journal abstract) is associated with a specific topic.

Topic 1 (company features) shows a high proportion over time, with a significant dip around 2000, followed by a sharp increase in the 2000s, maintaining a steady pattern until 2022.

Topic 2 (University & GRI features), Topic 3 (CEO features), and Topic 10 (Analytical Hierarchy Process) exhibit slight increasing trends over the time period.

Topic 5 (collaboration features), Topic 7 (location features), Topic 14 (transferee features), Topic 15 (competitiveness features), Topic 17 (electronic data interchange), and Topic 18 (policies for SMEs) all show a decreasing trend. For instance, collaboration features increased up to 0.3 in 1990 but gradually declined to around 0.1 by 2022.

Topic 4 (technology & innovation features) and Topic 8 (government features) display a “W” shaped trend, where the proportion starts high, decreases, peaks in the middle, declines again, and then increases in the 2020s.

Topic 6 (market features), Topic 11 (international technology transfer features), Topic 12 (intermediary features), Topic 16 (entrepreneurial university features), and Topic 19 (science park features) show minimal proportions throughout the entire time period.

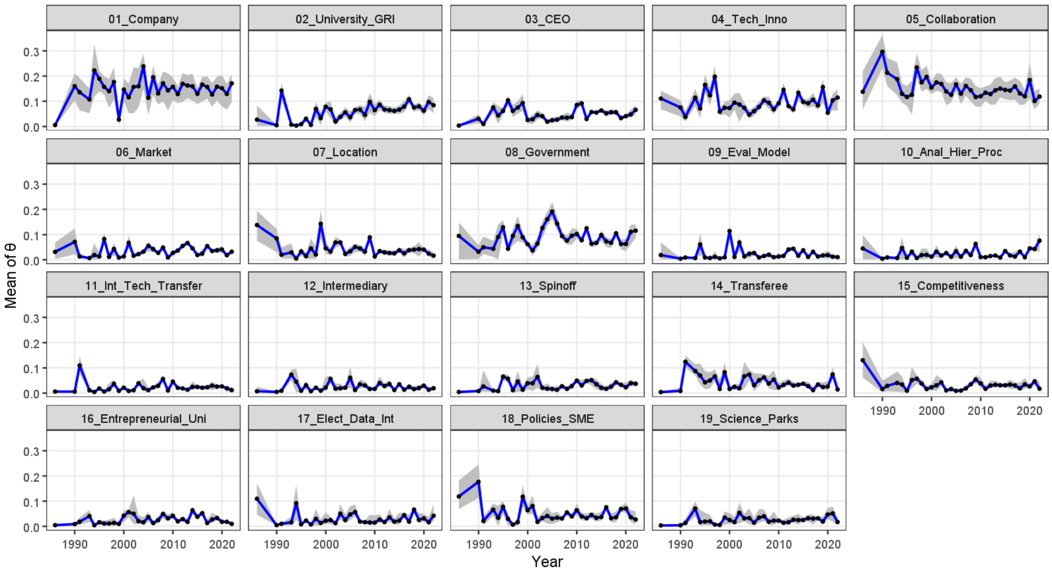

Fig. 4. Time Trend Analysis Result Using Average Prevalence Scores

5. Discussion and Conclusion

5.1 Discussion

In order to provide a more comprehensive analysis of the success factors of technology transfer and commercialization, the study examined journal abstracts using semi-supervised keyword topic modeling. By setting topics and keywords prior to fitting the model based on prior research, the study was able to identify which factors most significantly impacted technology transfer and commercialization across various journal articles. It was interesting to see how company features continuously showed high importance in technology transfer and commercialization, while CEO features, such as characteristics and business skills, were less important. Also, collaboration features, such as market and industry collaboration, showed an extremely high proportion in early publications but decreased over time. Additionally, technology and innovation features, including R&D capacity, innovative researchers, patents, and government features like innovation policies, strategic innovation, and innovation systems, demonstrated a "W" shaped trend.

Overall, the findings suggest that for South Korea to improve its public technology transfer rate and the commercialization of public technologies, the government should focus on enhancing the business process and knowledge management skills of public research institutes. Additionally, the Korean government should create an environment through innovative policies, strategies, and systems that can boost the performance of Technology Transfer Offices (TTOs), collaboration activities, and enhance firm-level innovation, such as patents. This aligns with Chang (2022), who emphasized that there is a lack of a qualitative approach in the performance of patents in South Korea.

5.2 Limitations and future research

There are several limitations to the study that could impact the generalizability and robustness of the findings:

First, regarding data collection and validation, while the study used semi-supervised keyword topic modeling, it did not validate the results using external assessment tools. Topic modeling results are open-ended and can be subject to creative interpretation, such as renaming topics based on the top keywords. To justify these interpretations, future studies should incorporate validation tools, such as focus group interviews or expert validation surveys, to provide a more holistic analysis. This would be particularly relevant to the policy recommendations in the conclusion, which suggest improvements in government efforts for technology transfer. Validating the key themes through expert input would ensure that the suggested focus areas—such as strengthening TTOs and enhancing innovation policies—are grounded in expert consensus.

Second, the study had limitations in data crawling. It relied on data from a single journal database, which may have omitted relevant journals. Since the analysis is heavily dependent on the quality and breadth of data, expanding the data collection process is crucial. A more diverse set of databases and broader access to journal articles would improve the robustness of the findings. To address this limitation and complement the study's conclusion, it is recommended that the South Korean government expand public databases and establish research hubs for technology commercialization. Such initiatives could foster more inclusive and comprehensive research outputs that reflect a broader range of factors impacting technology transfer.

Third, regarding keyword significance, although the study shows which keywords are associated with each topic, it does not precisely identify which keywords or combinations of keywords are most influential within each topic. A future avenue of research could involve using methods such as the Analytical Hierarchy Process (AHP) to prioritize specific success factors. This would provide more granular insights into the key drivers of technology transfer success and enable more targeted recommendations for policymakers and industry leaders.

Nonetheless, the study successfully examined journal abstracts from 1986 to 2022 to identify critical factors that influence the success of technology transfer and commercialization. The results also offer valuable insights into how the South Korean government can invest in enhancing its technology transfer and commercialization activities. Future research should focus on validating the findings through expert feedback, improving data collection methods, and using more precise analytical techniques to identify key success factors.

Notes

Author Contributions

Conceptualization: SD Chang, MS Park; Data collection: SD Chang; Formal Analysis: SD Chang,, MS Park; Writing-original draft: SD Chang; Writing-review&editing: SD Chang,, MS Park

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Conflicts of Interest

No author has any other conflict of interest to declare.

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