

Development and Empirical Research of Generic Technology Identification Methods: A Case Study of the Integrated Circuit Industry (Post-print)

Authors: Zheng Saishuo, Wang Xuezhao, Chen Xiaoli

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Abstract

[Purpose/Significance] To construct a generic technology identification methodology system for identifying industry generic technologies, thereby providing scientific decision-making basis for technology management, scientific research, and enterprise R&D. [Method/Process] Through conceptual analysis and characteristic judgment, fundamentality and universality are identified as the most critical features of generic technologies. Technological fundamentality is measured using centrality indicators and structural hole indicators, while universality is quantified by the number of industries covered by the technology, inter-industry technology fields, and intra-industry technology fields. The entropy weight method is utilized to assign weights to each indicator, and industry generic technology identification is performed through a four-quadrant combination analysis method. [Results/Conclusion] An empirical study on generic technology identification is conducted using the integrated circuit industry as a case example, with the feasibility and effectiveness of the method preliminarily verified through literature research.

Full Text

Construction and Empirical Study of Generic Technology Identification Methods—A Case Study of the Integrated Circuit Industry

Zheng Saishuo^{1,2}, **Wang Xuezhao**^{1,2}, **Chen Xiaoli**^{1,2} ¹ National Science Library, Chinese Academy of Sciences, Beijing 100190 ² Department of Library, Information and Archives Management, School of Economics and Management, University of Chinese Academy of Sciences, Beijing 100190

Abstract: [Purpose/Significance] This study constructs a methodological framework for identifying generic technologies within industries, providing a scientific decision-making basis for technology management, scientific research, and corporate R&D. [Method/Process] Through conceptual analysis and feature determination, the most critical characteristics of generic technology were identified as fundamentality and universality. Centrality and structure hole indices were employed to measure technological fundamentality, while the number of industries, inter-industry technology fields, and intra-industry technology fields covered by a technology were used to measure its universality. The entropy weight method was applied to assign weights to each indicator, and generic technologies were identified through four-quadrant combination analysis. [Result/Conclusion] An empirical study was conducted using the integrated circuit industry as a case example, with preliminary verification of the method's feasibility and effectiveness through literature review.

Keywords: Generic Technology Identification; Centrality; Structure Hole; Entropy Weight Method; Four-Quadrant Combination Analysis **Classification Number:** G250 **DOI:** 10.13266/j.issn.0252-3116.2021.15.015

China has attached great importance to the R&D and commercialization of generic technologies, integrating them into national development strategies. In 2016, the State Council's "13th Five-Year National Science and Technology Innovation Plan" proposed strengthening the R&D and application of key core generic technologies. In 2017, the 19th Party Congress report emphasized breakthroughs in key generic technologies, frontier leading technologies, modern engineering technologies, and disruptive technological innovations. In 2020, the Central Committee's recommendations for the 14th Five-Year Plan and long-range objectives for 2035 also mentioned improving the supply system of generic basic technologies.

Today's international technological competition environment is complex and volatile, with economic globalization facing headwinds. To enhance technological strategic risk prevention capabilities and industrial chain security, attention must be paid to generic technology innovation. As the first link in the generic technology innovation chain, generic technology identification is crucial for subsequent technology R&D and application. Effective identification of generic technologies can provide first-mover advantages in technology breakthroughs, R&D, and transfer, as well as industrial development discourse power. Against this background, this paper aims to clarify the concept of generic technology and construct a scientific and effective generic technology identification methodology to assist governments, researchers, and enterprises in strategy formulation, technology R&D, and innovation research.

1 Related Research

1.1 Research on Generic Technology Concepts

The concept of generic technology was first proposed by A. Granberg et al. in 1981, defining it as an integrated functional technology. China first mentioned the concept in the 1980s, when Yuan Shude et al. pointed out that the development strategy for mechatronics and intelligent instrumentation during the Seventh Five-Year Plan period was to develop generic technologies and basic components, emphasizing that generic technology is a fundamental technology. Although the concept has a long history, scholars have not yet reached a unified definition. Foreign scholars mainly define generic technology from an economic perspective, focusing on its role and impact in industrial development. B.C. Belanger et al., building upon Granberg's work, defined generic technology as technologies that have been or may be widely applied across many fields, with R&D outcomes that can be shared and exert profound influence on entire industries or multiple industries and enterprises. Economist G. Tassej, through long-term research on R&D policy, deepened his understanding of generic technology, considering it the first stage of technology R&D that can reduce technological risks before in-depth research. B. Jovanovic et al. viewed generic technology as a general-purpose technology that can diffuse to multiple fields or sectors, continuously improving sector efficiency, reducing costs, and driving product and process innovation across multiple sectors.

Domestic scholars have researched and defined generic technology from three perspectives: the technology itself, its application scope, and its benefit impact: (1) From the technology perspective, Xu Duanyang et al. considered generic technology as key core technologies and processes that constrain numerous technological breakthroughs, or technology clusters closely related to multiple industries, or technical standards that regulate one or more industries' development. Zhang Peng et al. noted that generic technology mainly addresses fundamental and critical problems in industrial development. (2) From the application scope perspective, Xu Duanyang et al. believed generic technology can be applied to multiple enterprises across different industries or industry clusters. Zhang Peng et al. stated that industry generic technology can be universally applied or widely applied in the future to multiple fields, with shareable R&D outcomes that profoundly impact entire industries or multiple industries and enterprises. Jiang Xian et al. considered that generic technology can be widely applied within one or multiple industries. (3) From the benefit impact perspective, Jiang Xian and Qin Xing et al. believed that generic technology R&D outcomes can bring broad economic and social benefits to enterprises and society.

1.2 Research on Generic Technology Identification Methods

As research has deepened, generic technology identification methods have continuously enriched and improved. Existing methods can be categorized by identification object as follows:

1.2.1 Expert Knowledge-Based Generic Technology Identification

Methods These methods rely on domain experts' practical experience for technical analysis. For example, the UK's national technology foresight program, initiated in 1993, established a technology foresight expert steering group to select generic technologies through technology foresight. Wei Yonglian et al. established a robust evaluation index system and employed expert scoring combined with fuzzy comprehensive evaluation to manually assess generic technology benefits. Yu Xijun identified generic technologies from a marketization perspective by analyzing market mechanisms based on industry chains, value chains, and technology chains, incorporating three types of experts: government science and technology department experts, enterprise experts, and disciplinary field experts.

Expert knowledge-based methods, while flexible and targeted, are limited by scholars' professional fields and levels, making them highly subjective and difficult to generalize to other industries. Due to limitations in expert numbers and experience, they are unsuitable for identifying generic technologies from massive datasets, and their identification effectiveness needs improvement.

1.2.2 Patent Analysis or Bibliometric-Based Generic Technology Identification

Methods These methods identify technologies through analysis of patent or literature data. For patent-based methods, R. Henderson et al. and Fan Xia et al. proposed using the number of technology fields based on IPC classification codes to measure generic technology. Zheng Yanning et al. noted that industry generic technology patents are generally distributed among highly cited patents. Chen Shuangli used the IMPORTF indicator, which measures a patent's technical impact on and importance to subsequent patents, to identify generic technology. Bibliometric-based methods are similar to patent-based methods, primarily identifying specific features of generic technology based on literature data. For example, Qin Xing noted that the number of citing disciplines can reflect the integrative nature of generic technology.

Patent analysis or bibliometric-based generic technology identification methods are more objective than expert knowledge-based methods. Due to format constraints of patents and papers, data standardization is relatively high, making data more complete and easier to extend and apply to other industries.

2 Construction of Generic Technology Identification Methods

2.1 Definition and Characteristics of Generic Technology

Through reviewing existing research on generic technology concepts, we found that: (1) scholars differ in their perspectives when defining generic technology; (2) the concept is often confused with general-purpose technology, core technology, and key technology; (3) there are significant differences in defining generic

technology's application scope. Therefore, before constructing identification methods, this study conducts conceptual discrimination and determines typical characteristics to define generic technology's connotation.

Comparative analysis reveals that, compared with general-purpose technology, U.S. scholar G. Tassef believed generic technology not only emphasizes wide application scope but also serves as a foundation for other technologies' development. Compared with core technology, generic technology is easily replicated and transplanted with broader application scope, enabling secondary development by other technologies, whereas core technology is difficult to imitate. Compared with key technology, both can enhance industrial competitiveness with certain economic benefits, but generic technology emphasizes fundamentality and can be widely applied within one or multiple industries, while key technology emphasizes "bottleneck" characteristics that can constrain other technologies' development. Therefore, compared with general-purpose, core, and key technologies, generic technology's most typical characteristic is its broad application scope while providing a foundation for subsequent technology R&D.

Regarding generic technology's application scope, some scholars believe universality refers to technology being applied across multiple departments or enterprises, while others believe it can be widely applied within or across industries. Generic technology widely applied within an industry is called intra-industry generic technology, while that applied across multiple industries is called inter-industry generic technology. Both are collectively referred to as generic technology.

Based on comprehensive analysis, fundamentality and universality are the most critical necessary characteristics of generic technology. Moreover, generic technology can be categorized as intra-industry or inter-industry based on its application scope.

2.2 Measurement of Generic Technology Characteristics

Generic technology fundamentality refers to generic technology serving as a development foundation for other technologies and holding an important position in industry fields. Centrality analysis and structure hole analysis are important social network analysis tools commonly used to measure nodes' important positions in networks. Centrality analysis measures nodes' central positions; nodes with high centrality occupy core positions in networks and can effectively control and influence other nodes' activities. By calculating network node centrality, core and peripheral nodes can be identified. Structure holes reflect nodes' control over network resources; nodes occupying structure hole positions are more likely to obtain diverse non-redundant information and thus more likely to become fundamental nodes. Therefore, this study selects degree centrality, closeness centrality, and betweenness centrality from centrality analysis, and constraint, efficiency, and effective size from structure hole analysis as measurement indicators for generic technology fundamentality.

Generic technology universality refers to technology being widely applied within or across industries. Patent citation structure can reflect the knowledge and technology upon which patents depend. Using patent citation data can demonstrate technology diffusion within or across industries, i.e., technology application universality. When a patent is cited by patents from multiple industries or technology fields, the technology it carries is more likely to diffuse to multiple industries or technology fields and be applied by them. Technologies cited by more industries or technology fields possess higher application universality and are more likely to be generic technologies. Therefore, this study selects the number of citing industries or technology fields as the measurement indicator for generic technology universality, including both inter-industry and intra-industry categories.

2.3 Comprehensive Evaluation

The entropy weight method is closely related to information entropy and can use entropy values to judge the dispersion degree of an indicator. The smaller the entropy value, the greater the indicator's dispersion, and the greater its impact (i.e., weight) on comprehensive evaluation. If all values of an indicator are equal, that indicator plays no role in comprehensive evaluation. This study applies the entropy weight method to evaluate generic technology fundamentality and universality, calculating each indicator's weight to compute comprehensive fundamentality and universality scores.

The specific implementation steps of the entropy weight method are: (1) Apply min-max standardization to fundamentality and universality measurement results, with standardized results denoted as x_{ij} , *distinguishing between positive and negative indicators during standardization*; (2) Calculate the proportion p_{ij} of the i -th indicator data in the j -th indicator; (3) Calculate the entropy $e_j = \ln(n) - 1/\sum p_{ij} \ln(p_{ij})$, where $e_j \geq 0$, and if $p_{ij} = 0$, $e_j = 0$; (4) Calculate information entropy redundancy $d_j = 1 - e_j$; (5) Calculate each indicator's weight $w_j = d_j / \sum d_j$; (6) Based on obtained weights and original scores, calculate comprehensive score $s_i = \sum w_j \cdot p_{ij}$.

2.4 Generic Technology Identification Methodology

This study uses fundamentality and universality—two key characteristics of generic technology—as entry points, combines measurement indicators and combination methods for these characteristics, and constructs a generic technology identification methodology based on technology co-occurrence networks and technology citation networks, as shown in Figure 1 [Figure 1: see original paper]. The methodology presented in Figure 1 consists of three stages: (1) calculation of comprehensive fundamentality scores; (2) calculation of comprehensive universality scores; and (3) identification of generic technologies using four-quadrant combination analysis based on fundamentality and universality scores.

2.5 Technology Fundamentality

In existing research, International Patent Classification (IPC) codes are commonly used to represent technology fields. Analyzing co-occurrence patterns among IPC codes can reveal relationships between technology fields. To describe and explore relationships among various technologies in industry fields, this study uses IPC codes and their co-occurrence patterns in patents to construct industry technology co-occurrence networks. Nodes in technology co-occurrence networks consist of IPC codes, with edge weights representing co-occurrence strength between two IPC codes.

Since IPC codes with extremely low occurrence frequencies are not highly relevant to industry fields, this study selects high-frequency IPC codes as industry technologies. Common methods for distinguishing high- and low-frequency terms include empirical judgment, Price's formula, and Zipf's law. Based on the advantages, disadvantages, and applicability of different methods, this study adopts the high/low-frequency term delineation formula (Formula (1)) proposed by J.C. Donohue based on Zipf's law:

$$I_n = \frac{-1 + \sqrt{1 + 8i}}{2}$$

where i represents the number of IPC codes appearing only once, and I_n represents the high-frequency term threshold. Using Formula (1) to determine high-frequency codes in industry patent literature, high-frequency codes serve as nodes in industry technology co-occurrence networks.

The concept of technology co-occurrence strength originates from H. Small's citation analysis theory and method. Existing standardization methods for technology co-occurrence strength mainly include Pearson correlation coefficient, Salton's cosine coefficient, and Jaccard coefficient. L. Leydesdorff noted in his research that Jaccard coefficient calculation only focuses on set intersections rather than data distribution, avoiding pseudo-correlation problems in co-occurrence matrices and being more suitable for standardizing co-occurrence frequencies. This study also selects Jaccard coefficient to calculate co-occurrence strength between IPC codes, as shown in Formula (2):

$$S(i, j) = \frac{coo(i, j)}{occ(i) + occ(j) - coo(i, j)}$$

In Formula (2), $S(i, j)$ represents the co-occurrence strength between codes i and j , $coo(i, j)$ represents their co-occurrence frequency in selected patent data, and $occ(i)$ and $occ(j)$ represent their individual occurrence frequencies. Based on IPC distribution in industry patents and the above co-occurrence strength calculation method, industry technology co-occurrence networks can be obtained.

Using the established industry technology co-occurrence networks and calculation formulas for degree centrality, closeness centrality, betweenness centrality,

constraint, efficiency, and effective size, measurement results for technology fundamentality indicators can be obtained. Based on these results, the entropy weight method can calculate each technology's comprehensive fundamentality score.

2.6 Technology Universality

2.6.1 Inter-Industry Universality To demonstrate industry technology universality across industries, this study counts the number of industries and inter-industry technology fields covered by technology. Specific steps are: (1) Construct an industry technology-patent citation network based on IPC and patent citation data; (2) Build mapping relationships from citing patents to industries and inter-industry technology fields based on patents and their primary IPC codes, combined with WIPO's IPC-industry/inter-industry technology field correspondence table; (3) Complete IPC-to-industry/inter-industry technology field mapping based on the industry technology-patent citation network and citing patent-to-industry/inter-industry technology field mapping relationships; (4) Count the number of industries/inter-industry technology fields to which IPC codes diffuse. The specific technology-industry/inter-industry technology field mapping logic is shown in Figure 2 [Figure 2: see original paper].

2.6.2 Intra-Industry Universality To count the number of intra-industry technology fields covered by technology, this study first clarifies intra-industry technology fields using the LDA topic extraction model. Specific steps to demonstrate technology universality within the industry are: (1) Use intra-industry patent data as corpus and LDA to extract intra-industry technology fields; (2) Establish mapping relationships from patents to intra-industry technology fields based on probability models; (3) Complete IPC-to-intra-industry technology field mapping based on IPC-patent correspondence and patent-intra-industry technology field mapping relationships; (4) Count the number of intra-industry technology fields to which IPC codes diffuse. To obtain more accurate industry technology field extraction results, topic coherence is used to determine the number of topics. The specific technology-intra-industry technology field mapping logic is shown in Figure 3 [Figure 3: see original paper].

Based on the mapping logics shown in Figures 2 and 3, the number of industries/inter-industry technology fields/intra-industry technology fields covered by technology can be obtained, enabling measurement of technology universality. Based on these results, the entropy weight method can calculate each technology's comprehensive universality score.

2.7 Four-Quadrant Combination Analysis

Based on comprehensive fundamentality and universality scores, four-quadrant combination analysis is used for generic technology identification. In the four-quadrant combination analysis chart shown in Figure 4 [Figure 4: see original paper], the X-axis represents comprehensive fundamentality score, the Y-axis

represents comprehensive universality score, and bubbles representing technologies' relative positions in the four quadrants correspond to technology categories with specific characteristics. Technologies in Quadrant I (T1) possess both important fundamental positions and broad application scope, making them more likely to be generic technologies worthy of focused attention and forward-looking deployment. Technologies in Quadrant II (T2) have certain application universality but insufficient fundamentality, making them more likely to be general-purpose technologies. Technologies in Quadrant III (T3) lack both fundamentality and broad application, making them more likely to be general technologies. Technologies in Quadrant IV (T4) are very fundamental but not widely applied, making them more likely to be specialized fundamental technologies.

3 Empirical Analysis of Generic Technology Identification

To verify the operability and effectiveness of the constructed generic technology identification method, an empirical analysis was conducted using the integrated circuit industry as an example. The integrated circuit industry is the core of the information technology industry, a strategic industry supporting economic and social development and national security, and a key force leading a new round of scientific and industrial revolutions. Due to the technological complexity, highly specialized industry structure, and high technological barriers in the integrated circuit field, many core patents are concentrated in integrated circuit powerhouses or giant enterprises.

3.1 Data Sources and Processing

The Derwent Innovation platform was selected as the data source. Patents with Derwent Manual Code U13 in the integrated circuit industry were retrieved, yielding 32,859 granted patents. After data cleaning, 31,857 patents remained. This study uses IPC codes to represent technology fields. Based on cleaned patent data, IPC occurrence frequencies in the integrated circuit field were counted. Using Donohue's model, the high-frequency code threshold was determined to be 12, yielding 91 main technology fields in the integrated circuit industry. The correspondence between main IPC codes and their meanings is shown in Table 1 .

Using IPC co-occurrence counts and Jaccard coefficient formula, the integrated circuit industry's main technology co-occurrence matrix was constructed. Ucinet was used to calculate centrality and structure hole indices for each IPC subclass in the integrated circuit field. The calculation results are shown in Table 2 .

3.2 Calculation of Integrated Circuit Industry Technology Fundamentality Scores

After normalizing the results presented in Table 2, the entropy weight method was used to calculate weights for each fundamentality measurement indicator,

as shown in Table 3 .

Based on indicator measurement results and weights, final comprehensive fundamentality scores were calculated, as shown in Table 4 .

3.3 Calculation of Integrated Circuit Industry Technology Universality Scores

Python programming was used to obtain 31,692 patent literature data corresponding to the 91 main IPC codes. Using citing patents' publication numbers, all citing patents for these documents were retrieved, yielding 400,337 new citing patent documents. Based on citation relationships between integrated circuit industry patents and citing patents, a citation network was constructed to reveal development and diffusion trends of integrated circuit industry technologies.

3.3.1 Inter-Industry Universality of Integrated Circuit Technologies

Using patent citation relationships and WIPO's IPC-industry/inter-industry technology correspondence table, connections between industry technology and inter-industry technology fields were established. WIPO's technology correspondence table divides technologies into 5 industries and 35 inter-industry technology fields, as shown in Table 5 .

The inter-industry application universality results for integrated circuit industry technologies are shown in Table 6 , which presents the number of industries or inter-industry technology fields to which each IPC diffuses. IPC codes covering more industries or inter-industry technology fields have higher inter-industry application universality.

3.3.2 Intra-Industry Universality of Integrated Circuit Technologies

To demonstrate intra-industry application universality, the LDA topic model was first used to extract technology fields within the integrated circuit industry. To ensure accurate technical topic extraction results, the number of topics needed to be determined. This study used topic coherence for extraction, and based on the relationship between topic coherence and topic number shown in Figure 5 [Figure 5: see original paper], the optimal number of technical topics was determined to be 7.

The specific extraction results for integrated circuit industry technology topics (intra-industry technology fields) are shown in Table 7 .

The seven extracted technology topics serve as intra-industry technology fields. Based on the mapping logic shown in Figure 3, the intra-industry application universality of integrated circuit industry technologies was obtained (Table 8), where IPC codes covering more intra-industry technology fields have higher intra-industry application universality.

3.3.3 Calculation of Comprehensive Universality Scores

Combining the numbers of industries, inter-industry technology fields, and intra-industry

technology fields covered by integrated circuit industry technologies, the entropy weight method was used to calculate indicator weights, as shown in Table 9 .

Based on indicator measurement results and weights, comprehensive universality scores were calculated, as shown in Table 10 .

3.4 Generic Technology Identification Results for Integrated Circuit Industry

Combining comprehensive fundamentality and universality scores, a four-quadrant combination analysis chart for integrated circuit industry technologies was plotted, as shown in Figure 6 [Figure 6: see original paper].

Figure 6 shows that 26 technologies with IPC codes including H01L, H04N, G06F, H03K, G06K, G02B, and G11C are located in Quadrant I, mainly including semiconductor devices, image communication, electric digital data processing, pulse technology, data recognition/representation, record carriers, optical elements, systems or instruments, and static memory. These technologies possess both strong fundamentality and broad application universality, making them generic technologies worthy of focused attention and forward-looking deployment. Nineteen technologies with IPC codes including H01S, H02M, G05B, and H03L are located in Quadrant II, mainly including devices using stimulated emission, equipment for DC/AC conversion and control/regulation for use with power supplies, general control or regulation systems and their functional units, and monitoring/testing devices for such systems, as well as automatic control, starting, synchronization, or stabilization of electronic oscillators or pulse generators. These technologies have strong application universality but weak fundamentality, making them general-purpose technologies. Forty technologies with IPC codes including H05B, C03C, and B64C are located in Quadrant III, mainly including electric heating/lighting, chemical composition of glass/glazes/enamel glazes, surface treatment of glass, surface treatment of fibers or filaments made from glass, minerals, or slag, and glass joining. These technologies have weak fundamentality and universality, making them general technologies. Six technologies with IPC codes including G06T, G01S, and B60R are located in Quadrant IV, mainly including general image data processing or generation, radio direction-finding and navigation, radio wave distance or speed measurement, positioning or presence detection using radio wave reflection or re-radiation, similar devices using other waves, and vehicle parts or components. These technologies have weak application universality but strong fundamentality, making them specialized fundamental technologies.

3.5 Validation of Integrated Circuit Generic Technology Identification Results

To verify the rationality of generic technology identification results in the integrated circuit field, literature-based validation was conducted using technologies with IPC codes H01L, H04N, and G06F, which are more likely to be generic

technologies both across and within industries. Analysis of institutional developments such as the Sichuan Power Semiconductor Technology Engineering Research Center, Hunan Power Semiconductor Device and Application Innovation Center, and State Key Laboratory of New Power Semiconductor Devices shows that power semiconductor devices (IPC: H01L) are recognized generic technologies. Jiang Zhanhong of South China University of Technology, by processing patented technologies of enterprises winning national science and technology progress awards across industries, also identified image communication technology (IPC: H04N) and electric digital data processing technology (IPC: G06F) as prominent industry generic technologies. These three cases demonstrate that technologies corresponding to H01L, H04N, and G06F being generic technologies is reasonable, providing preliminary proof of the proposed method's validity.

Conclusion

Based on existing research, this study determined through conceptual discrimination and feature judgment that the most critical characteristics of generic technology are fundamentality and universality. Using patent literature data to reflect actual technology application across and within industries, a generic technology identification methodology was constructed to assist governments, researchers, and enterprises in strategy formulation, technology R&D, and innovation research for generic technology breakthroughs. An empirical study using the integrated circuit industry preliminarily proved the method's feasibility and effectiveness.

The proposed generic technology identification method uses patent literature as analysis objects. Considering different definitions of generic technology application universality by researchers, it comprehensively examines both intra-industry and inter-industry application situations. The method not only has easily accessible data and an understandable implementation process but also provides new solutions for generic technology identification, offering certain universality and innovation. However, improvements remain possible: (1) The method uses high-frequency IPC codes to represent industry main technologies; future research can apply NLP methods to mine more refined technology fields. (2) Patent citations have time lags, making generic technology identification insufficiently forward-looking; future research can use time window partitioning or other methods to mitigate citation lag effects. (3) This study uses WIPO's technology correspondence table for technology-industry mapping; future research can apply text mining methods to deeply analyze technology-industry relationships to improve identification accuracy.

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paper revision; Chen Xiaoli: Research discussion and revision.

Abstract: [Purpose/significance] This paper constructs a new method to identify the generic technology of the industry. It provides scientific decision-making basis for science and technology management, scientific research and enterprise R&D. [Method/process] Through concept discrimination and feature judgment, the most important characteristics of generic technology were determined to be fundamentality and universality. The centrality index and structure hole index were used to measure the fundamentality of technology. The count of technology covering industries, inter-industry technology fields and intra-industry technology fields were used to measure the universality of technology. Entropy weight method was used to give weight to each index, combined with four quadrant analysis method to identify industry generic technology. [Result/conclusion] Taking the integrated circuit industry as an empirical study example, the feasibility and effectiveness of the method are preliminarily verified by literature research.

Keywords: generic technology identification; centrality; structure hole; entropy weight method; Four-quadrant combination analysis

Note: Figure translations are in progress. See original paper for figures.

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