Identification and Analysis of Innovation Value Stages in Research Fronts and follow-up studies

Research Fronts are often recognized as the most promising emerging research areas or research topics in a period, which have been paid much attention by research funding departments, research managers and researchers. The question "What innovations are being addressed in research fronts and follow-up studies?" is one of the concerns of research fronts users.

The expression of "innovation value stage" is considered as a staged division and classification of the value and function of basic scientific research in the process of knowledge innovation. It can further expand the bibliometric analysis from grammatical and semantic to pragmatic. It can not only enrich the measurement method system, reveal the law of scientific research value, but also judge the development trend of the discipline from the perspective of value and find out the breakthrough point of scientific innovation. It is also possible to conduct more direct and accurate scientific evaluation of researchers, groups and journals from the perspective of substantial value contribution, which is a value-added process for information, belonging to the ΔI part of the Brooks knowledge equation.

This study identified and analyzed the innovation value stages of research fronts and follow-up studies using ESI Research Fronts' core papers, citing papers and core authors' follow-up research papers, including the steps of the indexing of innovation value stage, the proposal of indexes of innovation value stage, the judgment of innovation value stage, the analysis of innovation value stage, the analysis of the stage of innovation value of the research groups, and the identification of the themes of innovation value stages.(Fig 1).
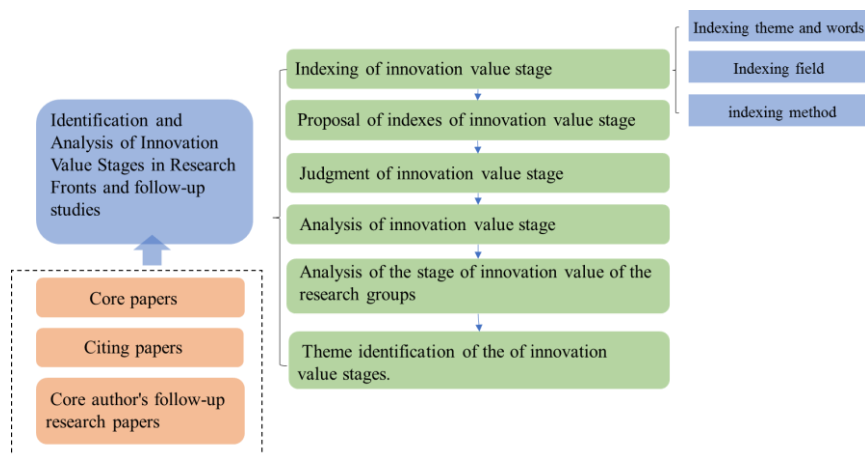

Figure1 The methodology system of this study

The innovation value stage indexing theme and words are determined by literature research and expert consultation. The innovation value stage is indexed from the three

structural fields of title, abstract and keyword. The indexing method adopts automatic word-indexing. The innovation value stage indexes are proposed, which the scores are scored according to the position of the indexing words (keyword 4 points, title 2 points, summary 1 point), and the scores of each value stage of each paper are calculated separately, finally, the value stage which has the maximum value is taken as the value stage of the paper. The analysis of the innovation value stages is carried out from the perspective of the distribution of the value stage and the annual development trend, the distribution of the value stage numbers and the annual development trend, in order to comprehensively perceive the research fronts and the innovation problems being solved. The value stages are tried to measure the scientific research of research subjects, as supplement to the measure method of paper numbers. The themes of innovation value stages are identified by following steps: extracting sentences where the indexed words are located in the abstract, natural language processing, phrase cleaning, expert interpretation.

And the corresponding empirical research is carried out with the research front of "$CH_3NH_3PbI_3$ perovskite solar cells and inorganic hole transport materials". In the empirical research, "efficiency, stability, reproducibility, manufacturability" are determined as the value stage indexing themes. The value stage analysis of the core paper, the citing paper and the author's follow-up research papers reveals that the main value stage of the core paper is efficiency, the citing paper and the authors' follow-up research paper are still focusing on efficiency, but the research value dimension is expanding, whether it is the overall perspective or the research dimension of a single paper, the research is oriented towards the comprehensive application of stability, reproducibility and manufacturability. The research on the value stage of research groups find that the analysis of the value stage can more clearly see the status of the research groups. By the method of theme identification, the main research materials, processes and corresponding index measurement techniques of the four value stages can be selected, which are different from the traditional text mining clustering based on title, keyword, abstract and full text, the corresponding topic features of the value stage are revealed relevantly; at the same time, the efficiency value of the efficiency value stage was extracted, and the research on efficiency was found to increase year by year.

Finally, the effectiveness of the research method system and the reliability of the empirical results were verified by expert consultation.