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Introspection of Case Studies: Toward an Interdisciplinary Philosophy of Science

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Abstract: *The case study method, originally developed for legal research and university teaching, was designed to enhance educational experiences and bridge the gap between academic theory and industry practice. Since Thomas Kuhn's influential work, scholars in the field of philosophy of science have begun incorporating historical events into philosophical discussions, extending their inquiries to include history and sociology. This approach facilitates a deeper understanding of the complexities of science and its real-world implications. Although the case study method faces challenges related to the universality of its theoretical applications, it offers significant advantages by aligning closely with practical realities. This method enables a move beyond the confines of logical positivism and abstract philosophical doctrines, engaging directly with real-world issues and providing flexible, realistic, and enlightening insights. Furthermore, as the scope of philosophy of science expands and its interdisciplinary interactions deepen, the case study approach fosters collaboration across sociology, history, and philosophy, promoting mutual development across these disciplines.*

Keywords: *Case study method; Philosophy of science; Universality; Interdisciplinary*

1. Introduction

The case study or case study method refers to the researcher's factual recording of an event that has occurred and studying it, that is, analyzing, evaluating, comparing, etc. As a research method and perspective, the case study method is commonly used in research in various fields of academia, including the philosophy of science. The philosophy of science, which takes science as its object of study, has shifted from logical positivism to Karl Popper's critical rationalism to historicism after Kuhn added specific historical facts as cases to his study. Since then, the philosophy of the scientific community has turned its attention beyond abstract scientific theories, and the case study method has been widely used with regard to specific aspects of the historical context and society in which scientific knowledge is produced. The case study as a method of philosophy of science research has achieved significant results, and the case study of this research method, the philosophical basis of the research method is still not clarified, the scope of application of the case study, and the use of the rules have not been determined. This makes it easy to question the legitimacy of case studies and the reliability of conclusions drawn from their use. This paper aims to sort out the origins of case studies and discuss the problems and discussions arising from the application of case studies in the philosophy of science, and finally clarify the legitimacy and necessity of using the case study method in the philosophy of science.

2. Case study and its origin

The case study method originated in law schools as a means to analyze and interpret real court judgments, thereby facilitating subsequent legal practice and research in academic settings. Harvard Law School officially adopted case-based teaching in 1921 and vigorously promoted it during the 1940s [5]. Influenced by this model, some U.S. business schools further developed case-based teaching and case study research into standalone methods that became primary teaching and research tools[7]. This approach was particularly valued for guiding students who lacked practical experience and struggled to bridge the gap between theory and practice. It not only engaged students' cognitive interests but also made a lasting impact through the retelling of cases[5]. Drawn from practical industry work, case studies were also seen as a means to deepen students' understanding of the industries they would later join, thus easing cognitive barriers and shortening the adaptation period required for

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real-world professional activities[7].

Case-based teaching and case study boast several advantages, underpinned by the philosophical and theoretical foundations of the pragmatic system that originated in the United States. However, as Li (2007) highlighted, several philosophical issues remain unresolved. First, there is a concern that the intentional selection and use of specific cases by learners might represent a disguised form of rote learning, potentially influencing the subjective and objective differentiation in learning outcomes. Second, the practicality of case teaching in research and discussion may impact the reliability of conclusions drawn from case studies. Third, there is a question of whether the case study method overly amplifies the interpretability of its research cases in deductive and inductive reasoning and theories. Li (2007) noted that the case analysis method, which evolved from case-based teaching, posits that "cognition is manifested by feelings" and "impressions are a reflection of previous experience." While this method benefits from cognitivism, it also harbors anti-rational and non-value-oriented tendencies typical of narratology. Moreover, a contradiction exists between the constructivist approach and the relatively fixed and stable requirements of knowledge systems that result from empirical trial and error. Although the case analysis method offers unique advantages, its philosophical underpinnings require further exploration and discussion.

3. Case study method in the philosophy of science

Since the publication of Thomas Kuhn's *The Structure of Scientific Revolutions* in 1962, the study of science is no longer limited to the field of philosophy, achieving the integration of the history of science and philosophy of science, and providing novel and powerful answers to questions such as the philosophical foundation of science. The field of philosophy of science has since completed its turn, with research themes and concepts that are significantly different from previous generations. This turn has provided novel and powerful insights into questions such as the philosophical foundations of science. History and practice, namely cases discussed in the philosophy of science, have become an indispensable part of the philosophy of science studies. From purely theoretical research, the philosophy of science shifted its focus initiated by Kuhn, was detached from history, and had questionable practicality compared with its previous research findings. The academic community recognizes Kuhn's contributions, and many successors have also followed Kuhn's research methods and topics. However, Kuhn made suggestions and regulations on how to introduce historical case studies into philosophical research. And soon, the historical and philosophical communities realized that this was an exceptionally 'expedient wedding' [3]. Pinnick and Gale (2000) argued that there is a "paradox" in the combination of history and philosophy, namely, "the better the history, the worse the philosophy" (p.109). Philosophers who are committed to developing a historically advanced philosophy of science use case study methods to conduct philosophical thinking based on case studies, but the universality and normativity of theories and the problem of falling into narrative traps remain unresolved [9]. Some philosophers of science even challenge the overall scientificity of the historical community. Hempel believes that historians should reject overly narrative "explanations" and instead support a more scientific and universal "covering law model" explanation [8]. The core idea of this model is that if history is to become cognitive knowledge, it must conform to the interpretive standards provided by natural sciences. Hempel's demands are unique, as he attempts to align the interpretive standards of history with those of natural sciences. However, historians almost unanimously oppose the coverage of legal models, believing that such models are too simplistic and fail to fully capture the complexity and diversity of history [1]. There has been no further discussion on whether the introduction of historical cases in the philosophy of science and the challenges it poses require a scientific approach to history.

Pitt (2001) also proposed the dilemma of case study in the field of philosophy of science: "On the one hand, if the case is selected because it exemplifies the philosophical point, then it is not clear that the historical data has been manipulated to fit the point[10]. On the other hand, if one starts with a case study, it is not clear where to go from there---for it is unreasonable to generalize from one case or even two or three." (p.373) Applying the case study method in the field of philosophy of science, if one starts from a certain theory then it is likely to be trapped in a narrative trap, issues similar to the theory of observational infiltration have not been resolved, either. If one starts with actual cases, one needs to further determine what theories to introduce to analyze the cases and how to conduct specific research, which is also full of uncertainty and doubt. Similar to the discussion starting from the case teaching method, issues arising from the case study method such as narrative traps and the theoretical universality problem have also been widely discussed in the field of philosophy of science.

Some scholars have also responded to discussions on case study methods. Burian (2001) directly

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responded to Pitt's questions. Firstly, Burian defined the connotation of the concept of case study that he was discussing[2]. He believes that case studies do not focus on the work of scientists on a specific topic within a limited time frame, but rather on the general understanding of the focal issues addressed by the case study, in which he differs from Pitt. Based on this understanding of the case study, Burian believes it will not fall into Pitt's Heracleitiean dilemma unless flawed assumptions about science are accepted or the correct use of case study methods is misunderstood. In the philosophy of science, science is not an object and cannot be discussed using abstract principles and isolated cases. To understand a particular scientific event, close attention must be paid to its historical background, particularly the special social context in which scientific research is conducted. Therefore, case studies used in the philosophy of science should be grouped. The dilemma of case studies does not exist: if starting from or based on theory or the researcher's assumptions, as long as the case study follows real history, regardless of whether the initial assumptions are overturned or not after repeated factual arguments, the research conclusions are credible.

At the same time, case studies will not lose the universality of their research conclusions because of the specificity of one or a few histories or events they select, and even pursuing complete universality itself is wrong. Science has no essence, and it is futile to search for unified methodological rules and philosophical principles in science. Burian (2001) believes that we can only and must study and strive to find effective but limited generalizations and conclusions in specific cases. In relation to Kuhn's example, Burian (2001) argues against Pitt's assertion that the selection and examination of facts in case studies are neither completely independent of theory nor wholly correct. Burian (2001) emphasizes that while controversies exist in Kuhn's perspective as extreme-paradigm controversies, we have developed methods to conduct research and reach conclusions in a non-controversial manner. Burian (2001) further concludes that the recent shift in philosophy has led to a focus on practical considerations for optimizing empirical knowledge in specific real-life contexts, as opposed to pursuing universality[2]. This shift has also influenced the philosophy of science and history to move towards practical applications. Additionally, it opens up the possibility of developing a philosophy of science that fully acknowledges fallibility, thereby revealing the intricate and non-inevitable relationship between theory and experimentation in scientific practice. Case studies are invaluable for delving into the key issues and debates within the academic community, offering insights into scientific practices through the lens of the history and philosophy of science.

Yuan and Tong (2021) discussed the use of case study methods in the field of philosophy of science, focusing on the historical shift initiated by Kuhn in the philosophy of science and the use of case studies to illustrate and test the scientific development model[13]. They believe that Kuhn's Structure of Scientific Revolution proposed the concepts of "paradigm" and "scientific community", leading to two directions of research in the philosophy of science. The concept of paradigm leads to philosophical thinking, while the concept of scientific community leads to sociological examination. The combination of these two concepts provides more of a philosophical sociological link rather than a philosophical historical link. The "historical turn" led by Kuhn has prompted philosophers of science to pay more attention to the study of scientific discovery cases. However, Kuhn’s connection between philosophical and sociological thinking is not the history of science or the philosophy of science. Kuhn's case study method lacks solid support from history and has not undergone rigorous philosophical reflection. Kuhn's approach to handling historical cases inherits from Koyre's, selecting cases of similar scientific ideas, concepts, and scientific communities at different specific historical nodes, which is a case study method that prioritizes synchronic analysis [6]. After Kuhn, Hacking also focused on historical cases in the field of the philosophy of science and used another method of selecting cases. Hacking, under the banner of "New Experimentalism", focuses on the study of experimental styles and absorbs the research results of the Oxford historian of science, Crombie, which have long-term historical characteristics. It is a case study method that prioritizes diachronic analysis [4]. Yuan and Tong (2021) believe that the historical case study model that prioritizes synchronic analysis leads to the theory of historical uniqueness, which does not help reason to play a directional role in long-term history[13]. On the other hand, the historical study that emphasizes the priority of diachronic analysis can introduce the time factor into scientific philosophical thinking. By combining synchronic analysis and diachronic analysis, case studies in scientific philosophy can solve the circular argumentation between theory and experience, and the one-sided propositional logical analysis model of logical empiricism without time structure, helping scientific philosophy and scientific history research to reach a balance point.

In their discussion of the philosophical foundation of case studies, You and Chen (2023) focus on a specific approach to case studies—case-oriented research —and compare it with variable-oriented research in the context of empirical research[12]. By explaining the main analytical path of case-oriented

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research, they demonstrate that case-oriented research is a combination of theoretical thinking, research design, and various analytical techniques. Regarding mechanism verification and theoretical development, case studies have unique advantages over quantitative research analysis paths. The case-oriented research they discussed specifically refers to a methodological system that uses any of these three methods: cross-case comparative research, in-case analysis to explore sufficient and necessary conditions or exploration of causal mechanisms. It mainly includes in-case causal analysis with theoretical construction and causal inference as the goal, case comparative research, and qualitative comparative analysis. It is a research method centered on comparative methods. You and Chen (2023) traced the debate between case-oriented and variable-oriented research methods to the political science survey database in the 1970s[12]. At that time, the development and application of complex statistical models and software made data acquisition more convenient, and experimental methods emerged in the field of social sciences. Researchers preferred quantitative research for various reasons. Quantitative methods follow the causal assumption of "regularity probability theory", which states that a cause is theorized as increasing the probability of a result occurring in the population. If three criteria are met (correlation, causal temporality, nonspurious correlation, or regular correlation), it can be inferred that the causal relationship is established; Case oriented research follows the causal assumption of "mechanistic determinism", identifying causal mechanisms to test causal relationships, and determining causal associations or logical causal inferences based on the matching between theoretical predictions and evidence or a small number of case comparisons. Variable-oriented and case-oriented research both belong to the scientific traditional path under positivism and to the same epistemology, but their assumptions about causal ontology are different. You and Chen (2023) believe that whether it is case studies, intra-case analysis, comparative analysis, or qualitative comparative analysis, case-oriented research is conducted from two paths: exploring causal relationships and clarifying causal mechanisms[12]. It belongs to the logical system, including the theoretical basis of classic discourses such as seeking similarities and differences, and has a solid philosophical foundation. Finally, they made suggestions on how to conduct more effective and rigorous case-oriented research: the analytical boundaries and limitations inherent in case-oriented research cannot be avoided, and more diverse research methods should be adopted to select appropriate cases for different research objectives.

Xuan (2010) criticized positivism through historicism, focusing on discussing the problems of case analysis in practical applications and proposing measures to solve corresponding problems. Xuan (2001) traced back to the case analysis method, which combines typical cases in social life to analyze, synthesize, and evaluate them organically when teaching legal theory and interpreting legal provisions. Starting with specific cases, he abstracted rules and derived corresponding concepts, categories, and internal connections in theoretical research. Xuan (2001) proposed that the essence of the case analysis method mainly includes the following two aspects: using individual arguments as a general basis and using a large amount of empirical facts to argue theories, based on empirical philosophy, especially positivist philosophy. Examining the case analysis method in the context of positivism and summarizing general theories from individual cases inevitably involves the issue of the coverage of inductive methods. The relationship between practice and theory also affects the reliability of the case analysis method. Whether the practice is supported by theory, whether it can be proven by theory individually, the relationship between practice and theory cannot be clarified, and the relationship between the selected cases as practice fragments and the theories involved or derived during their discussion, as well as the specific guidelines that should be followed when applying this research method, cannot be clarified and unified. In addition, the case analysis method also has disadvantages in practical applications. Xuan (2010) summarized that, firstly the measurable variables and known factors included in the case analysis method are sometimes difficult to quantify. The case study method of establishing a theory based on empirical data through the "grounded theory" and studying any of the top five theoretical hypotheses is a bottom-up approach to constructing the theory. However, defining the research scope first is inevitable. After determining the scope, the data collected in the empirical research method, historical experience, and the selection of variables under different environmental conditions need to be considered and discussed. Moreover, a case data page may be difficult to obtain owning to its limitations and particularities. Secondly, unmeasurable variables and unknowable factors, such as the case study of scientific weather prediction in chaos theory, cannot compensate for the randomness caused by unmeasurable and unknowable factors. Finally, Xuan (2010) believed that the combination of falsification and confirmation, deduction and induction, and the introduction of various analytical methods such as dynamic analysis and analogy can to some extent facilitate the correct application of case study methods and promote the common progress of research methods and results. Despite significant efforts in the application and practice of case analysis, Xuan's discourse appears relatively brief in delving into the theoretical universality and normative issues that previous scholars

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have focused on regarding case analysis.[11]

4. Toward an Interdisciplinary Philosophy of Science and Facing Reality

The case study method originated in legal research and university teaching and was originally intended to benefit education and reduce the gap between classroom and industrial practice. In the field of philosophy of science, instead of focusing on abstract scientific theories, tracing scientific ideas, and discussing the logic of science, since Kuhn, scholars have begun to turn to "external history" to discuss the developmental patterns of science, and have started to select historical events as case studies to introduce into philosophical discussions, which have been extended to history and sociology to understand the more complex and far-reaching fields of science today, as well as the real world that has been deeply affected by science. It has been extended to history and sociology to understand today's more complex and far-reaching fields of science, as well as the real world, which has been deeply affected by science. As discussed earlier, the case study method has its own unavoidable shortcomings, and the debate over the priorities of theory and examples cannot be resolved. Even if we put aside the question of whether theory and practice are interpenetrating, and temporarily set aside the argument of choosing cases first, deriving theory from cases, or theory first or assumption first, and using cases to argue and confirm or falsify, the universality of the theory in the case study and the covering law model can't be completely solved, and even as long as it involves induction, the theory can't be logically completely detached from the question of universality. As mentioned earlier, although some case study methods have introduced a quantitative approach, the scope of application and rules of use of case studies in the field of philosophy of science have been discussed and suggested, but there is still no universally recognized and accepted viewpoint.

What are the strengths of the case study method and its advantages for research in the philosophy of science? What makes scholars use the case study method even in the face of the risk of being challenged? The case study method traces its origins to the fact that it has been proposed and applied because it is more relevant to practice and reality. By introducing the case study method and incorporating the historical dimension, the topics discussed in the philosophy of science can go beyond logical positivism and abstract philosophical standards, philosophy can face the real world more directly, and the questions of reality can be answered in a more flexible, realistic, and enlightening discussion. Undeniably, studies and theories that have been challenged the question of universality can still be illuminating. Moreover, the disintegration of the quest for universality and the abandonment of the search for "a theory of everything" have reduced the extent to which the universality of case studies has been challenged.

5. Conclusion

Without intersecting with other disciplines, pure philosophical inquiry with science as its object is insufficient to solve the many problems posed by science, nor can the philosophy of science continue to develop and progress. The use of the case study method, which is commonly applied in sociology and history, is more capable of realizing interdisciplinary interaction and communication, as well as smoother communication and wider cooperation with scholars in different fields through the same research method, so as to achieve richer research results and promote the common development of various disciplines. The case study method bridges philosophy and the world, and in analyzing the historical lineage and concepts as well as refuting the practices, philosophy realizes its purpose of changing the world and facing all times. In the face of the challenge of how to deal with reality and the real world, and in the atmosphere of the academic community that is actively looking for interdisciplinary research methods to solve more complex problems, the case study method is a powerful contribution to the enrichment of research results in the philosophy of science.

In conclusion, the case study method is invaluable in its capacity to merge philosophical rigor with empirical investigation and reality, thereby contributing profoundly to the development of the philosophy of science. As the academic community seeks innovative ways to address increasingly complex and interdisciplinary questions, the case study method will undoubtedly remain at the forefront of scholarly endeavors, shaping the future of philosophical and scientific inquiry.

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