

Philosophy of Science and Philosophy of Science Review: Historical Analysis and Perspectives of Ontology, Epistemology, and Axiology

Research Article

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Abstract. Philosophy of science is a branch of philosophy that discusses the foundations, methodologies, and goals of science, as well as providing an ethical foundation for the development of science. This study explores the development of philosophy of science from the Ancient Greek period to the contemporary era, and analyzes the main dimensions of philosophy of science: ontology, epistemology, and axiology. Rational thinking in the Greek period, through figures such as Thales, Socrates, Plato, and Aristotle, became the basis of systematic science. In the golden age of Islam, figures such as Al-Farabi, Ibn Sina, and Al-Ghazali introduced an integration of revelation and reason that enriched scientific methodologies. The Renaissance period was marked by the contributions of Galileo and Copernicus who developed experimental scientific methods. In the contemporary era, the philosophy of science developed with Einstein's theory of relativity, Popper's falsifiability, and Kuhn's scientific paradigm. This study highlights the relevance of philosophy of science in answering the challenges of ethics, technology, and sustainability, with a qualitative approach and descriptive-analytical methods. This research provides insight into the contribution of philosophy of science in developing more ethical and responsible science.

Keywords:

Philosophy of Science,
Ontology, Epistemology,
Axiology

Introduction

Philosophy of science is a branch of philosophy that discusses the basics, methods, and goals of science. An understanding of the philosophy of science helps scientists and academics understand the nature of knowledge, how to acquire knowledge, and ethical values in its use. In its history, the philosophy of science has developed rapidly since the Ancient Greek era, which was characterized by the rational thinking of Thales, Socrates, Plato, and Aristotle, to the contemporary era with the contributions of thinkers such as Karl Popper and Thomas Kuhn. This thought became the basis for further development in various civilizations, including the golden age of Islam, where figures such as Al-Farabi and Ibn Sina enriched the understanding of the philosophy of science with the integration of reason and revelation (kuhn, 2020)(Graham, (2021).)

The golden period of Islam made a significant contribution to the development of philosophy of science, where figures such as Al-Farabi, Ibn Sina, and Al-Ghazali blended Greek thought with Islamic traditions, creating an approach that integrated revelation and reason. This marked the emergence of science as an activity that is not only rational but also has a spiritual dimension .

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During the Renaissance, experimental methods and systematic observations were introduced by Galileo and Copernicus, providing the basis for the development of the modern scientific method. Furthermore, Galileo and Newton strengthened the foothold of modern science with a systematic scientific approach, based on experiments and in-depth observations. In the contemporary era, philosophy of science continues to develop with a multidisciplinary approach, such as Einstein through the theory of relativity and Karl Popper with the concept of falsifiability. This contribution is increasingly relevant in the midst of the complexity of today's science that includes technology, ethics, and sustainability. The study of the philosophy of science that includes the dimensions of ontology, epistemology, and axiology not only helps to understand the nature of science, but also provides direction for the development of more ethical and responsible science (Gibson, (2021)) (Reardon, 2023).

History of Philosophy of Science

Philosophy of science has a long history that reflects the development of human thought in understanding the world and reality. In Ancient Greece, philosophy of science began to develop through figures such as Thales, Socrates, Plato, and Aristotle. Thales is known as the first philosopher to try to explain natural phenomena rationally without myths, while Aristotle developed a system of deductive logic and classification of science that became the basis for the scientific method (Graham, (2021)). In the golden period of Islam, Greek thought was combined with Islamic tradition through figures such as Al-Kindi, Al-Farabi, Ibn Sina, and Al-Ghazali. They not only adopt, but also develop philosophical thinking by integrating revelation and reason. Ibn Sina, for example, combined the empirical method with philosophical reflection, while Al-Ghazali criticized the Greek philosophical view in his work *Tahafut al-Falasifah* (Nasr, (2020)).

Furthermore, the Renaissance period became an important era for the development of philosophy of science. Galileo and Copernicus introduced experimental methods and systematic observations, while Newton laid the foundations of the laws of physics that changed the way people view the universe. In the contemporary era, figures such as Albert Einstein, Karl Popper, and Thomas Kuhn brought a new paradigm in the philosophy of science. Einstein introduced the theory of relativity, while Popper and Kuhn provided a new perspective on the validity and evolution of science through falsifiability and paradigm revolution. (Browne, 2021)(Popper, 2019)(kuhn, 2020)

Definition of Philosophy of Science

Philosophy of science can be defined as a branch of philosophy that studies the basics, methodologies, and goals of science. The philosophy of science seeks to explain how science is acquired, tested, and applied, as well as to understand the relationship between theory and reality. In a broader sense, philosophy of science also includes the study of the limits of science, how scientific knowledge is developed, and what distinguishes science from other knowledge that is speculative or dogmatic. The philosophy of science focuses on fundamental

questions about the ontology, epistemology, and axiology of science, which are the foundation for the development and application of science in life (Popper, 2019)(kuhn, 2020)(Gibson, (2021)) (Rosida,2023)

Main Dimensions in Philosophy of Science

The philosophy of science consists of three main dimensions: ontology, epistemology and Axiology. Ontology discussing the nature of reality and objects that are the objects of knowledge in science. In philosophy of science, ontology questions whether reality only includes the physical world or whether there are also non-material dimensions such as mind and consciousness. The thought of Aristotle and Ibn Sina, for example, emphasizes the importance of observation of objects that exist in the physical world, while Al-Ghazali reminds that reality is not only limited to what can be observed empirically, but also includes the metaphysical dimension; (Graham, (2021).) (Nasr, (2020)) Epistemology It relates to the question of how knowledge is acquired and what makes it valid. Scientific epistemology encompasses a wide range of approaches, from empiricism that emphasizes sensory observation to rationalism that prioritizes the use of reason. Karl Popper, with his theory of falsifiability, proposed that a scientific theory must be testable and proven wrong through experiments or observations. (Popper, 2019)Axiology investigate the values contained in science, including questions about the purpose of science and whether science should be used for moral and social good. Al-Ghazali and contemporary philosophers emphasized that science should not only be practical, but should also bring benefits to humanity and contribute to social welfare.(Reardon, 2023)

Relevance of Philosophy of Science

The philosophy of science remains relevant in the development of science, especially in facing the challenges of modern science that are increasingly complex. In the context of technological and biotechnology developments, philosophy of science provides a framework for understanding the ethical implications of scientific innovation. For example, the question of the responsibility of scientists in the use of technology that can affect human life and the environment requires guidance from the philosophy of science. In addition, philosophy of science is also important in forming a new scientific paradigm. Thomas Kuhn, in his theory of the scientific paradigm, points out that science evolved through major changes in the way scientists viewed the world, which often involved paradigm shifts. An analysis of the philosophy of science that includes the dimensions of ontology, epistemology, and axiology ensures that science develops ethically, responsibly, and is relevant in the era of globalization, where issues such as sustainability and technological ethics are becoming increasingly important.(kuhn, 2020)(Tegmark M. , 2023)(Reardon, 2023)(Lubis,F., 2024) (Yani, A., 2024)

Method

This research uses a qualitative approach with a descriptive-analytical method. This approach aims to deeply understand the development of philosophy of science and its analysis through systematic literature analysis. The descriptive-analytical method is chosen to describe historical facts about the philosophy of science as well as analyze the main themes, such as ontology, epistemology, and axiology, which are important dimensions in the philosophy of science.(Creswell, (2018)).

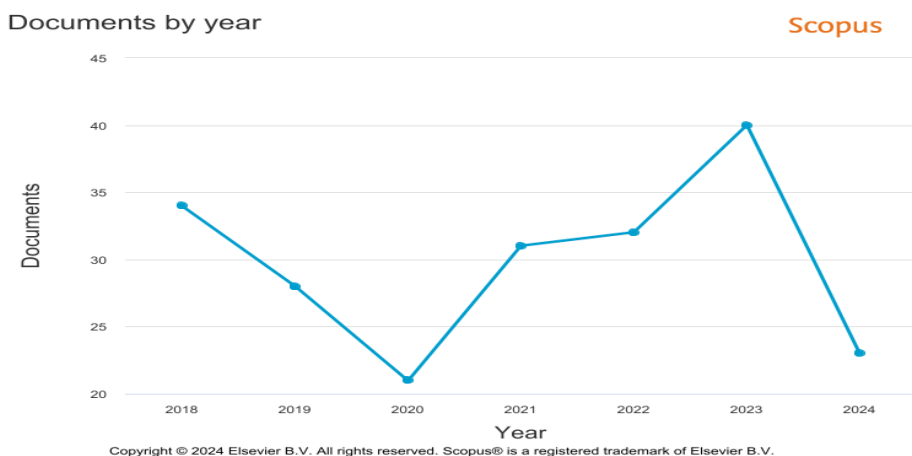
The data used in this study consisted of primary data and secondary data. Primary data includes classical and modern works relevant to the philosophy of science, both from the Greek, Islamic, Renaissance, to contemporary eras. Secondary data includes journal articles, books, and relevant papers, including search results using VOSviewer's bibliometric software. A total of 200 articles from 2018 to 2024 with keywords "Philosophy of Science" and "Philosophy of science" analyzed to obtain relevant and up-to-date literature in this field (Van Eck, 2019). Data collection is carried out through literature studies that include a review of literature relevant to the philosophy of science. This method allows researchers to understand the historical context, theories, and major contributions in the field of philosophy of science. In addition, bibliometric analysis through VOSviewer is used to identify current research trends and research networks in the field of philosophy of science.(Van Eck, 2019) (Kara, S. 2024)

The data analysis techniques used include historical and thematic approaches. Historical approach It is used to trace the development of philosophy of science from the Ancient Greek period, the golden period of Islam, the Renaissance, to the contemporary era. This approach helps to understand the paradigm shift and the contribution of each era to the philosophy of science. (Graham, (2021)).(Nasr, (2020))Thematic approach It is used to analyze the main dimensions in the philosophy of science, namely ontology, epistemology, and axiology. This analysis was carried out to explore important themes that emerged in the literature and their implications for modern science.(Gibson, (2021))

Discussion

Results

Based on a search conducted on the Scopus terindks journal using the keyword "philosophy AND of AND science" in 2018 – 2024, it found 209 articles



Graph 1. Number of research in 2018-2024 in the Scopus journal

Figure 1 shows a trend chart of the number of philosophy of science research and philosophy of science studies in the last six years, the most in 2023 with a total of 40 studies. From 2018-2024, 209 studies were published. It is known that in 2018 there were 34 studies. In 2019 there were 28 studies, in 2020 it decreased to 21 studies and in 2021 it increased by 31 studies, in 2022 there were 32 studies and in 2023 it increased by 40 studies while in 2023 it decreased to 23 studies. Thus, 2020 was the year with the least number of studies compared to the previous six years.

Research related to the philosophy of science and the study of the philosophy of science was made by visualizing the network, on VOSviewer. The mapping results in VOSviewer are characterized by a bibliometric network consisting of network visualization.

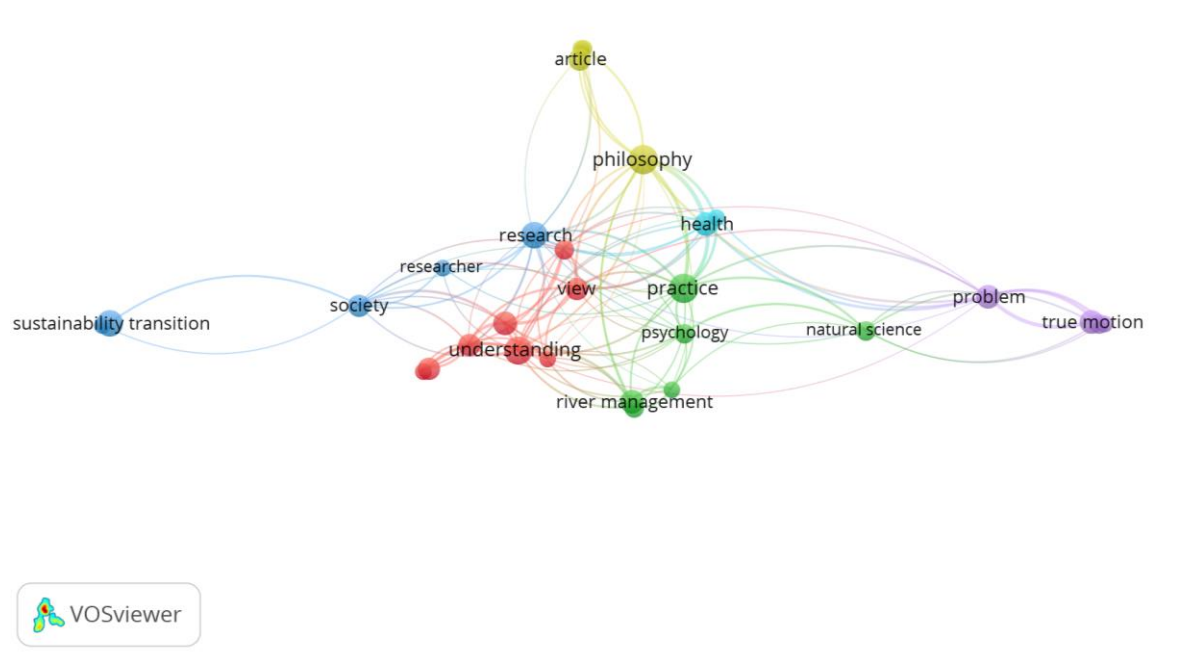


Figure 1. Network Visualization

The author used the keyword "philosophy AND of AND science" to search the literature of the Scopus journal and analyze it through VOSviewer, resulting in 6 clusters consisting of 29 items and 123 links in red, green, blue, light blue, yellow and purple which can be explained in table 1

Table 1. . Network Visualization (division of clusters and their items)	
Cluster 1 (8 items)	Field, influence, machine, machine metaphor, peman, comprehension, display
Cluster 2 (6 items)	natural sciences, practice, psychology, restoration enhachment, river management, scientists
Cluster 3 (5 items)	Research, researchers, society, sustainability transition, Taoist philosophy

Cluster 4 (4 items)	Articles, philosophy, professor Adam Schaff, sociology
Cluster 5 (4 items)	Differences, support, problems, true movement
Cluster 6 (2 items)	Concept of disease, health

From Figure 2 above, it can be concluded that the most discussed cluster is cluster 1 which is marked with red, cluster 2 is dominated by green, cluster 3 is blue, cluster 4 is yellow, cluster 5 is purple and cluster 6 is light blue.

This research reveals the development of philosophy of science from the Greek period to the contemporary era and the contribution of each era to the understanding of ontology, epistemology, and axiology dimensions. In the Greek period, figures such as Thales, Socrates, Plato, and Aristotle provided the initial foundation for the philosophy of science. Aristotle, for example, through his work "Metaphysics," defined deductive logic and introduced the concept of substance as the basis of reality. The golden age of Islam brought about the integration between Greek thought and Islamic tradition by figures such as Al-Farabi and Ibn Sina, who developed scientific methods based on revelation and reason. During the Renaissance, the experimental approach introduced by Galileo and Copernicus accelerated the development of the scientific method, while Newton solidified the laws of physics on which modern science is based. (Graham, (2021).) (Nasr, (2020)) (Browne, 2021)

The contemporary era has recorded multidisciplinary advances, such as Albert Einstein with his theory of relativity and Karl Popper with the concept of falsifiability. Thomas Kuhn introduced a scientific paradigm that describes the change of science through a great revolution, which is relevant in understanding the development of science in the modern technological era. Bibliometric analysis using VOSviewer shows that philosophy of science research during the 2018–2024 period is dominated by studies on the relationship between philosophy of science and technology, sustainability, and ethical values, reflecting the contemporary relevance of philosophy of science. (Popper, 2019) (kuhn, 2020).

The ontology, epistemology, and axiology dimensions in the philosophy of science provide an important framework for understanding how science develops and is applied. Ontology discussing the nature of reality that is the object of knowledge. In Greek times, Aristotle emphasized empirical observation of physical reality, while in the Islamic tradition, Ibn Sina integrated the metaphysical dimension through revelation. Dimension (Gibson, (2021)) epistemology developed from an empirical and rational approach in the Greek period to a systematic experimental approach in the Renaissance. Karl Popper's view of falsifiability underscores the importance of empirical testing in the validity of scientific theories. (Popper, 2019) (Chandratherya, 2024) (John, O.N. 2013)

Dimension Axiology highlighting the values in science, including the moral implications and purpose of knowledge. Al-Ghazali emphasized that science should be used to get closer to God and advance human welfare, while the

contemporary era expands axiology to include social responsibility and sustainability. The study also finds that the philosophy of science is not only relevant in the development of the science paradigm, but also in answering modern scientific challenges, such as technological ethics and sustainability. An analysis of the philosophy of science that includes these dimensions ensures that science develops ethically, responsibly, and is relevant in the era of globalization. (Nasr, (2020)) (Reardon, 2023)

References

- Browne, N. (2021). *The Renaissance and the Rise of Modern Science*. Oxford University Press.
- Chandratheya, A. (2024) Epistemology in Research: Understanding the Foundations of Knowledge. Enhancing Research for Academicians in Higher Education. Doi.10.4018/979-8-3693-4496-5.ch008
- Gibson, Q. ((2021)). *Ontology and the Nature of Reality*. Palgrave Macmillan.
- Graham, D. ((2021).). *Aristotle on Science and the Metaphysics of Substance*. Cambridge University Press.
- John, O. N. (2013). Concepts of the 'Scientific Revolution': An analysis of the historiographical appraisal of the traditional claims of the science. *UIB Resopositori*. <http://hdl.handle.net/11201/2625>
- Kara, S. (2024). Trending Themes on the Nature of Science in Science Education: A Bibliometric Analysis with VOSviewer. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, 18(2), 480-502. <https://doi.org/10.17522/balikesirnef.1548266>
- Kuhn, T. (2020). *The Structure of Scientific Revolutions*. University of Chicago Press.
- Lubis, F (2024). Analytical Study on Integration of Islamic Science in Indonesia Based on Ontology, Epistemology, and Axiology. *Southeast Asian Journal of Islamic Education*. Vol 6 No 2. <https://doi.org/10.21093/sajie.v6i2.8655>
- Nasr, S. H. ((2020)). *Islamic Science: An Illustrated Study*. World Wisdom.
- Popper, K. (2019). *The Logic of Scientific Discovery*. Routledge.
- Reardon, S. (2023). *The Ethics of Biotechnology: Implications for Science and Society*. Springer.
- Rosida, F.R, et.al. (2023) The Process of Forming Knowledge: In the Study Of Ontology Epistimology, and Axiology. *Intenasional Journal For Education and Vocation*. Vol.5, No.1. <https://doi.org/10.29103/ijevs.v5i1.12980>
- Tegmark, M. (2023). *Life 3.0: Being Human in the Age of Artificial Intelligence*. Penguin Books.
- Yani, A. (2024) Philosophy Of Science As An Epistemological Foundation In The Development Of Islamic Education Management Theory. *Journal Al-Fikrah*. Vol,13. No,2 <https://doi.org/10.54621/jiaf.v13i2.889>
- Van Eck, N. (2019). *VOSviewer Manual*. Leiden University.