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The Revolution Of Helix Theory: Transforming Public Policy

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Helix Theory, Public Policy, Innovation, Sustainability, Stakeholder Collaboration

Abstract
This research aims to analyze the urgency and impact of the helix theory revolution on transforming public policy. Using a comparative analysis method that includes bibliometric analysis and literature review, we examine various helix models: Triple Helix, Quadruple Helix, Quintuple Helix, Penta Helix, Open Innovation Helix, and Hexa Helix. The findings demonstrate that each model offers unique advantages in promoting innovation, inclusivity, and sustainability in public policy. The integration of diverse stakeholders such as universities, industry, government, civil society, media, and NGOs enhances policy responsiveness and effectiveness, addressing societal challenges holistically. Existing research on helix models primarily focuses on individual frameworks without comprehensive comparisons or evaluations of their cumulative impact on public policy. Additionally, there is limited exploration of the practical implementation and effectiveness of these models in various socio-economic contexts. This research addresses these gaps by providing a comparative analysis of multiple helix models and their collective influence on public policy transformation. The novelty of this research lies in its holistic approach to evaluating multiple helix models simultaneously, offering a comprehensive understanding of their comparative advantages and potential synergies. By integrating bibliometric analysis with an extensive literature review, this study provides new insights into how diverse stakeholder collaboration can enhance the innovation, inclusivity, and sustainability of public policies. This approach not only fills existing research gaps but also proposes a more integrated framework for policy-making in complex and dynamic environments.

Introduction

The current issues are predominantly related to social media and the internet, public trust issues, hoaxes, and intimidation towards policy products formulated and implemented by the government. The existing condition indicates that the majority of the population uses the internet. The data on global internet users can be seen in Figure 1 below:

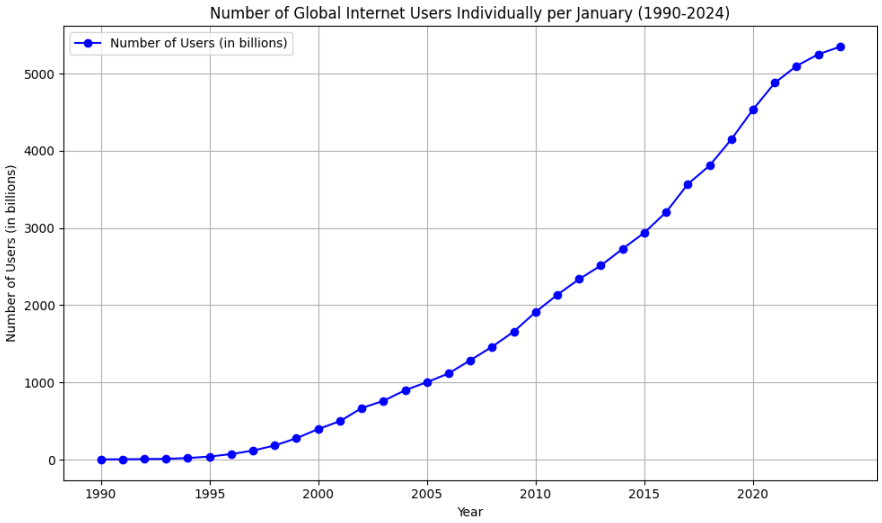

Figure 1. Number of Global Internet Users Individually Per January (1990-2024)
Source: We are social, 2024

The graph depicting the number of global individual internet users from 1990 to 2024 demonstrates a significant upward trend over time. Starting from around 2.6 billion internet users in 1990, this number has surged to over 5.3 billion by 2024. This graph reflects consistent and rapid growth over the past three decades. There are also several notable points of significant increase, particularly in the early 2000s, when internet adoption in many countries rose dramatically due to technological advancements and wider internet dissemination. The slower increase in the early 1990s may have been due to technological access limitations and lower awareness of the internet. However, as technology developed and access costs decreased, internet adoption increased dramatically.

This graph also mirrors the impact of globalization and digitalization on the economy and social life, where the internet has become critical infrastructure for communication, trade, education, and entertainment worldwide. As the number of internet users continues to grow, future projections indicate that internet adoption in more remote or developing areas will continue to rise, although challenges related to access and infrastructure remain. Figure 1 illustrates the significant evolution of the internet as a global force influencing how we interact, learn, and work. It also underscores the importance of investing in digital infrastructure to support economic growth and social inclusion worldwide. Below is the data on global hoax content over the past five years, as shown in Figure 2.

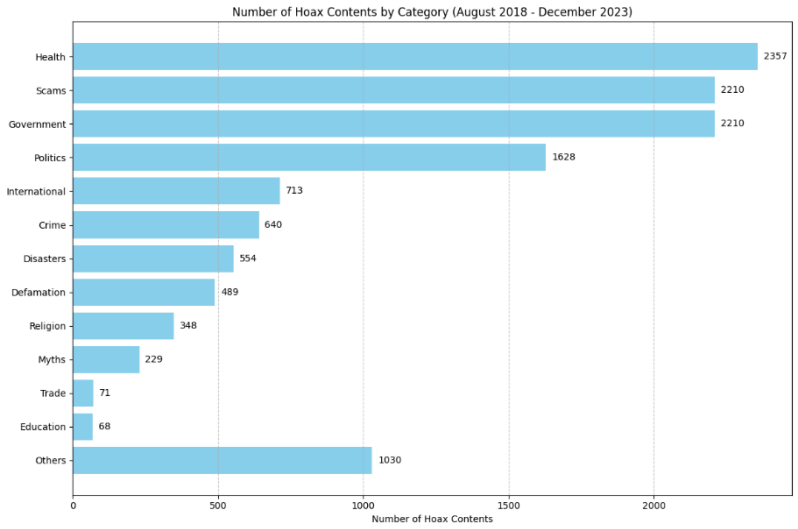

Figure 2. Number of Hoax Content Based on Category (August 2018-December 2023)
Source: AIS Directorate General of Information Applications

Graph 2 reveals several key findings regarding the number of hoax contents by category from August 2018 to December 2023. The category with the highest number of hoaxes is "Health" with 2,357 hoaxes, followed by "Fraud" and "Government" with 2,210 hoaxes each. This indicates that these topics are primary targets for the spread of hoaxes, highlighting the importance of caution in managing information related to health and governmental issues. On the other hand, the categories with the lowest number of hoaxes are "Education" with 68 hoaxes and "Trade" with 71 hoaxes, suggesting that these topics are rarely targeted by hoaxes. This graph also illustrates a clear distribution pattern of hoaxes in categories such as "Politics," "International," "Crime," and "Disaster," underscoring the sensitivity of information in global and socio-political contexts. The implications of these findings are that careful and critical information management becomes crucial, especially in the era of social media and online information, where hoaxes can quickly spread and influence public opinion and societal decisions. By visualizing and understanding this distribution of hoaxes, this graph provides a basis for developing effective mitigation strategies and enhancing digital literacy among the general public.

The graph of the number of global internet users from 1990 to 2024 shows a significant increase over time, reflecting the evolution of the internet as a global force influencing various aspects of life, including social interaction, learning, and work. Along with this increase, another graph depicts the distribution of hoaxes by category from August 2018 to December 2023. Categories with the highest number of hoaxes, such as "Health," "Fraud," and "Government," indicate primary trends in the spread of hoaxes, underscoring the importance of careful information management, particularly in the context of health and governmental issues. Conversely, categories like "Education" and "Trade" have relatively low numbers of hoaxes, indicating these topics are rarely targeted. This graph provides a clear view of how hoaxes are distributed in specific

categories like "Politics," "International," "Crime," and "Disaster," highlighting the sensitivity of information in global and socio-political contexts. The implication is that in the increasingly digitally connected era of Society, 5.0, careful information management and improved digital literacy are crucial to mitigating the negative impacts of hoaxes that can influence public opinion and societal decisions broadly. Research on the helix theory revolution is essential in the context of public policy transformation because it provides a more dynamic and inclusive framework for decision-making and policy implementation. The Triple Helix model emphasizes collaboration between universities, industries, and governments as keys to innovation and economic growth. In the era of globalization and the fourth industrial revolution, integration among academics, businesses, and policymakers is necessary to create responsive and innovative policies. Further research on the Triple Helix can help understand these collaborative dynamics and address the challenges arising from cross-sectoral coordination.

The addition of civil society in the Quadruple Helix model introduces a crucial social dimension, ensuring that public policies not only focus on economic growth but also social welfare. The Quadruple Helix is important for research as it recognizes the role of society in innovation and the development of inclusive and sustainable policies. Meanwhile, the Quintuple Helix adds an environmental dimension, highly relevant in the context of climate change and sustainability, Vani et al (2022) describe that The Quintuple Helix model involves five key actors who participate in activities aimed at sustainable community development. Public policies that do not consider environmental impacts can cause long-term damage. Research on the Quintuple Helix is vital to ensure environmentally friendly policies that support sustainable development. According to the Quadruple Helix theory, a country's economic structure rests on four helices: government, academia, industry, and civil society through a synergistic collaboration scheme. Synergy, adaptability, and continuous innovation can drive economic growth (Afonso in Wahdiniwaty, 2022). Media plays a critical role in information dissemination and public opinion formation. In the Penta Helix model, media acts as a bridge between the government, society, and other sectors, ensuring transparency and accountability. Research on the Penta Helix can help identify effective ways to use media in supporting public policies and enhancing public participation. The Open Innovation Helix concept emphasizes open collaboration among various actors to spur faster and more relevant innovation. In an increasingly complex and rapidly changing world, this model allows for more flexible adaptation and response to new challenges. Research on this model is essential to develop mechanisms and structures that support open and collaborative innovation.

Adding NGOs (Non-Governmental Organizations) in the Hexa Helix emphasizes the important role of non-governmental actors in the development and implementation of public policies. NGOs often have closer ties to local community issues and can provide unique and critical perspectives. Research on the Hexa Helix is important to explore how NGOs can contribute more effectively in multi-sectoral

collaboration. Research on various helix models in the transformation of public policy is urgent to address the complex challenges of the modern era. Each helix model offers different perspectives and approaches to collaboration among key actors in society. By understanding and implementing these theories, public policies can become more adaptive, inclusive, and sustainable, thus providing more effective and holistic solutions to social, economic, and environmental issues.

Method

This study topic was reviewed in the literature using mathematical and statistical methods. Hakim (2020) defines bibliometrics as a study that measures the development of research, literature, books, or documents in a specific field either quantitatively or qualitatively using statistical methods. Bibliometrics is divided into two major categories: descriptive bibliometrics and behavioral bibliometrics. Descriptive bibliometrics describes the characteristics of the literature, while behavioral bibliometrics examines the relationships formed between the components of the literature. Rafika et al. (2017) state that in 2004, Google launched a new service called Google Scholar (also known as Google Cendekia in Indonesian). Google Scholar has advanced tools for quickly tracking, analyzing, and visualizing research results within fractions of a second. Google Scholar can map research results based on the year of research, author, keywords, publisher, publication year, and keywords, which can be set in the left-hand dashboard. Asy'ari et al. (2021) mention that Harzing's Publish or Perish is a free software tool that facilitates the process of searching for articles, neatly organized and connected across various publication sites (currently, the metadata covered by Harzing's Publish or Perish includes Google Scholar, Microsoft Academic, Scopus, and Web of Science), making it easier for researchers to find articles for literature review references. The collected data is then analyzed using a literature review method through traditional review techniques.

In this analysis, the researchers collected data from Google Scholar using Publish or Perish because it provides advanced filtering features for the specific metadata categories, such as the publication name and journal type. Publish or Perish also offers keyword and title word features that allow researchers to find accurate journal metadata.This article utilizes the Publish or Perish tool to scan available articles on Google Scholar, using specific keywords to identify research gaps and novelties. The search covers the period from 1995, when the Triple Helix concept was first introduced, to 2024. Article filtering was conducted with a maximum result of 1,000 articles. The filtering results indicate:

1. Keywords: Transformation Policy, Triple Helix, Quadruple Helix, Quintuple Helix, Sextuple Helix, Septuple Helix, Penta Helix, Open Innovation Helix, and Hexa Helix resulted in 99 papers available from 2003 to 2024, with a total of 6,305 citations, averaging 300 citations per year, 2 authors per year, and an h-Index of 16 and g-Index of 79.

2. Keywords: Triple Helix, Quadruple Helix, Quintuple Helix, Sextuple Helix, Septuple Helix, Penta Helix, Open Innovation Helix, and Hexa Helix resulted in 134 papers available from 2003 to 2024, with a total of 6,916 citations, averaging 329 citations per year, 2 authors per paper, and an h-Index of 20 and g-Index of 83.

Filtering VOSviewer binary counting based on a map based on data with network visualization and overlay visualization as follows:

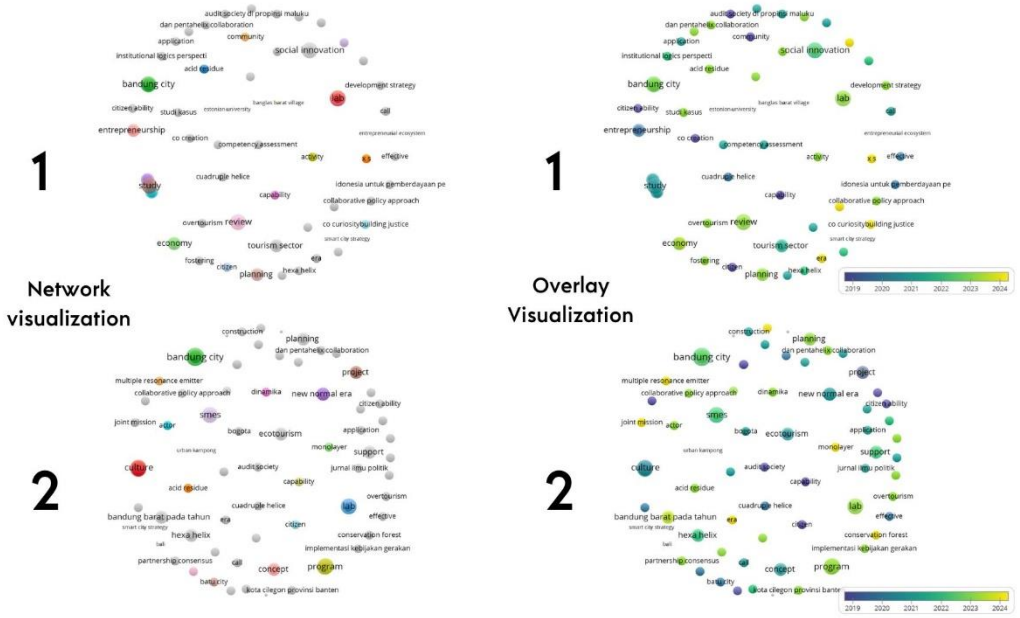

Figure 3. Filtering VOSviewer binary counting based on a map based on data with network visualization and overlay visualization
Source: Research Analysis, 2024

Based on the VOSviewer analysis in the figure above, the bibliometric analysis using the Publish or Perish tool, as depicted in the graphic, examines two sets of keywords over the period from 2003 to 2024. The analysis includes several key metrics: number of papers, total citations, citations per year, authors per paper, h-Index, and g-Index. The second keyword set, which omits "Transformation Policy," has a significantly higher number of papers (134) compared to the first set (99). This indicates that research specific to the helix models without the explicit focus on "Transformation Policy" is more prevalent in the academic literature. The total number of citations is higher for the second keyword set, with 6,916 citations compared to 6,305 citations for the first set. This suggests that articles focusing on the helix models without explicitly mentioning "Transformation Policy" have been cited more frequently, possibly reflecting broader or more intense academic interest. Citations per year are higher for the second keyword set (329 citations/year) compared to the first set (300 citations/year). This metric reinforces the trend seen in the total citations, indicating a higher citation rate for research articles on the helix models without the "Transformation Policy" keyword.

Both keyword sets have an average of 2 authors per paper, indicating a consistent level of collaboration among researchers in this field across both keyword sets. The h-Index is higher for the second keyword set (20) compared to the first set (16). The h-Index measures both the productivity and citation impact of the publications, and a higher h-Index indicates that the research on helix models without the explicit mention of "Transformation Policy" tends to be both more prolific and influential. The g-Index is also higher for the second keyword set (83) compared to the first set (79). The g-Index gives more weight to highly cited articles and suggests that research on the helix models without the "Transformation Policy" keyword includes more high-impact articles. To facilitate visualization of this research analysis, refer to the image below:

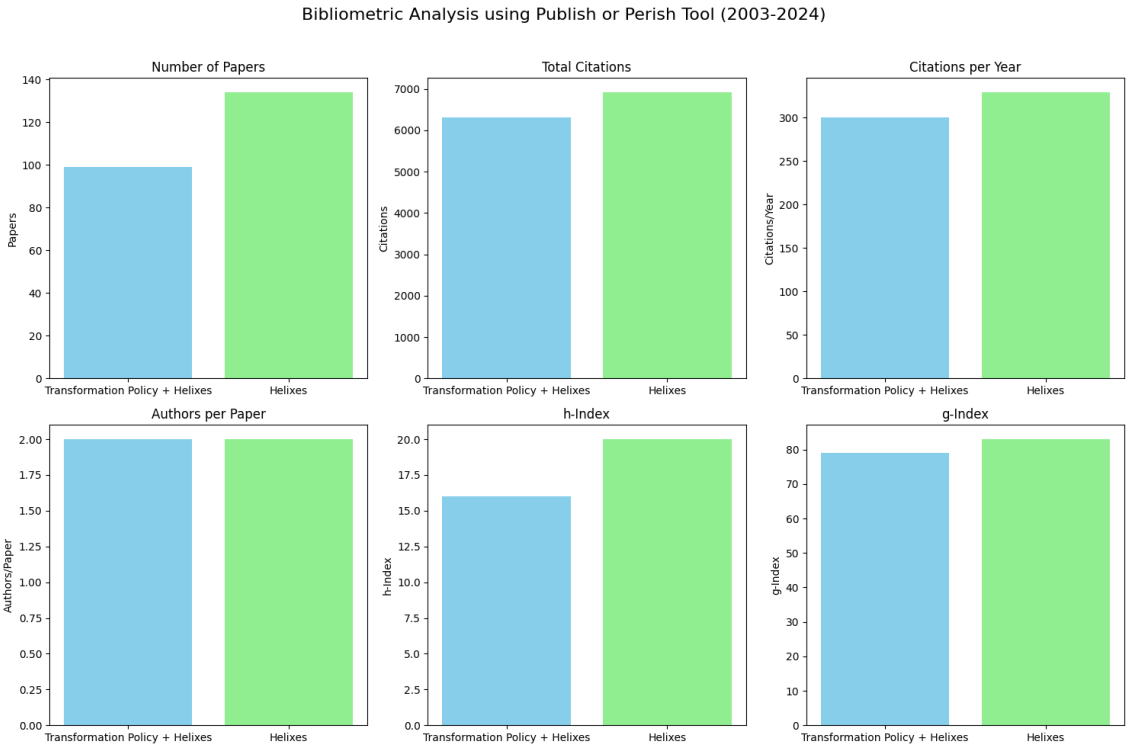

Figure. 4: Blibliometric Analysis Using publish or Perish Tools (2003-2004)
Source: Research Analysis, 2024

The visual representation highlights the differences in bibliometric metrics between the two keyword sets, providing a clear comparison of their academic impact over the analyzed period. The graphic analysis clearly shows that research involving the helix models—Triple Helix, Quadruple Helix, Quintuple Helix, Penta Helix, Open Innovation Helix, and Hexa Helix—has garnered significant academic interest, as evidenced by the number of papers and citation metrics. However, when the keyword "Transformation Policy" is included, there is a noticeable decrease in the number of papers and citations, suggesting that while the transformation of policy is an important area, it might not be as widely covered or cited as the broader helix concepts themselves. This comprehensive bibliometric analysis highlights the significance of helix theory in academic research and its evolving impact on public policy, innovation,

and sustainability. The insights provided by this study can inform future research directions and policy-making processes, emphasizing the importance of multi-stakeholder collaboration in addressing complex societal challenges.

Result and Discussion

The revolution of helix theory represents a paradigm shift in understanding and fostering innovation through structured multi-stakeholder collaboration. Initially conceptualized as the Triple Helix model, which emphasizes the interplay between universities, industry, and government, the theory has evolved to include additional stakeholders, reflecting the complexity and interdependence of modern innovation ecosystems. The expansion to Quadruple Helix (adding civil society) and Quintuple Helix (incorporating environmental considerations), among others, underscores a growing recognition that sustainable and inclusive innovation requires diverse perspectives and expertise. This theoretical evolution signifies not only a broader framework for collaboration but also a more nuanced approach to addressing contemporary socio-economic and environmental challenges.

Therefore, the analysis of the entire helix theory revolution yields a new, more modern helix that adapts to current developments and acknowledges humans as social beings who are increasingly transforming their engagement, actively using social media and the internet to express opinions and critique government policies. The following analysis includes the 8 helices, including the new helix that serves as a novelty in this research, namely the "Octuple Helix":

1. Triple Helix (Etzkowitz and Leydesdorff, 1995)
2. Quadruple Helix (Carayannis and Campbell, 2009)
3. Quintuple Helix (Carayannis and Campbell, 2010)
4. Sextuple Helix (2014 in Vieira et al, 2024)
5. Septuple Helix (2015 in Vieira et al, 2024)
6. Penta Helix (Riyanto, 2018)
7. Open Innovation Helix (Henry Chesbrough, 2003)
8. Hexa Helix (Rachim et al, 2020)
9. Octuple Helix (Resa et al, 2024)

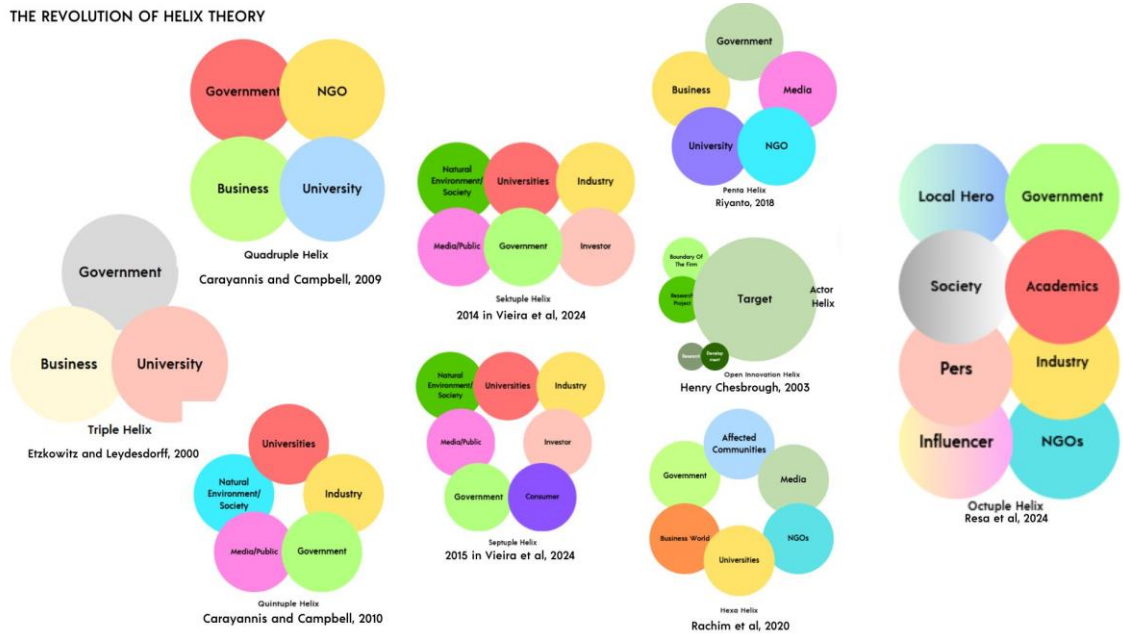

Figure 5. The Revolution of Helix Theory
Source: Research Analysis, 2024

The impact of the helix theory revolution on transforming public policy is profound and multifaceted. By integrating various stakeholders into the policy-making process, helix models foster a more collaborative and responsive governance structure. This inclusive approach ensures that policies are not only grounded in academic research and industrial capabilities but also reflect societal needs and environmental imperatives. As a result, public policies developed under the helix framework are more innovative, adaptable, and sustainable. The practical implementation of these models has demonstrated enhanced policy effectiveness, as diverse input leads to more comprehensive solutions to complex challenges. Ultimately, the helix theory revolution is reshaping public policy into a more dynamic, inclusive, and forward-thinking endeavor:

1. The Revolution of Helix Theory

Research on the revolution of helix theory is crucial in the context of transforming public policy, as it provides a more dynamic and inclusive framework for decision-making and policy implementation. The Triple Helix model emphasizes collaboration between universities, industry, and government as the key to innovation and economic growth. In the era of globalization and the Fourth Industrial Revolution, the integration of academia, business, and policymakers is essential for creating responsive and innovative policies. Further research on the Triple Helix can help understand this collaborative dynamic and address the challenges that arise in cross-sector coordination.

The inclusion of civil society in the Quadruple Helix model adds an important social dimension, ensuring that public policies focus not only on

economic growth but also on social welfare. The Quadruple Helix is important for research because it recognizes the role of society in innovation and the development of inclusive and sustainable policies. Meanwhile, the Quintuple Helix adds an environmental dimension, which is highly relevant in the context of climate change and sustainability. Public policies that do not consider environmental impacts can lead to long-term damage. Research on the Quintuple Helix is crucial to ensure environmentally friendly policies that support sustainable development.

Media plays a significant role in disseminating information and shaping public opinion. In the Penta Helix model, media acts as a bridge between the government, society, and other sectors, ensuring transparency and accountability. Research on the Penta Helix can help identify effective ways to use media in supporting public policies and enhancing public participation. The concept of the Open Innovation Helix emphasizes open collaboration among various actors to accelerate and make innovation more relevant. In an increasingly complex and rapidly changing world, this model allows for more flexible adaptation and response to new challenges. Research on this model is essential for developing mechanisms and structures that support open and collaborative innovation.

The addition of NGOs (Non-Governmental Organizations) in the Hexa Helix underscores the important role of non-governmental actors in the development and implementation of public policies. NGOs often have a closer connection to local societal issues and can provide unique and critical perspectives. Research on the Hexa Helix is important to explore how NGOs can contribute more effectively in multi-sectoral collaboration. Research on various helix models in transforming public policy is urgently needed to address the complex challenges of the modern era. Each helix model offers different perspectives and approaches for collaboration among key actors in society. By understanding and implementing these theories, public policies can become more adaptive, inclusive, and sustainable, thus providing more effective and holistic solutions to social, economic, and environmental issues.

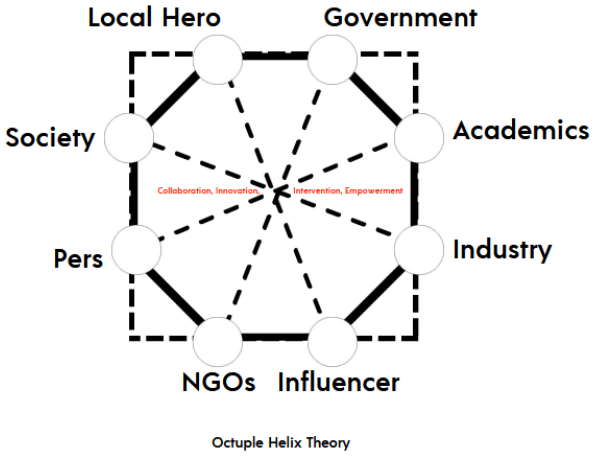

Figure 6. Octuple Helix Theory
Source: Research Analysis, 2024

The presence of the Octuple Helix represents a significant transformation in the collaboration of actors in implementing public policies that are more transparent and innovative. By incorporating eight key indicators, including government, academia, industry, and community groups, this model not only expands the scope of stakeholders involved in the policy process but also promotes broader participation from civil society, media, influencers, and non-governmental organizations. This creates a more dynamic ecosystem that is responsive to the needs and aspirations of society, enabling faster adoption of technology and innovations that are relevant to contemporary challenges. Thus, the Octuple Helix not only shifts the paradigm of collaboration in public policy towards greater transparency but also strengthens the ability to generate innovative solutions that enhance overall quality of life and public services (Suherman et al., 2021). The Octuple Helix is a concept that advances previous models by incorporating eight key indicators reflecting the diverse roles of stakeholders in the innovation ecosystem. Here is an analysis:

1. Local Hero: Represents local figures or initiatives that are primary drivers of innovation at the local or community level.
2. Government: Encompasses the role of government in policy regulation, providing incentives, and creating an environment supportive of innovation.
3. Academics**:** Refers to universities, research institutions, and higher education involved in research and knowledge transfer.
4. Society**:** Describes the role of the broader society, including community groups, civil society organizations, and citizens in the innovation process.
5. Press: Media and journalism influencing public opinion and providing platforms for sharing information about innovation.
6. Industry: The industrial and business sectors involved in the development, commercialization, and adoption of new technologies.
7. Influencers**:** Individuals or groups with significant influence in promoting innovation adoption and shaping public opinion.

8. NGOs: Non-governmental organizations focusing on social, environmental, or humanitarian issues that can play a critical role in supporting or criticizing innovation.

The Octuple Helix excels compared to previous models by accommodating more types of stakeholders, such as influencers and NGOs, thereby expanding participation and recognizing that innovation originates not only from formal sectors like business and academia. This model also captures new dynamics in innovation processes influenced by social media and the influence of NGOs on global issues. Another advantage is its flexibility in responding to social, economic, and environmental changes affecting innovation, allowing for a more holistic approach to considering various perspectives within the innovation ecosystem. Therefore, the Octuple Helix not only offers a more comprehensive and modern framework for understanding innovation but also underscores the importance of cross-sectoral collaboration and broader inclusion in advancing sustainable and impactful innovation for society as a whole. The analysis of the Octuple Helix concept directly illustrates how the evolution of Helix theory produces newer models that are more modern and relevant to changing times and the transformation of human behavior in the digital era.

1. Broad Stakeholder Inclusion**:** The Octuple Helix accommodates various stakeholders from society, media, influencers, to NGOs, reflecting recognition of the complexity of today's innovation ecosystem where interactions among stakeholders from diverse backgrounds greatly influence innovation dynamics.
2. Relevance with Technological and Social Media Developments: New Helix models like the Octuple Helix not only adapt traditional factors like government, academia, and industry but also consider the influence of social media and the internet. The role of social media in shaping public opinion, mobilizing society, and disseminating information influences how innovation is understood, accepted, or criticized.
3. Active Participation of Society: The transformation of human behavior into actively using social media to voice opinions and critique government policies creates new dynamics in the innovation process. Newer Helix models consider that society is no longer just a recipient of innovation but also a key driver contributing their ideas and perspectives.
4. Impact on Public Policy**:** Inclusion of elements such as influencers and NGOs in the Octuple Helix shows that the opinions and advocacy of these groups can influence public policy and innovation orientation. Modern Helix models acknowledge that the success of innovation depends not only on economic or technological factors but also on the acceptance and active participation of society in the innovation process.

Thus, the evolution of Helix theory towards more complex models like the Octuple Helix not only reflects adaptation to technological and societal developments but also responds to the increasingly active and influential role of humans in conceiving, adopting, and shaping innovations in a modern society that is more interconnected and informed.

2. The Impact of Helix Theory Revolution on Transforming Public Policy

In practice, the synergy and collaboration among actors within each helix have dual and continuous roles in collaboration (Firmansyah et al., 2022). The revolution of helix theory has significant implications for transforming public policy. By integrating diverse stakeholders and emphasizing collaboration, the various helix models offer frameworks that enhance the development, implementation, and effectiveness of public policies. Here's an in-depth look at the impact of each helix model:

1. Triple Helix (University-Business-Government)

The Triple Helix model fosters innovation and economic growth by promoting synergy between universities, industry, and government. This triadic interaction encourages the co-creation of knowledge and the commercialization of research, leading to policies that are better informed by scientific research and technological advancements. This model enhances the ability of public policies to adapt to rapid technological changes and economic needs. According to Etzkowitz, as cited in Aan (2019), the Triple Helix is necessary to explain the interaction model among universities, industry, and government. The analysis of the Triple Helix states that this interaction is key to improving conditions for knowledge-based societal innovation. The successful collaboration among these three actors is intended to provide beneficial and balanced synergy, enabling each to ideally perform their functions to build a robust and sustainable creative sector (Wasitowati, as cited in Asmiddin et al., 2021). These three actors are the drivers behind the emergence of creativity, ideas, knowledge, and vital technology for the growth of the creative industries. The term "drivers" here refers to aspects, conditions, and mechanisms considered as the main variables determining the success of creative industry development. These drivers are crucial factors in forming the foundation and pillars (Sugiono and Sasongko, 2014).

2. Quadruple Helix (University-Business-Government-NGO)

Incorporating civil society into the helix structure introduces a social dimension, ensuring that public policies address societal needs and values. This inclusivity enhances democratic governance by involving citizens in the policy-making process, leading to policies that are more equitable and socially responsive. The Quadruple Helix adds another crucial element: the role of civil society as both consumers and members of specific community groups. By integrating government, businesses, academia, and society into creative and intellectual activities (Jaelani, as cited in Alfadri, 2023), the Quadruple Helix principle proves effective in realizing the concept of Smart Villages in Indonesia.

Collaboration among government, academia, industry, and society is key to utilizing ICT (Information and Communication Technology) to develop villages and improve the quality of life in rural communities (Alfarizi, 2023). As a concept, the Quadruple Helix is essentially an extension of the Triple Helix, integrating civil society and integrating innovation and knowledge (Oscar, as cited in Imron, 2020). In the Quad Helix concept, universities (academic) develop science with human resources and knowledge that can generate new ideas through a series of systematic analyses and research as producers and users of innovation (Ramdhani, 2019). The refined Triple Helix concept into the Quadruple Helix can give birth to new creativity, ideas, skills, and new knowledge (Suyoto and Mas'ud, 2022).

3. Quintuple Helix (University-Industry-Government-Civil Society-Natural Environment)

The addition of the environmental dimension in the Quintuple Helix model underscores the importance of sustainability. This model encourages integrating

ecological considerations into policy development, promoting environmental stewardship alongside economic and social goals. Policies informed by this model are better equipped to address global challenges such as climate change, biodiversity loss, and resource depletion, thereby fostering sustainable development.

The innovation approach of the Quintuple Helix, proposed by Carayannis & Campbell, introduces a new group related to the helix-based innovation model (Prasetyanti & Kusuma, as cited in Fitria et al., 2023). The Quintuple Helix model, which integrates the application of science and technology with natural environmental systems, provides a step-by-step model for understanding effective quality-based development management, restoring balance with nature, and allowing future generations to have a pluralistic and diverse life on Earth (Carayannis and Campbell, as cited in Padil and Antin, 2018). Quintuple Helix connects actors from the Quadruple Helix supported by socio-natural environmental elements (Setyanti, 2018).

4. Sextuple Helix (University-Industry-Government-Civil Society-Natural Environment-Investor)

The Sextuple Helix emphasizes the importance of broader collaboration and integration across various sectors of society to achieve sustainable and inclusive innovation. This model expands upon the Triple Helix concept by incorporating the dimensions of natural environment and civil society as key elements contributing to the process of innovation and technology development.

5. Septuple Helix (University-Industry-Government-Civil Society-Natural Environment-Investor-Consumer)

The Septuple Helix depicts a more complex and integrated framework for sustainable and inclusive innovation. In this context, collaboration among universities, industry, government, civil society, natural environment, investors, and consumers is crucial to address global challenges and leverage opportunities arising from the current industrial and digitalization revolutions.

6. Penta Helix (University-Business-Government-NGO/Civil Society-Media)

The Penta Helix model emphasizes the pivotal role of media in influencing public opinion and ensuring transparency. Media's active participation ensures effective dissemination of information, which fosters informed public discourse and promotes accountability. This model enhances the visibility and comprehension of public policies, thereby facilitating increased public engagement and support. It also plays a crucial role in identifying and correcting misinformation, ensuring that policies are communicated clearly and comprehensively. The implementation of the Penta Helix model is an element of the creative economy involving academia, business sectors, communities, government, and media (Karunia et al., 2018). The collaborative role of Penta Helix aims at innovation and contributes to the socio-economic progress of regions (Vani et al., 2020).

The Penta Helix collaboration model builds upon the Triple Helix (collaboration among government, business sectors, and universities) and Quadruple Helix (which adds the community or civil society to facilitate perspectives from the general public). Media is introduced as an independent element in the Quadruple Helix model, resulting in the Penta Helix collaboration model (Kismartini, 2018). The Penta Helix model, composed of Academic, Business, Government, Community, and Media (ABCGM) components, is considered a concrete step forward (Sadat et al., 2023).

7. Open Innovation Helix (Collaborative innovation among various stakeholders Helix)

The Open Innovation Helix model promotes a culture of open collaboration, aiming to break down silos between different sectors. This approach accelerates innovation by leveraging the collective expertise and resources of diverse actors. Public policies developed through this model are characterized by their innovation and flexibility, capable of swiftly adapting to new challenges and opportunities. It fosters a more resilient and responsive policy environment. In this model, each actor plays a distinct role: academia generates knowledge, industry absorbs and applies this knowledge, and government regulates the interaction among academia, industry, and itself (Asmara and Kusumastuti, 2021).

8. Hexa Helix (University-Business-Government-NGOs-Media-Affected Communities)

The integration of NGOs into the Hexa Helix model introduces specialized knowledge and advocacy for diverse social and environmental issues. NGOs typically maintain close ties with local communities, offering valuable insights and alternative viewpoints. Their participation ensures that public policies are more comprehensive and inclusive, effectively addressing the needs of marginalized and vulnerable populations. This model enhances the ability of public policies to advance broader social justice and sustainability objectives.

9. Octuple Helix (Local Hero, Government, Society, Pers, Academics, Industry, NGos, dan influencer)

The concept of the Octuple Helix involves eight key actors: Local Heroes, Government, Society, Media, Academia, Industry, NGOs, and Influencers. The Octuple Helix is crucial for transforming public policy by integrating diverse perspectives and expertise to create more comprehensive and inclusive solutions. The collaborative involvement of all these actors ensures that public policies are not based on a single perspective but are the result of multidisciplinary interaction and contribution that enriches the policy-making process. Local Heroes act as change agents within their communities, driving local initiatives and building grassroots trust. Government provides regulatory frameworks and resources necessary for policy implementation. Society, as the primary beneficiaries of public policies, provides essential feedback for successful implementation. Media plays a crucial role in disseminating information and shaping public opinion.

Academia contributes research-based knowledge that enhances policy quality. Industry brings practical perspectives and innovations that can enhance policy efficiency and effectiveness. NGOs serve as independent watchdogs and advocates for public interests, often voicing concerns for underrepresented groups. Finally, Influencers have the ability to reach a wide audience and shape public perception and attitudes towards policies.The collaborative engagement of all these actors in the Octuple Helix ensures that public policies are not only comprehensive and inclusive but also benefit from diverse perspectives and expertise. Thus, the Octuple Helix can improve the quality and sustainability of public policies generated.

Conclusion

The revolution of Helix theory, culminating in the concept of the Octuple Helix, marks a profound transformation in how we understand and implement public policies. By expanding upon earlier, simpler models like the Triple Helix to include up to the Hexa Helix, this approach acknowledges the complexity of modern innovation

ecosystems involving various stakeholders from the public, private, academic, civil society, media, influencers, and non-governmental organizations sectors. This not only strengthens cross-sectoral collaboration but also fosters more sustainable innovation that is responsive to societal needs. Closer collaboration across sectors also yields holistic and sustainable innovative solutions through stakeholder forums and cross-sectoral initiatives that promote knowledge exchange. Ensuring broad civil society participation, especially through digital platforms and transparent public consultations, enhances policy legitimacy and strengthens government accountability. Investments in education, technology development, and innovation capacity building are also necessary to enhance stakeholders' ability to contribute effectively within the innovation ecosystem, creating more responsive, adaptive, and relevant public policy processes to address increasingly complex global challenges.

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