

## REVIEW ARTICLE

Peer-reviewed | Open Access

# Green Innovation Hubs: A Systematic Review of University-Industry Research Collaboration in Vocational Education for Climate Crisis Mitigation

Tika Widiastuti<sup>1\*</sup>, Anwar Ma'ruf<sup>1</sup>, Eighty Mardiyani Kurniawati<sup>2</sup>, Novianto Edi Suharno<sup>1</sup> and Riska Nur Rosyidiana<sup>1</sup>

<sup>1</sup>Faculty of Vocational Studies, Universitas Airlangga, Surabaya, Indonesia

<sup>2</sup>Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

## ARTICLE INFO

## Article history

RECEIVED: 10-Mar-25

REVISED: 06-Jun-25

ACCEPTED: 14-Jun-25

PUBLISHED: 15-Jul-25

## \*Corresponding Author

Tika Widiastuti

E-mail: [tika.widiastuti@feb.unair.ac.id](mailto:tika.widiastuti@feb.unair.ac.id)

## Co-Author(s):

Author 2: Anwar Ma'ruf

E-mail: [anwarmaruf@fkh.unair.ac.id](mailto:anwarmaruf@fkh.unair.ac.id)

Author 3: Eighty Mardiyani Kurniawati

E-mail: [eighty-m-k@fk.unair.ac.id](mailto:eighty-m-k@fk.unair.ac.id)

Author 4: Novianto Edi Suharno

E-mail: [novianto-edi@vokasi.unair.ac.id](mailto:novianto-edi@vokasi.unair.ac.id)

Author 5: Riska Nur Rosyidiana

E-mail: [riska.rosyidiana@vokasi.unair.ac.id](mailto:riska.rosyidiana@vokasi.unair.ac.id)

**Citation:** Tika Widiastuti, Anwar Ma'ruf, Eighty Mardiyani Kurniawati, Novianto Edi Suharno and Riska Nur Rosyidiana (2025). Green Innovation Hubs: A Systematic Review of University-Industry Research Collaboration in Vocational Education for Climate Crisis Mitigation. Horizon J. Hum. Soc. Sci. Res. 7 (S), 7–19. <https://doi.org/10.37534/bp.jhssr.2025.v7.nS.id1291.p7-19>



## ABSTRACT

**Introduction:** Green Innovation Hubs are increasingly recognized as vital mechanisms for fostering collaboration between universities and industries in addressing the climate crisis. Despite growing interest, the specific role of **vocational education** within these collaborative frameworks remains underexplored. This study aims to examine the intersection of green innovation, university-industry collaboration, and vocational education in the context of climate crisis mitigation. **Methods:** A systematic and bibliometric review was conducted using data from **Scopus-indexed international journals** published between **1993 and 2024**. A total of **118 articles** were identified and analyzed to explore thematic trends, dominant research areas, and existing gaps in the literature concerning Green Innovation Hubs and vocational education. **Results:** The analysis revealed that Green Innovation Hubs are instrumental in advancing research collaboration between universities and industries, particularly in the development and transfer of green technologies. Frequently cited keywords included “sustainable development,” “collaboration,” “green innovation,” and “technology transfer.” However, the literature shows a significant lack of focus on the integration of **vocational education** into these collaborations, despite its potential to support practical, workforce-driven solutions to climate challenges. **Discussion and Conclusion:** The findings underscore the need for a conceptual shift in understanding the role of vocational education in sustainability initiatives. Vocational education institutions, especially those affiliated with universities, should be more actively engaged in designing green innovation-based curricula that align with industry needs. Future research should prioritize integrated models that bring together **vocational training, green innovation, and university-industry partnerships** to accelerate efforts in climate crisis mitigation.

**Keywords:** Green Innovation Hubs, Climate Crisis, Vocational Education, University, Industry

## 1. INTRODUCTION

The global climate crisis is an urgent challenge requiring immediate action from various sectors, including education and industry. Green innovation plays

an important role in creating sustainable solutions that can help mitigate the effects of climate change. Green innovation also correlates with energy efficiency, carbon and fossil fuel emission control, waste management,

renewable production, and corporate environmental protection (Ahmed et al., 2023) this research aims to examine the effect of green innovation on environmental performance, which leads to organizational performance. Another objective is to measure the impact of two dimensions of green innovation, such as green process & green product measures, on green innovation. The second prime aim of this research is to evaluate the moderation of management commitment & human resource practices in an association between green innovation and organizational & environmental performance. A total of 320 employees provided their perspectives on a self-administrated questionnaire from the textile industry of Pakistan. We have employed SEM-based multivariate modeling to examine the data. This research has measured the reflective indicators measurement model through confirmatory factor analysis, an obvious choice of structural equation modeling to examine observed and unobserved variables and indicators using PLS-SEM (partial least square-structural equation modeling). Green innovation focuses on reducing the risk of environmental exploitation and the resulting negative impacts on resources, including energy (Basana et al., 2022). *The United Nations Environment Programme* Hasid (2022) attributes green growth to strengthening social justice, people's welfare, and ecological deficiencies and reducing the resulting environmental impacts. Green innovation is relevant in the face of climate change and promotes sustainable economic growth by strengthening the industrial and energy sectors. Collaboration between universities and industry has a great impact on the development of green innovation (Yan et al, 2024).

Universities have a pivotal role in the research and development of green innovations, while industry can implement such solutions on a large scale. For example, research conducted by Yan (2024); Li & Zhou (2022) shows that collaboration between universities and industry can accelerate the adoption of green innovations in various industrial sectors. This collaboration facilitates technology transfer and enables the creation of more practical and applicable innovations in climate crisis mitigation.

Vocational education can deliver immense potential impact on the mitigation of climate crises, with millions of students around the world. The introduction of green technologies and innovations into vocational training will significantly quicken the pace at which these sustainable practices take hold in various industries because it is a large arena with many participants involved. The mass numbers within vocational education multiply its potential manifold to develop a workforce that is not only endowed with the use of technical skills but also aligned with the demands for a low-carbon economy. The vocational

education also furthers positive social change by creating pathways to employments in the green industries that address the environmental concern but at the same time reduce social inequalities in the offers of opportunities for underrepresented communities to the green economy. This addresses the global demands of achieving social justice through sustainable development initiatives.

However, the role of vocational education in fostering green innovation has been underrepresented in the literature. Vocational education is critical as it prepares a workforce with the technical skills needed to support the implementation of green technologies in the field (Kaliappan & Hamid, 2021). According to Rosenberg, Lotz-Sisitka, & Ramsarup (2018), the green innovation transition will impact an economy increasingly, leading to a green economy and has become a concern for some countries in recent years. The development of green innovation in various sectors, especially the economy, will undoubtedly significantly impact the labour market and curriculum development, and these changes will be a challenge for vocational education (Baumgarten & Kiag, 2016). Vocational education can, therefore, be the bridge that connects university research with industry practice, ensuring that the future workforce has green skills that match the demands of a low-carbon economy. Vocational education integrated with green innovation can also support climate change mitigation efforts more effectively by providing hands-on skills relevant to the industrial sector.

The Green Innovation Center is a platform that brings together universities, industry and vocational education to develop sustainable solutions to the climate crisis. However, there is a lack of previous research on the gap in integrating vocational education into green innovation. However, many previous studies have shown that industry-university collaboration has been successful in various sectors. Research by Giannopoulou et al. (2019) shows that universities and Research and Technology Organizations (RTOs) have different but complementary contributions to innovation development. In addition, research (Guan & Zhao, 2013) shows that collaboration between industries and universities in interdisciplinary fields is growing rapidly. Therefore, this research addresses the gap by highlighting the importance of closer collaboration between universities, industry and vocational education to accelerate the adoption of green innovations that support climate crisis mitigation.

The paper contributes to the creation of new knowledge by revealing the often-neglected role of vocational education in green innovation. This meets the need for vocational curricula to further integrate green technologies and create new opportunities for research

into how best to design curricula in concert with industrial demands for sustainability.

## 2. MATERIAL AND METHODS

This research used two quantitative methods to answer the researcher's question. In RQ 1, we mapped green innovation and university-industry collaboration in vocational studies in response to climate change. This part requires quantitative analysis to describe the overall research productivity, so we used bibliometric analysis. Furthermore, in RQ2 researchers need a deeper understanding of the content to explore specific themes to clarify the important role of vocational education and green innovation hubs in response to climate change. In brief, this research design follows the Delle Foglie & Keshminder (2022) pattern, namely, Data selection, and bibliometric analysis. The first stage of data selection is searching keywords on a trusted database, namely Scopus, to find peer-reviewed articles. Since this research combines two different concepts, namely green innovation and vocational studies, a combined effort was made to obtain coincide articles. The keywords (TITLE-ABS-KEY ("green" OR "renewable energy" OR "climate") AND TITLE-ABS-KEY (university) AND TITLE-ABS-KEY (industry) AND TITLE-ABS-KEY (collaboration) AND (LIMIT-TO (LANGUAGE, "English") AND (LIMIT-TO (SRCTYPE, "j")) to get articles specialized in green innovation in vocational studies. A total of 155 articles were found at this stage. Further filtering efforts were made to eliminate articles sourced from predatory journals (n=3), non-English (n=3), and non-article & journal type (n=24). This stage successfully eliminated 36document that did not fit the data criteria.

In the bibliometric analysis part to answer RQ1, researchers mostly used R-BiblioshinyBibliometrix (Aria and Cuccurullo, 2017). The main information displays a three-plane plot graph as the opening graph. After that, we proceeded to the Source Analysis section, which consisted of the most relevant Sources, Production over time, and Reference publication year spectroscopy (RPYS) which is a scientometric method that studies the annual distribution of references cited in an article (Ballandonne and Cersosimo, 2021). Furthermore, the Author Analysis session consists of three: Countries' Collaboration World Map, and Affiliations' Production over Time, and Factor Analysis to find affiliations. This analysis will display item labels with colored circles by year to avoid overlapping labels between items and see the direction of topic development each year. The more important a theme is, the bigger the label and circle (van Eck and Waltman, 2010). Furthermore, we visualize the keywords with thematic maps to identify the most important keywords in a theme and provide gaps for future research.

## 3. RESULTS

This study analyzes the relationship between university and industry collaboration, focusing on green innovation in vocational education to address the climate crisis. Using bibliometric analysis, 436 authors wrote 119 documents from 1993 to 2024. During that period, the annual growth rate was 9.96%, averaging 35.6 citations per document. These results show that the study of green innovation in vocational education and collaboration between universities and industry is growing. Document types vary but are dominated by 93 documents in the form of scientific articles.

Figure 1 illustrates the annual scientific production, with 2024 recording the highest number of publications with 19 documents. In addition, there has been an increasing trend of publications in the last three years. This increase is driven by the growing prominence of the Sustainable Development Goals (SDGs) and Environmental Social Governance (ESG) agenda, which encourages academics at various universities to focus their research on green innovation, particularly in

**Table 1.** Main Information

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1993:2024
Sources (Journals, Books, etc)	95
Documents	119
Annual Growth Rate %	9.96
Document Average Age	6.73
Average citations per doc	35.6
References	6031
DOCUMENT CONTENTS	
Keywords Plus (ID)	886
Author's Keywords (DE)	477
AUTHORS	
Authors	436
Authors of single-authored docs	15
AUTHORS COLLABORATION	
Single-authored docs	15
Co-Authors per Doc	3.75
International co-authorships %	21.85
DOCUMENT TYPES	
article	93
conference paper	6
editorial	1
erratum	1
letter	1
note	2
review	15

Source: Biblioshiny Report (2024).

vocational education that involves collaboration between universities and industry. Overall, publications on green innovation, climate change, and university-industry collaboration show a significant upward trend, reflecting a growing awareness among academics of the importance of these studies.

The average citations in Table 2 show that 2009 had the highest average citations, at 62.5 citations per year, followed by 1998 with 21.33 citations per year. However, although 2024 recorded the highest number of publications, the average citations in that year were the lowest after 1998, where no articles were cited.

Figure 2 displays the Three-Fields Plot, which provides a comprehensive view of the relationship between different aspects of the research in one visualization. In the figure, it can be seen that the most researched documents are closely related to the keywords "sustainability" and "university-industry collaboration." In addition, other keywords such as "innovation," "climate change," "renewable energy," and "partnership" also highlight the importance of green innovation in vocational education through university-industry collaboration.

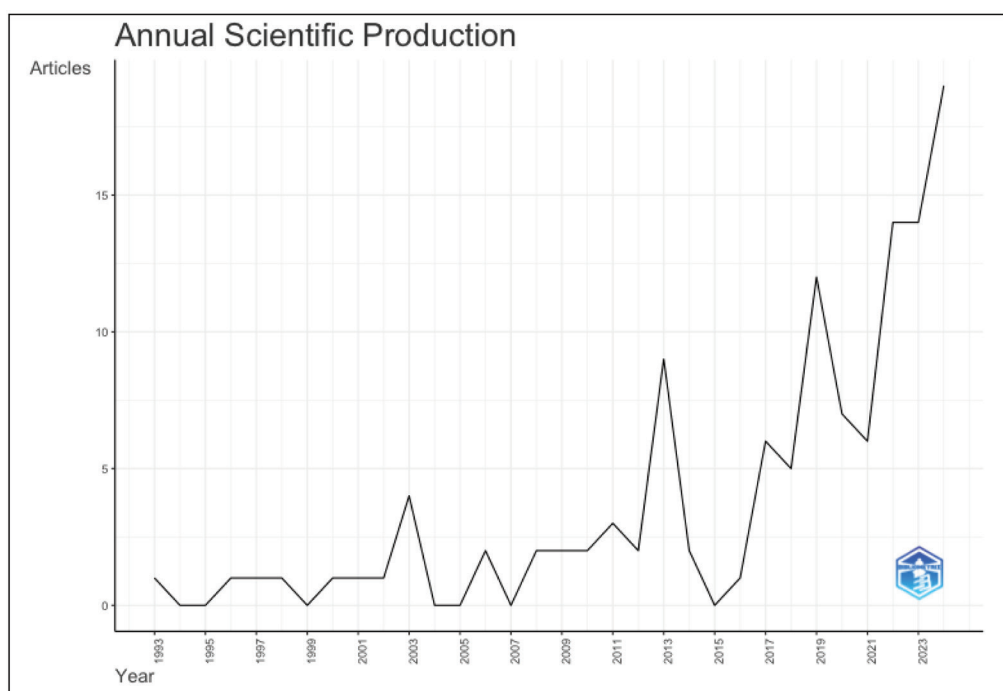
Figure 3 shows the journals with the highest number of publications. "Sustainability (Switzerland)" ranked first with 11 documents, followed by 'Joule' and 'Technological Forecasting and Social Change,' each with 3 documents. "Sustainability (Switzerland)" is a Q1 journal that focuses on the Social Sciences category, with the subcategory of Geography, Planning, and Development, which is highly relevant to topics related to green environment, climate

change, and renewable energy. Therefore, it makes perfect sense that this journal has the highest number of publications related to green innovation in vocational education through university and industry collaboration. On the other hand, "Joule" focuses on the general energy and energy category, while "Technological Forecasting and Social Change" focuses on the Business, Management, and Accounting, and Psychology categories.

Figure 4 shows the most relevant affiliations, with University College London (UCL) coming out on top with 28 documents. In addition, is Washington State University, with 9 documents, and the University of Macerata, with 8 documents. University College London is currently focusing on discussions related to green innovation, with its Green Innovation Policy Commission focusing on the impact of implementing green innovation.

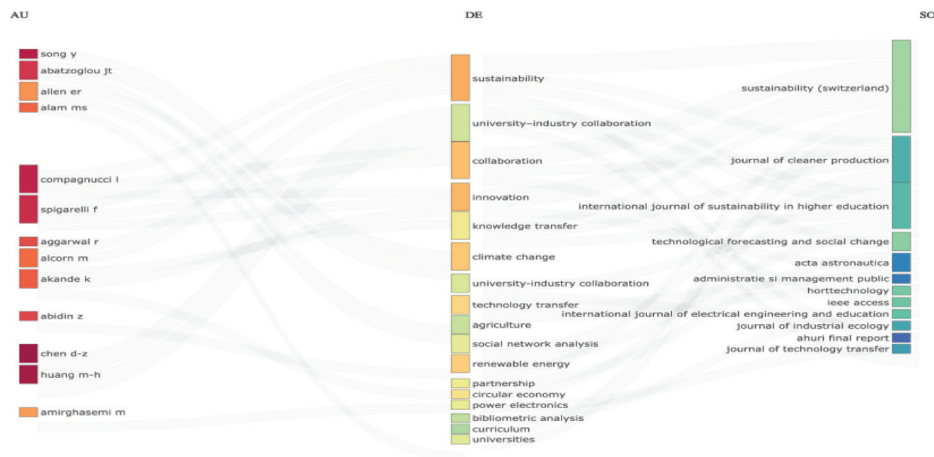
Furthermore, Figure 5 shows the collaboration between countries depicted by SCP (Single Country publication) in green and MCP (MultipleCountry Publication) in red. The analysis shows that publications on green innovation and collaboration between universities and industry in vocational education are generated mainly by single-country publications, indicating a lack of collaboration between countries. This is an important note for academics to increase international collaboration to broaden perspectives in research on green innovation hubs in vocational education.

The World Cloud shown in Figure 6 visualizes the most frequently occurring words in the document under analysis. In Figure 6, the three most used keywords



**Figure 1.** Annual Scientific Production.

Source: *Biblioshiny Report (2024)*.



**Figure 2.** Three-Fields Plot.

Source: *Biblioshiny Report (2024)*.

**Table 2.** Average Citation

Year	Mean TC per Art	N	Mean TC per Year	Citable Years
1993	5	1	0.16	32
1996	15	1	0.52	29
1997	0	1	0	28
1998	576	1	21.33	27
2000	25	1	1	25
2001	2	1	0.08	24
2002	0	1	0	23
2003	65	4	2.95	22
2006	24	2	1.26	19
2008	23	2	1.35	17
2009	1000	2	62.5	16
2010	42	2	2.8	15
2011	8.67	3	0.62	14
2012	16	2	1.23	13
2013	21	9	1.75	12
2014	2	2	0.18	11
2016	7	1	0.78	9
2017	21.67	6	2.71	8
2018	14.8	5	2.11	7
2019	21.83	12	3.64	6
2020	31.43	7	6.29	5
2021	18	6	4.5	4
2022	4.86	14	1.62	3
2023	3.64	14	1.82	2
2024	0.21	19	0.21	1

Source: *Biblioshiny Report (2024)*.

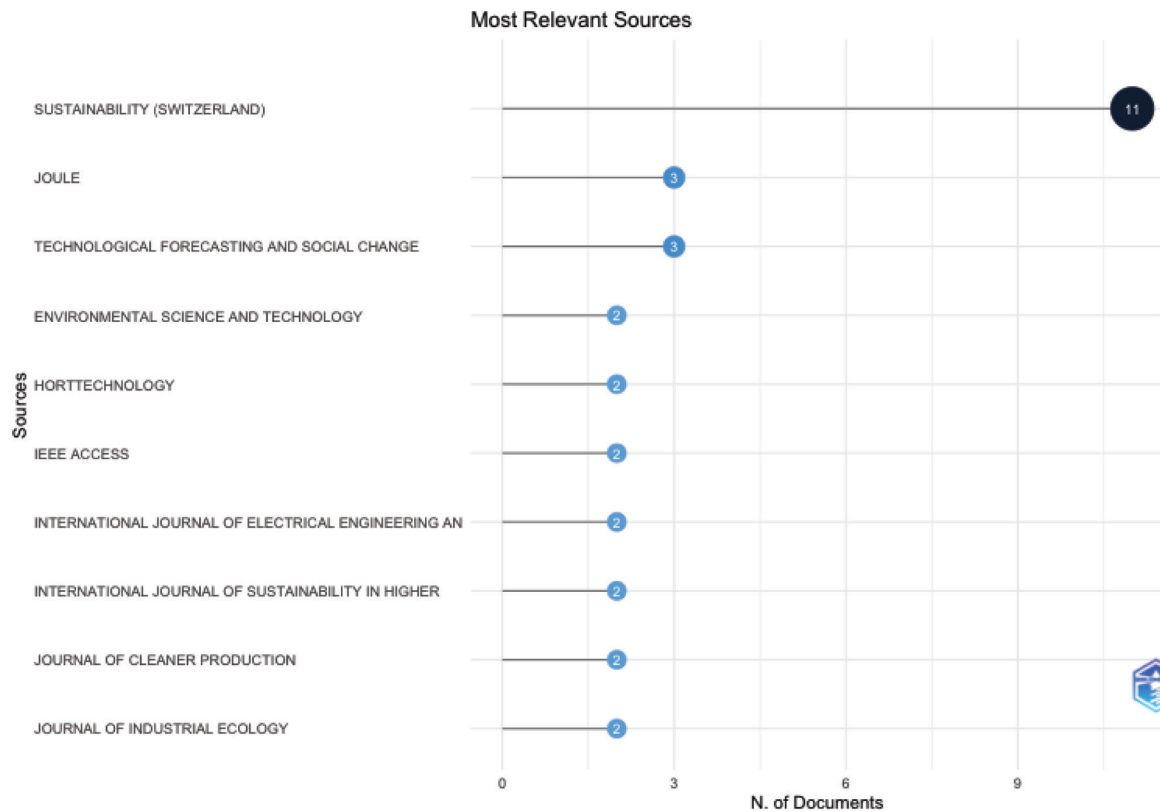
are “sustainable development”, “innovation”, and “climate change”. This shows that discussions related to sustainable development, innovation, and climate change are the main focus in the study of research collaboration between universities and industry. The concept of green innovation hubs examined in this research is closely

connected to efforts to deal with the climate crisis through innovations made in vocational education and effective collaboration between academia and the industrial sector. This word cloud emphasizes the importance of cross-sector collaboration in developing innovative solutions to support climate crisis mitigation through skills-based and vocational education.

In terms of trends in the topics most researched by academics, as shown in Figure 8, the most discussed topics in the last 5 years to date are “alternative energy”, “sustainability”, and “climate change”. The focus on alternative energy and sustainability suggests that academia increasingly focuses on innovations supporting the transition to a low-carbon economy. In the context of vocational education, collaboration between universities and industry is critical in developing green innovation hubs capable of producing a skilled workforce to support climate crisis mitigation. This research trend underscores the importance of integrating education, technological innovation and sustainable practices to address global challenges related to climate change.

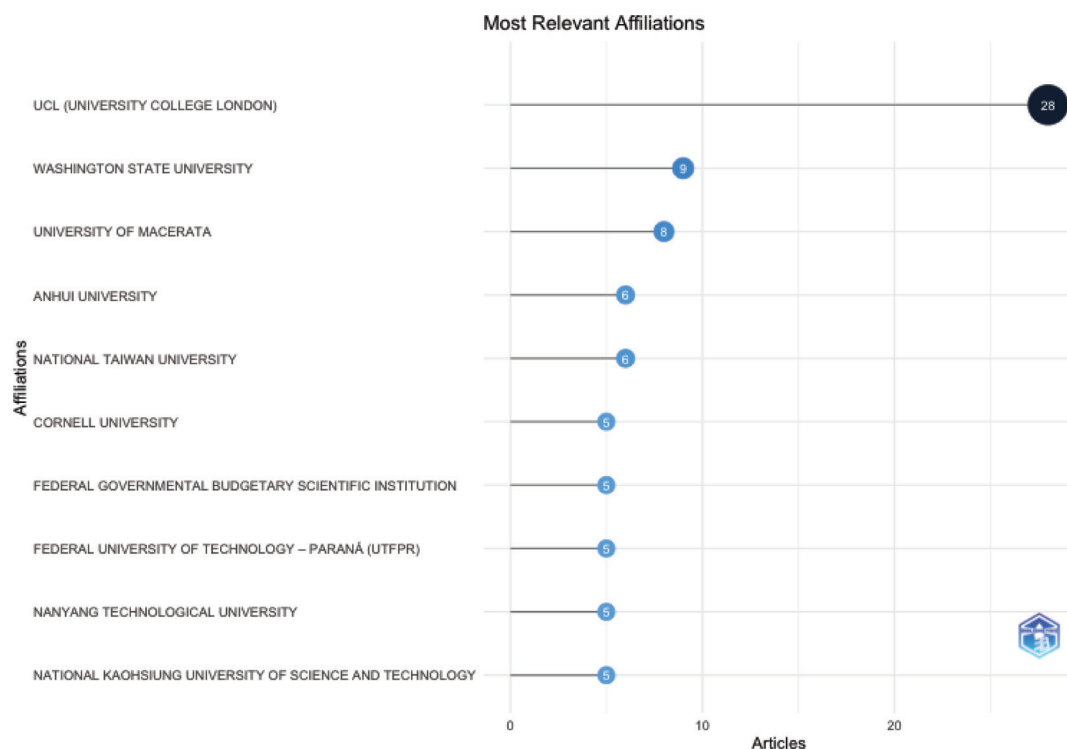
Factorial analysis in bibliometrics visualizes the relationships between terms or concepts from the articles (Figure 9). The results of the factorial analysis show that the main themes in university-industry collaboration for green innovation in climate crisis mitigation include governance and policy approaches, which are important factors in directing this collaboration. Terms such as energy efficiency, renewable energy and environmental protection also stand out, emphasizing the focus on green technologies. In addition, the theme of vocational education and technology transfer demonstrates the significant role of the education sector in supporting skills development and green innovation, with close collaboration between institutions being crucial to success.





**Figure 3.** Most Relevant Sources.

Source: *Biblioshiny Report (2024)*.



**Figure 4.** Most relevant Affiliations.

Source: *Biblioshiny Report (2024)*.

#### 4. DISCUSSION

This research analyzes the relationship between university and industry collaboration, focusing on green innovations in vocational education to address the climate

crisis. There are important points that can be highlighted in the study of green innovation hubs in vocational education to mitigate climate change's impact. Through factorial analysis, the results show that the governance

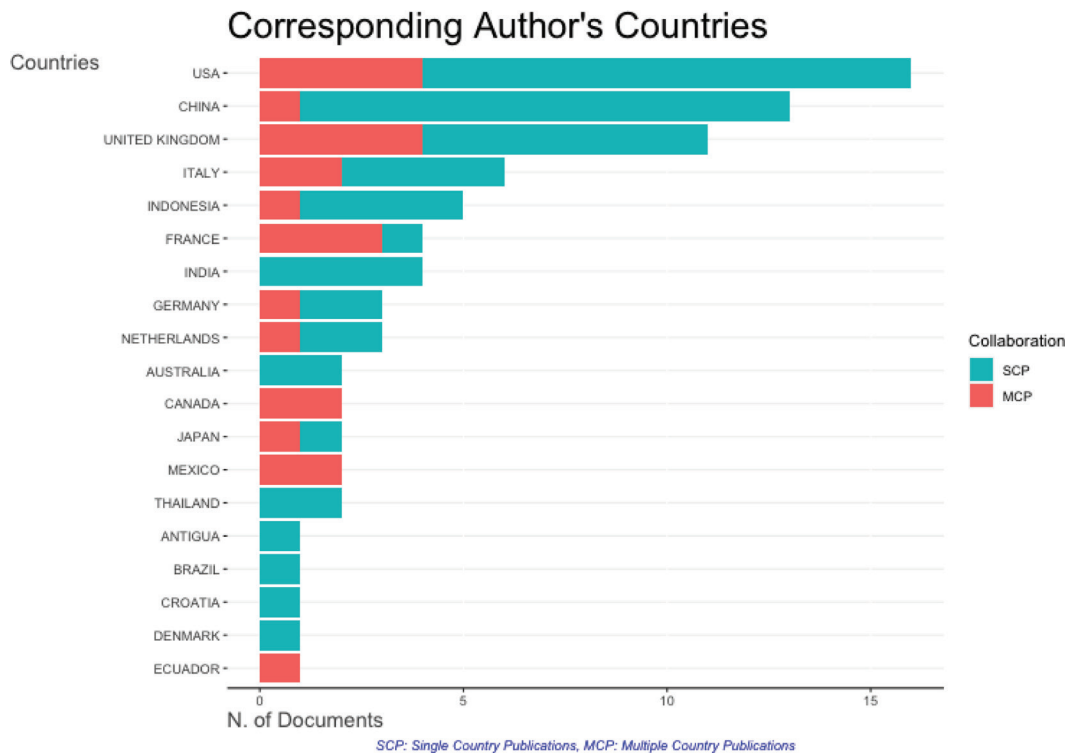


Figure 5. Countries Collaboration.

Source: Biblioshiny Report (2024).



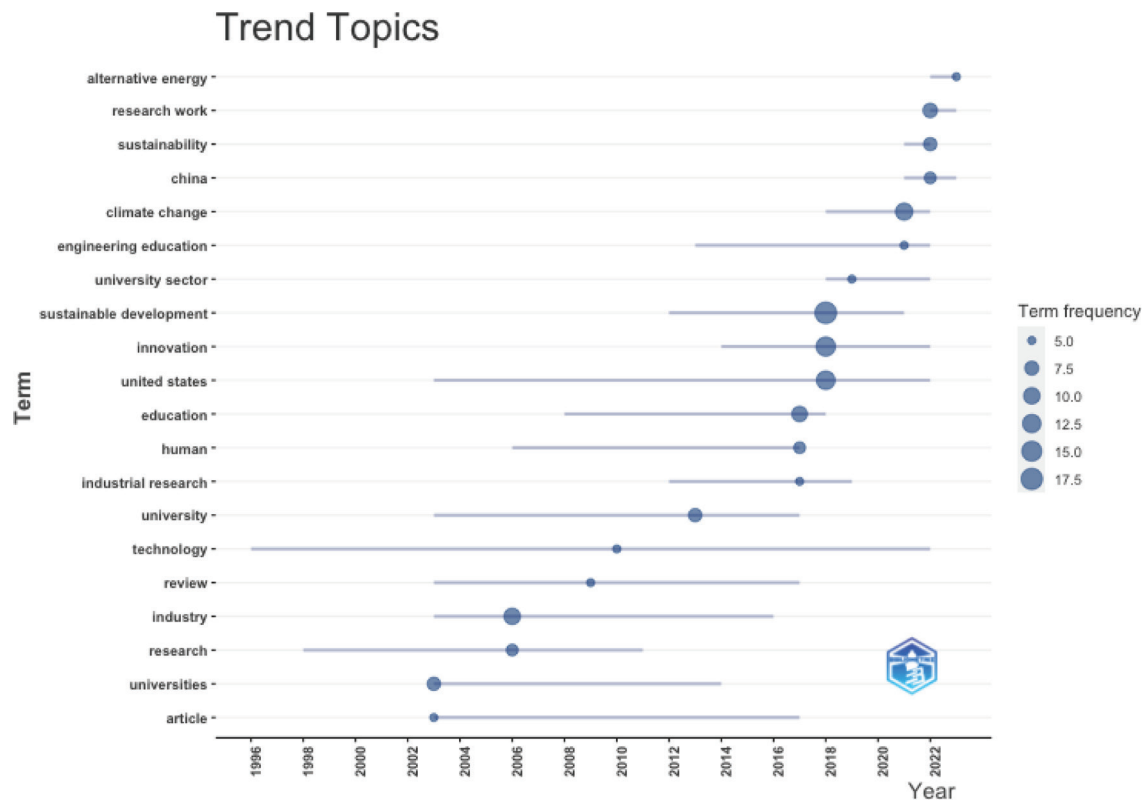
Figure 6. World Cloud.

Source: Biblioshiny Report (2024).

approach is at the top, indicating that governance aspects are an important element in university-industry collaboration focused on green innovation and climate crisis mitigation. Terms such as policy approach and university sector are also very close, indicating a strong interaction between policy, the role of academic institutions and environmental management. In addition, it is noticeable that the dominant research areas include terms such as sustainable development, energy efficiency and renewable energy. This confirms that much of the research in this area focuses on energy-related innovation and sustainability, which is an important part of efforts to mitigate the climate crisis. Other terms such as innovation, technology transfer and environmental impact were also crucial topics, demonstrating the importance of research

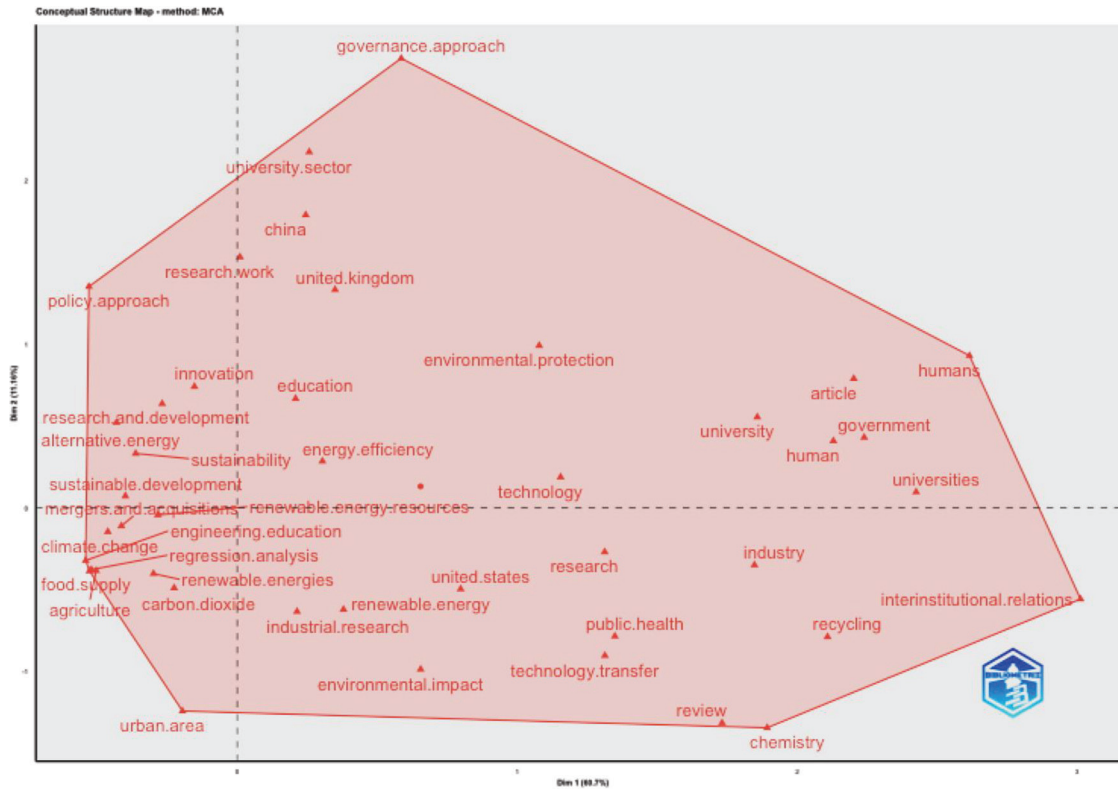
in developing new technologies and knowledge transfer from academia to industry.

Geographically, terms such as China and the United Kingdom indicate that the studies analyzed in this review involve diverse regions, with significant contributions from these countries in climate innovation. The role of universities also takes centre stage, as evidenced by the multiple occurrences of the term universities, which underscores the importance of higher education institutions in driving green innovation. Other terms such as mergers and acquisitions, policy approach, and public health indicate that research in this field also includes policy, economic, and health dimensions, reflecting the complexity of addressing climate change through a multidisciplinary approach. While the term vocational



**Figure 8.** Trend Topics.

Source: Biblioshiny Report (2024).



**Figure 9.** Factorial Analysis.

Source: Biblioshiny Report (2024).



education is not explicitly visible in this map, related terms such as engineering education suggest that research also highlights educational strategies to train future industry professionals in green technologies.

In the context of climate change mitigation, the role of vocational education is critical, especially as it directly involves the development of technical skills relevant to industry needs (Hausia Havea et al., 2020; Pavlova, 2019; Thunqvist et al., 2023) author(s). Collaboration between universities and industry in green innovation hubs for vocational education should be strategically designed to accelerate the adoption of green technologies, prepare a workforce capable of adapting to climate change, and create innovative and sustainable solutions (Amante & Fernandes, 2023) but there has been a shift in both the education and workforce settings to work closely together, coordinating initiatives across all sectors, namely higher education (HE). Vocational education prepares graduates with practical skills directly connected to industry needs. In the context of climate crisis mitigation, vocational education can focus on developing skills in renewable energy, energy efficiency, natural resource management, sustainable agriculture and other green technologies. The practical application of skills makes vocational education a vital component in supporting the shift to a green economy.

Collaboration between universities and industry to create Green Innovation Hubs in vocational education should include several key elements. First, Industry-Based Curriculum Development: Vocational education curricula should be developed based on industry needs relevant to green solutions and sustainability (Handayani et al., 2021). Industry knows the latest technologies and market needs, while universities can provide research-based training and technical skills. Curriculum development incorporating renewable energy technologies, energy efficiency techniques and innovative solutions for waste management can help produce graduates ready to enter the green sector (Ciriminna et al., 2016; Kumar et al., 2024).

Second, Collaborative Research and Technology Development: In green innovation hubs, collaborative research between universities and industry is indispensable for developing new environmentally friendly technologies (Chandran et al., 2014; Ramli et al., 2013). Universities can provide research laboratories, while industry can provide resources and real-world application trials. For example, the renewable energy industry can work with universities to develop more efficient solar panel technology or environmentally friendly waste management systems. This collaboration also allows vocational education to use the latest innovations in training.

Third, Work-Based Learning projects: Real-world projects based on climate issues, such as energy efficiency, sustainable building, or water management technologies, can be an important part of vocational education (Batchelder et al., 2023; Bohvalovs et al., 2023; Friess, 2011) and the application of appropriate strategies to reduce instantaneous and yearly energy consumption. The respective course syllabi often focus on examples applicable within the range of the regional or national climatic conditions; for example, in the UAE little time is typically spent on discussing heating equipment; the focus is on air conditioning and reduction of solar gains. In addition to climatic considerations, building energy-efficiency related coursework requires developing an understanding of what the consumption is when instantaneous energy use is integrated over the hours of the day and over the course of a year. This step is not intuitive, as, while the theoretical background is primarily developed in steady state (such as heat transmission through walls and windows, infiltration, solar gains, heating and air conditioning loads, etc.). Through partnerships with industry, vocational students can be involved in hands-on projects in the field. This helps them understand the practical application of the skills learned and prepares them to work in the green sector after graduation.

Fourth, Skills Training for Green Technology: A significant focus of vocational education in green innovation hubs is to train a workforce with green technology skills. For example, training technicians in the maintenance and installation of solar, wind, or water treatment technologies. Industry can provide input on the required skills and assist universities in designing training programs that align with the latest technological developments.

Fifth, Internships and Job Placements in Green Industries: Good collaboration between universities and industry can expand internship and work placement opportunities at companies in the renewable energy, waste management, or green infrastructure sectors. This will give vocational students hands-on experience in green industries and ensure that the skills they acquire are relevant to labour market needs. Sixth, Cross-Disciplinary Competency Development: Vocational education in green innovation hubs should also encourage the development of cross-disciplinary competencies. By involving fields of study such as engineering, agriculture, information technology and management, students can understand how green technologies and sustainability solutions can be practically applied in various industrial sectors.

Seventh, Use of Digital Technology in Vocational Education: Using digital technologies, such as virtual simulations, energy management software, or distance

learning platforms, can help vocational students learn green technologies more effectively. These technologies can also be used for remote training, allowing students from remote areas to access education relevant to green industry needs. Overall, this factorial analysis shows how various themes are interlinked in the existing literature, providing direction for policymakers, educational institutions and industry to collaborate on green innovation and vocational education to mitigate climate change.

## 5. CONCLUSION

This study aims to assess the contribution of vocational education in university-industry collaboration focused on green innovation for climate crisis mitigation by conducting a systematic and bibliometric review of 119 works of literature published in Scopus-indexed international journals from 1993 to 2024. The method used involved bibliometric analysis to identify trends, research focus and gaps in the related literature. The results showed that green innovation in vocational education is receiving increasing attention, especially about university-industry collaboration. However, the integration of vocational education in discussions on climate crisis mitigation remains under-explored. The findings indicate the need to develop vocational curricula that are more integrated with green technology and sustainability and strengthen cross-country collaboration. This research implies the importance of designing vocational education strategies that are more responsive to climate challenges through strengthening partnerships between academia and industry. The limitation of this study is the lack of in-depth empirical studies on the specific context of vocational education in developing countries. Therefore, suggestions for future research are to conduct field studies that focus more on the direct influence of vocational education on the application of green technology in the industrial sector and expand the geographical coverage to explore cross-country collaboration.

## Acknowledgements

We are very grateful to Faculty of Vocational Studies, Universitas Airlangga for their support. In addition, we would like to express our gratitude to the editors and editorial staff of JHSSR for their assistance during publication period.

## Funding

The authors received no financial support for the research.

## Declaration of Conflicting Interests

The authors declare that they have no competing interests.

## REFERENCES

- Ahmed, R. R., Akbar, W., Aijaz, M., Channar, Z. A., Ahmed, F., & Parmar, V. (2023). The role of green innovation on environmental and organizational performance: Moderation of human resource practices and management commitment. *Heliyon*, 9(1), e12679. <https://doi.org/10.1016/j.heliyon.2022.e12679>
- Amante, S., & Fernandes, R. (2023). Aligning HE Pedagogical Innovation with VET, Industry, and Research Partnerships: Insights on the Demola Portugal Initiative. *Education Sciences*, 13(1), 1–18. <https://doi.org/10.3390/educsci13010093>
- Basana, S. R., Suprpto, W., Andreani, F., & Tarigan, Z. J. H. (2022). The impact of supply chain practice on green hotel performance through internal, upstream, and downstream integration. *Uncertain Supply Chain Management*, 10(1), 169–180. <https://doi.org/10.5267/j.uscm.2021.9.010>
- Batchelder, M., Swinney, M., O'Hara, T., Goddard, A., Lewis, E., Cox, J., & Fowler, H. J. (2023). Experiences from a School–University Partnership Climate and Sustainability Education Project in England: The Value of Citizen Science and Practical STEM Approaches. *Sustainability (Switzerland)*, 15(12), 1–14. <https://doi.org/10.3390/su15129401>
- Bohvalovs, G., Kalnbajķite, A., Pakere, I., Vanaga, R., Kirsanovs, V., Lauka, D., Prodanuks, T., Laktuka, K., Dolģe, K., Zundāns, Z., Brēmane, I., Blumberga, D., & Blumberga, A. (2023). Driving Sustainable Practices in Vocational Education Infrastructure: A Case Study from Latvia. *Sustainability (Switzerland)*, 15(14), 1–16. <https://doi.org/10.3390/su151410998>
- Chandran, V. G. R., Sundram, V. P. K., & Santhidran, S. (2014). Innovation systems in Malaysia: A perspective of university-industry R&D collaboration. *AI and Society*, 29(3), 435–444. <https://doi.org/10.1007/s00146-013-0468-9>
- Ciriminna, R., Meneguzzo, F., Pecoraino, M., & Pagliaro, M. (2016). Reshaping the education of energy managers. *Energy Research and Social Science*, 21, 44–48. <https://doi.org/10.1016/j.erss.2016.06.022>
- Draft, M. (2024). Journal of Cleaner Production Green technology innovation models , environmental regulation and the willingness of government-university-industry to collaborate on green innovation. *Energy Reports*, 12(3), 2901–2912. <https://doi.org/10.1016/j.egy.2024.08.031>
- Friess, A. (2011). A sustainable buildings course for an international student population; enhancing understanding of geographic and seasonal factors through energy simulation. *SEFI Annual Conference 2011*, 1062–1067.
- Giannopoulou, E., Barlatier, P. J., & Pénin, J. (2019). Same but different? Research and technology organizations, universities and the innovation activities of firms. *Research Policy*, 48(1), 223–233. <https://doi.org/10.1016/j.respol.2018.08.008>
- Guan, J., & Zhao, Q. (2013). The impact of university-industry collaboration networks on innovation in nanobiopharmaceuticals. *Technological Forecasting and Social Change*, 80(7), 1271–1286. <https://doi.org/10.1016/j.techfore.2012.11.013>
- Handayani, M. N., Kamis, A., Ali, M., Wahyudin, D., & Mukhidin, M. (2021). Development of green skills module for meat processing technology study. *Journal*

- of *Food Science Education*, 20(4), 189–196. <https://doi.org/10.1111/1541-4329.12231>
- Hausia Havea, P., Siga, A., Rabuatoka, T., Tagivetaua Tamani, A., Devi, P., Senikula, R., Hemstock, S. L., & Jacot des Combes, H. (2020). Using vocational education to support development solutions in the Pacific: An emphasis on climate change and health. *Applied Environmental Education and Communication*, 19(2), 171–186. <https://doi.org/10.1080/1533015X.2019.1569571>
- Kaliappan, A., & Hamid, H. (2021). Green technology: A must or a need in tvet education in Malaysia? *Journal of Technical Education and Training*, 13(1), 86–96. <https://doi.org/10.30880/jtet.2021.13.01.009>
- Kumar, B., Voith, K., Sándor, K., Szamosi, Z., & Rosas-Casals, M. (2024). Educational paradigm shift: assessing the prospects of a master's course in green energy transition. *Discover Sustainability*, 5(1). <https://doi.org/10.1007/s43621-024-00458-1>
- Li, T., & Zhou, X. (2022). Research on the Mechanism of Government–Industry– University–Institute Collaborative Innovation in Green Technology Based on Game–Based Cellular Automata. *International Journal of Environmental Research and Public Health*, 19(5). <https://doi.org/10.3390/ijerph19053046>
- Pavlova, M. (2019). Emerging environmental industries: impact on required skills and TVET systems. *International Journal of Training Research*, 17(sup1), 144–158. <https://doi.org/10.1080/14480220.2019.1639276>
- Ramli, F., Lim, W. Y., & Senin, A. A. (2013). Proposing a conceptual framework on factors to develop successful university industry R&D collaboration in Malaysia. *Jurnal Teknologi (Sciences and Engineering)*, 64(2), 13–19. <https://doi.org/10.11113/jt.v64.2213>
- Thunqvist, D. P., Gustavsson, M., & Lundkvist, A. H. (2023). The Role of VET in a Green Transition of Industry: A Literature Review. *International Journal for Research in Vocational Education and Training (IJRVET)*, 10(3), 361–382. <https://doi.org/10.25656/01>

## Biographical Statement of Author(s)

### Prof. Dr. Tika Widiastuti,

**SE., M.Si.** is a professor in Islamic Social Finance and Economics at Universitas Airlangga, Indonesia. She serves as Vice Dean of the Faculty of Vocational Studies and is also a senior lecturer at the Faculty of Economics and Business. Her research interests cover Islamic social finance, zakat governance, and sustainable development. Prof. Tika has published extensively in national and international journals on topics such as zakat, waqf, Islamic finance, and social empowerment. She actively contributes to research on the integration of Islamic economics and community development.



### Prof. Dr. Tika Widiastuti, SE., M.Si.

Faculty of Vocational Studies  
Universitas Airlangga, Surabaya  
Indonesia

**Email:** [tika.widiastuti@feb.unair.ac.id](mailto:tika.widiastuti@feb.unair.ac.id)

### Prof. Dr. Anwar Ma'ruf,

**M.Kes., drh** is a professor of Veterinary and Basic Medicine and currently serves as the Dean of the Faculty of Vocational Studies at Universitas Airlangga, Indonesia. His research focuses on growth hormones, IGF-1, and protein signaling for improving livestock quality. He is also involved in academic leadership as a reviewer and journal editor, and has contributed to various national and international research collaborations.



Prof. Anwar remains active in advancing higher education governance and vocational-based research.

### Prof. Dr. Anwar Ma'ruf, M.Kes., drh

Faculty of Vocational Studies  
Universitas Airlangga, Surabaya  
Indonesia

**Email:** [anwarmaruf@fkh.unair.ac.id](mailto:anwarmaruf@fkh.unair.ac.id)

### Prof. Dr. Eighty Mardiyani

**Kurniawati, dr., Sp.OG-K** is a professor of Obstetrics and Gynaecology at the Faculty of Medicine, Universitas Airlangga, Indonesia. Her research focuses on women's reproductive health, including cervical cancer, uterine prolapse, and maternal health. She has published extensively on gynaecology, women's health, and urogynaecology, contributing to national and international journals.



Prof. Eighty is actively engaged in clinical practice and academic research related to obstetrics and gynaecology.

### Prof. Dr. Eighty Mardiyani Kurniawati, dr., Sp.OG-K

Faculty of Medicine  
Universitas Airlangga, Surabaya  
Indonesia

**Email:** [eighty-m-k@fk.unair.ac.id](mailto:eighty-m-k@fk.unair.ac.id)

### Novianto Edi Suharno, SST.

**Par., M.Si.** is a senior lecturer at the Faculty of Vocational Studies, Universitas Airlangga, Indonesia. His academic focus lies in tourism development, community-based tourism, and creative industries. His research explores sustainable tourism, agrotourism, and tourism management innovations.



Novianto has been involved in various government and community projects related to tourism development, policy, and planning.

He has also authored several books and holds multiple copyrights related to tourism and vocational education systems.

### Novianto Edi Suharno, SST. Par., M.Si.

Faculty of Vocational Studies  
Universitas Airlangga, Surabaya  
Indonesia

**Email:** [novianto-edi@vokasi.unair.ac.id](mailto:novianto-edi@vokasi.unair.ac.id)

**Riska Nur Rosyidiana, S.E., M.Ak., CRA., CPMA., CAPF., AWP** is a doctoral candidate in Accounting at Universitas Airlangga, Surabaya, Indonesia, and a lecturer in the Business Department, Faculty of Vocational Studies at the same university. Her teaching and research interests include Financial Accounting, Management Accounting, and Sustainability, with a particular focus on Micro, Small, and Medium Enterprises (MSMEs).



Her research explores a range of topics, including the quality of financial reporting, the adoption of financial technologies such as XBRL and blockchain, and the effects of digitalization on the sustainability performance of MSMEs. She has published extensively in academic journals and is the author of educational materials for which she holds several Intellectual Property Rights (IPRs).

Riska also holds multiple professional certifications, including Certified Risk Associate (CRA), Certified Professional Management Accountant (CPMA), Certified Analyst in Project Finance (CAPF), and Associate Wealth Planner (AWP).

**Riska Nur Rosyidiana, S.E., M.Ak., CRA., CPMA., CAPF., AWP**  
Faculty of Vocational Studies  
Universitas Airlangga, Surabaya  
Indonesia

**Email:** [riska.rosyidiana@vokasi.unair.ac.id](mailto:riska.rosyidiana@vokasi.unair.ac.id)



**Open Access:** This article is published under the CC BY 4.0 (Creative Commons Attribution 4.0 International) license which enables re-users to distribute, remix, adapt, and build upon the material in any medium or format, so long as attribution is given to the creator. The license allows for commercial use.

CC BY includes the following elements:



BY: credit must be given to the creator.

To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.